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Business Case for Integrated Technical Information for the Air Logistics Centers (ITI-ALC)

Ron Kelly
Ken Evers
David Kennedy

Systems Research and Applications Corporation
4031 Colonel Glenn Highway, Suite 100
Beavercreek, OH 45431

Cheryl L. Batchelor
Air Force Research Laboratory

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Human Effectiveness Directorate
Deployment and Sustainment Division
Logistics Readiness Branch
2698 G Street
Wright-Patterson AFB OH 45433-7604

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FOR THE COMMANDER

Mark M. Hoffman

MARK M. HOFFMAN
Deputy Chief
Deployment and Sustainment Division
Air Force Research Laboratory

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The objective of the Integrated Technical Information for the Air Logistics Centers (ITI-ALC) program was to improve the efficiency and effectiveness of the Air Force's depot maintenance process, with specific emphasis on Programmed Depot Maintenance (PDM) operations and with a limited look at component repair. The Business Case presents proposed process improvements for reducing operating expense, improving mechanic performance, and reducing the number of flow days for organic aircraft depot maintenance. This Business Case summarizes the approach the ITI-ALC team used to describe and analyze the organic aircraft PDM process in the Air Force Materiel Command (AFMC). The Business Case identifies the objectives of the process. This document includes the cost of doing business in the organic aircraft PDM process as it currently exists at Sacramento Air Logistics Center (SM-ALC) and Warner-Robins Air Logistics Center (WR-ALC), as well as the expected cost of implementing the proposed process improvements. This provides a view of a potential privatization and organic depot.

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PREFACE

...There always comes a moment in time when a door opens and lets the future in. For more than four decades the Defense Department has built its strategy and programs on dealing with the cold war. The ending of the cold war has opened a door, and the future is waiting to come in. By our actions, and by the new strategies we develop, we can shape the future, instead of being shaped by it.

Secretary of Defense William Perry

The purpose of the ITI-ALC system is to improve the efficiency and effectiveness of programmed depot maintenance operations by developing technology and reengineered processes that improve, standardize, integrate, and easily access information. The fully developed ITI-ALC system will integrate many independent sources of information such as engineering drawings, manufacturing specifications, technical orders, and dynamic diagnostics, to provide the depot mechanic with a single source of maintenance information. ITI-ALC will reduce operating costs, improve mechanic performance, reduce the number of flow days for organic aircraft depot maintenance, and increase throughput.

During the first phase of the ITI-ALC program, ITI-ALC team members visited the Air Logistics Centers to support the data collection and validation process. The team would like to express its appreciation for the invaluable contributions and support received from the personnel of the following organizations:

- Headquarters, Air Force Materiel Command
- USAF Occupational Measurement Squadron
- Ogden Air Logistics Center (OO-ALC)
- Oklahoma Air Logistics Center (OC-ALC)
- Sacramento Air Logistics Center (SM-ALC)
- San Antonio Air Logistics Center (SA-ALC)
- Warner-Robins Air Logistics Center (WR-ALC)

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1. *INTRODUCTION*

This is the Business Case for the Integrated Technical Information for the Air Logistics Centers (ITI-ALC) project. This report was developed under contract F41624-94-C-5021 in accordance with Contract Data Requirements List (CDRL) sequence number A002. The work is sponsored by Armstrong Laboratory/Logistics Research Division, Operational Logistics Branch (AL/HRGO) at Wright-Patterson Air Force Base (WPAFB), OH, and is accomplished by Systems Research and Applications (SRA) Corporation and ARINC Research Corporation. This report was developed under the leadership of Ms. Barbara Masquelier, AL/HRGO Program Manager, and Mr. Ron Kelly, SRA Corporation Principal Investigator for the ITI-ALC program.

1.1 PURPOSE OF THE BUSINESS CASE

The Business Case presents proposed process improvements for reducing operating expense, improving mechanic performance, and reducing the number of flow days for organic aircraft depot maintenance. This Business Case summarizes the approach the ITI-ALC team used to describe and analyze the organic aircraft Programmed Depot Maintenance (PDM) process in the Air Force Materiel Command (AFMC). The Business Case identifies the objectives of the process. This document includes the cost of doing business in the organic aircraft PDM process as it currently exists at Sacramento Air Logistics Center (SM-ALC) and Warner-Robins Air Logistics Center (WR-ALC), as well as the expected cost of implementing the proposed process improvements. This provides a view of a potential privitization and organic depot.

1.2 DOCUMENT ORGANIZATION

This document is organized as follows:

Section 1, "Introduction," describes the purpose of the Business Case, its' background and significance, and the approach to system requirements determination, system engineering, and business case development.

Section 2, "The Current PDM Process," describes the current PDM process, depot maintenance process and project objectives and measures, the output and cost of PDM, and the operating expense baseline.

Section 3, "PDM Process Improvements and Proposals," describes and estimates the benefits of process improvements and proposals based on engineering assessments and simulations.

Section 4, "Data and System Cost Analysis," provides estimates of the costs associated with the proposals including training, software, hardware, installation, maintenance, data conversion, and interfaces to external systems at SM-ALC and WR-ALC.

Section 5, "Conclusions," compares the benefits and costs of each proposal, and suggests the best proposal for SM-ALC and WR-ALC.

1.3 BACKGROUND

Depot maintenance is responsible for scheduled and unscheduled maintenance of aircraft, other aerospace vehicles, and associated systems and components such as engines and landing gears. An effective depot maintenance process provides the using organizations with sufficient quantities of aircraft and serviceable items to train aircrews in peacetime and to fly missions in the event of war. Many aircraft and aircraft components are mature and those that remain in service require additional maintenance. Maintaining increased reliability is constrained by decreasing budgets for new systems, spares, and mechanic training. Finding more effective ways to accomplish the depot maintenance process is more challenging today than ever before.

Many projects have improved the information available within and between maintenance organizations through advances in information technology. Other projects have improved tools and maintenance aids for mechanics. However, until now, no attempt has been made to integrate the available information, tools, and aids for the depot mechanic. The ITI-ALC system focuses on the mechanic's needs as the most important aspect of this integration process. The value of ITI-ALC and its' acceptance by the user is linked to the program's effectiveness in achieving measurable performance improvements at the mechanic level. This viewpoint is the foundation for the systematic approach used by the ITI-ALC team to achieve the ITI-ALC program objectives.

1.4 APPROACH

This section summarizes the major steps in the iterative approach the ITI-ALC team used to accomplish the project. The project approach included requirements determination, system engineering, and business case development. Figure 1-1 illustrates that approach. More details are included in the *ITI-ALC Architecture Report* (SRA, June 1995). The methodologies employed were consistent with the Department of Defense's (DoD) *Framework for Managing Process Improvement* as directed in DOD 8020.1-M, *Functional Process Improvement.* The economic analysis components of the approach followed the direction in the DoD Corporate Information Management (CIM) *Functional Economic Analysis Guidebook* (January 1993) and the requirements from the Office of Assistant Secretary of Defense's (OSD) *Guide for Developing AIS Cost and Operational Effectiveness Analyses* (OSD, June 1994).

1.4.1 Data Collection and Modeling

During the data collection effort, the ITI-ALC team reviewed the AFMC and depot maintenance mission, objectives, and strategy. Pertinent Air Force, AFMC, and DoD planning documents were reviewed and interviews conducted at each of the five Air Logistics Centers (ALCs) to identify function and information relationships. During data collection at the select sites, SM-ALC and WR-ALC, (refer to Section 1.4.2), manpower and cost information was obtained through the financial management and production directorates. Using data about functions and information relationships, the team constructed the following models of the organic aircraft PDM:

- $IDEF_0$ - model of the current activities called the ITI-ALC "AS-IS" Functional Model.

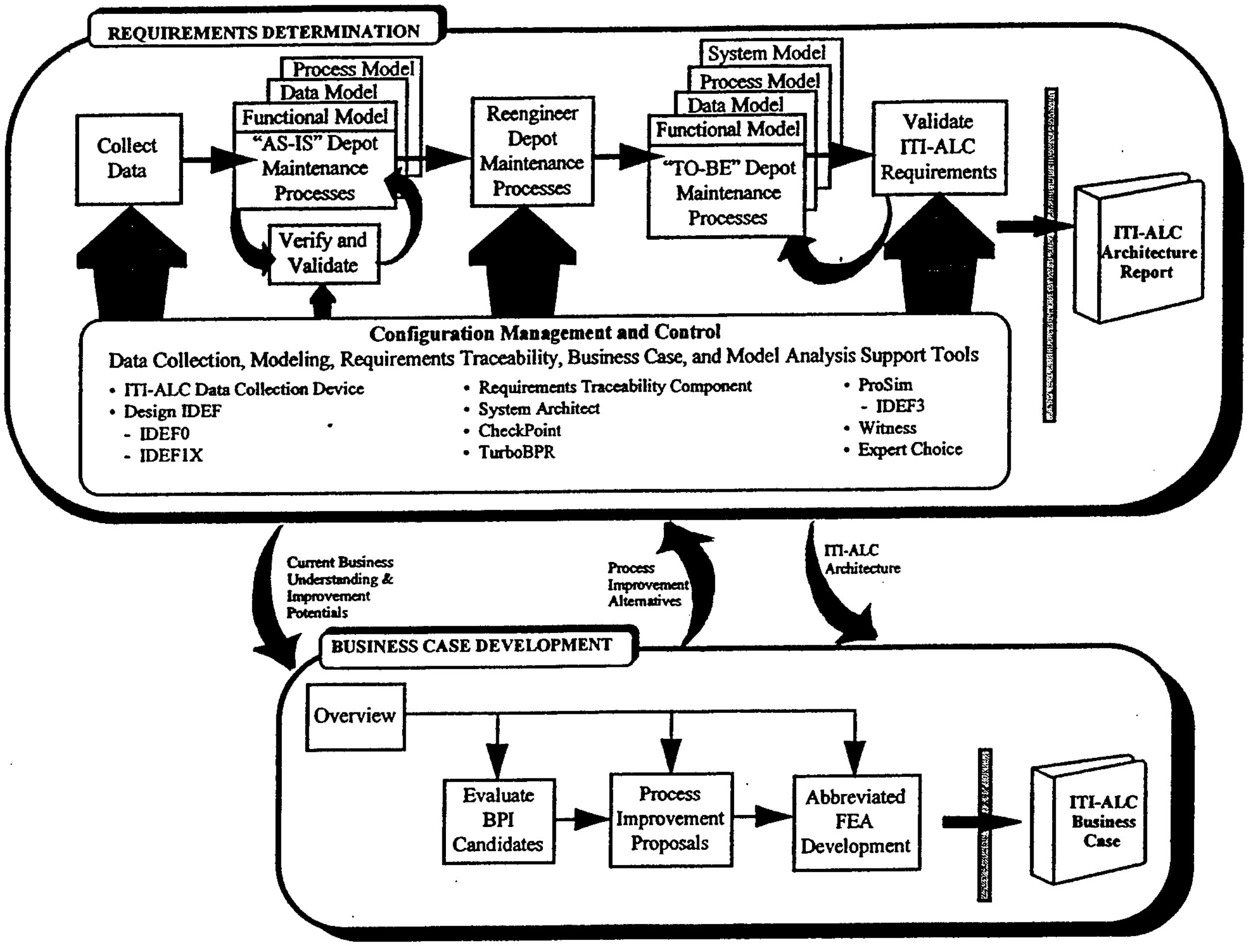


Figure 1-1. ITI-ALC Approach to Business Case Development

- $IDEF_{1X}$ - logical model of the current data and relationships called the ITI-ALC "AS-IS" Data Model.
- $IDEF_3$ - sequenced model of the current activities called the ITI-ALC "AS-IS" Process Model.

These models represent the activities, information, and other resources currently used in the ALCs today and were validated by ALC and AL/HRGO representatives. The team then associated resource consumption with each activity in the "AS-IS" Functional Model resulting in an activity-based cost functional model to the lowest level.

1.4.2 Site Selection

During the data collection and modeling efforts, two select sites (ALCs) were proposed on which to base this business case and at which to demonstrate an ITI-ALC system. The evaluation technique and set of criteria used to select the sites are described in Appendix A. With agreement from AL/HRGO, SM-ALC and WR-ALC were chosen as the select sites.

1.4.3 Engineering Assessments

The next step in the analysis of the depot maintenance processes represented in the static models was to perform engineering assessments. During these engineering assessments, the ITI-ALC team applied expert judgment to the processes and information relationships to identify potentials for improvement. The depot maintenance processes were analyzed using the following techniques:

- Focusing on activities with the greatest resource consumption.
- Identifying unnecessary administrative tasks, approvals, and paperwork for removal.
- Identifying identical activities performed at different parts of the process.
- Evaluating every activity in the process to determine its contribution to meeting combat command requirements.
- Reducing the complexity of the process, including organizational communication.
- Identifying ways to compress cycle time to meet or exceed customer expectations and minimize material storage costs.
- Identifying ways to facilitate the performance of activities.
- Identifying ways to more effectively use capital equipment and the working environment.
- Identifying single ways to perform an activity so all employees always do the activity the same way.
- Identifying areas where the quality of inputs can be leveraged to improve the quality of the outputs.
- Applying tools, equipment, and computers to routine activities to free up employees to accomplish more creative activities.

In addition, the team did the following:

- Applied lessons learned from reports of previous and ongoing process improvement activities in the DoD and other federal government agencies (refer to Appendix B for summaries of these reports).
- Collected and recorded process improvement recommendations from mechanics and other ALC personnel.
- Applied best practices that were identified during visits to commercial organizations that have similar maintenance activities.
- Performed benefit/cost analysis with business case analysts, functional experts and information engineers.

1.4.4 Simulations

The results of the data collection, modeling efforts and engineering assessments were tested using a dynamic simulation technique. The models provided the framework for the simulation (see Figure 1-2). The simulations used performance data collected from the ALCs. The modeling tool, PROSIM™, and a simulation product, WITNESS®, were used to support the discrete event simulation objectives. Using these tools, timing constraints and resources for depot maintenance operations were defined. Characteristics of the individual processes were defined with a number of probability distributions appropriate to the depot maintenance environment. The conditional behavior of the system was studied to assess the flow rates, bottlenecks, idle time, throughput, cycle times, workload, and other dynamic properties. Recognizing the potential incompleteness of collected data, simulation supported what-if analyses to define performance boundaries. Potential business process improvements were simulated first, then slices of major process improvements were grouped into proposals. The result was a series of process improvement recommendations, which are summarized in Section 3 and detailed in Appendix C. Using these recommendations, the ITI-ALC team developed proposals to structure viable approaches for achieving the objectives.

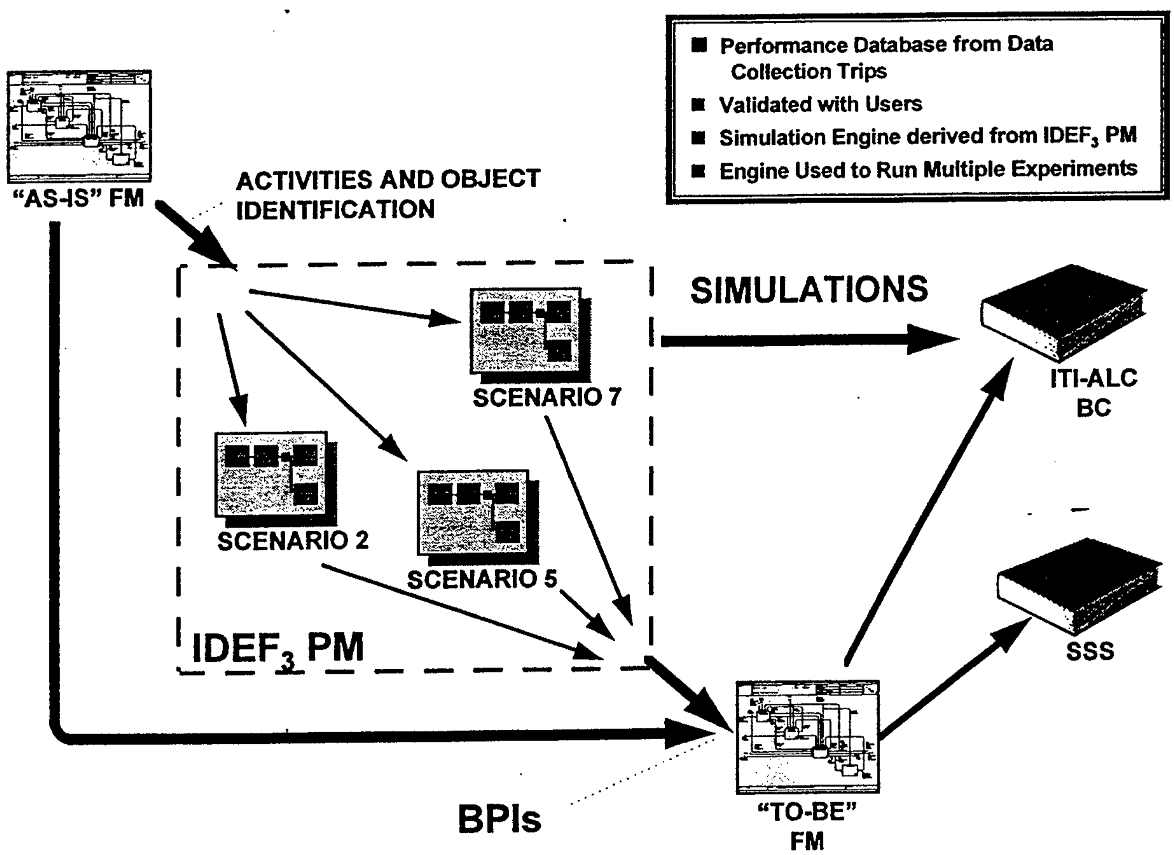


Figure 1-2. Process Model (IDEF$_3$) Support of ITI-ALC

Throughout the iterative process, groupings of process improvements were tested using SRA's TurboBPR2 (functional economic analysis modeling tools).

1.4.5 The Link to the ITI-ALC "TO-BE" FM and SSS

Information extracted from the engineering assessments, process modeling efforts, and simulations was used to develop the ITI-ALC "TO-BE" Functional Model. In turn, the ITI-ALC "TO BE" Functional Model (FM) supported the ITI-ALC system requirements documented in the *ITI-ALC System/Segment Specification* (SSS) (SRA, October 1995) and the business reengineering concepts described in this Business Case.

1.5 GROUND RULES AND ASSUMPTIONS

Certain ground rules and assumptions were made when creating this Business Case. They are identified below to provide context for the following sections. Appendices A, B, D, F, G, H, I, and J contain more detailed information about these assumptions.

1.5.1 General

1. The required level of detail and accuracy is a rough order of magnitude estimate of the cost elements. The estimate is to be used to assess the proposed alternatives to the "AS-IS" process, data, and system baselines and to select a preferred alternative for more detailed functional, technical, and economic analyses.

2. AFMC objectives, as reflected in documents reviewed for this business case reflect the Air Force vision and the critical requirements of AFMC customers.

1.5.2 Financial

1. The base year for workload and resource consumption is Fiscal Year 1994 (FY94).

2. The period of the analysis is FY95 through FY04 (over a 10 year period).

3. All dollar amounts are in FY94 dollars.

4. The cost finding techniques described in the DoD Accounting Manual, DoD 7220.9-M, Chapter 74, support this project.

5. Inflation indices were applied in accordance with Air Force Instruction 65-503 dated 3 February 1995.

6. For estimating purposes, AFMC civilian standard pay rates are reflected in Air Force Instruction 65-503, Appendix A28-1.

7. The cost of production for labor repair group categories A and B represents the cost of the organic aircraft PDMs performed during the year. These repair group categories are reflected in the AFMC repair group categories profit and loss statements for FY94 for SM-ALC and WR-ALC.

1.5.3 Business Process Improvements and Proposals

1. Each business process improvement has merit on its own, but full benefit is derived only from implementing the process improvement packages as proposed in Section 3.

2. AFMC will put in place the policy changes recommended in the process improvements. All policy changes will be in effect before the first installation of the ITI-ALC system.

3. Personnel who will use the ITI-ALC system will be trained.

4. Installation of the ITI-ALC system includes running parallel systems processing during 1998 and 1999.

1.5.4 Workload

1. Aircraft modification programs at SM-ALC and WR-ALC are considered part of PDM.

2. The scope of this Business Case is limited to the activities (nodes) identified in the ITI-ALC "AS-IS" Functional Model, except where specifically stated in order not to exclude significant alternatives. The Repair/Manufacture Components activity (A4), was represented in the ITI-ALC "AS-IS" Functional Model to foster process integration in the development of the "TO-BE", but did not consume PDM resources.

3. Workload projections for organic aircraft PDM obtained from SM-ALC and WR-ALC are the most reasonable estimates of future efforts to be performed at the two sites.

4. Dynamic characteristics used to support the simulations and obtained from the ALCs are the most reasonable estimates for actual completion times for the high-level activities depicted in the ITI-ALC "AS-IS" Functional Model.

5. The number of organic aircraft PDMs produced during a fiscal year is a reasonable representation of the effort performed by the ITI-ALC "AS-IS" Functional Model.

6. The relationship between the number of units produced and the cost of production units during FY94 will continue into the future, given that the workload estimate and the work process do not change.

1.5.5 Cost Estimation

1. The cost of Electronic Technical Manual (ETM) and legacy data conversion will be similar to the cost of preparing data for the Depot Maintenance Standard System (DMSS).

2. When ITI-ALC becomes operational, the Materiel Management Standard System (MMSS) will be in place and have converted paper technical manuals into IETM technical information.

3. Emerging information standard systems and legacy information systems will not significantly affect the cost of the activities in the ITI-ALC "AS-IS" Functional Model.

4. The cost of all communications hardware and software for the ITI-ALC connection to the Integrated Maintenance Data System (IMDS) will be absorbed by the IMDS program except for the ITI-ALC side of the connection, which is included in the development estimate for ITI-ALC.

5. The cost to interface with many of the DMSS components was derived from work done by SRA on the Spare Parts Production and Reproduction (SPARES) program (contract # F33615-90-C-5000). Although the Application Programming Interface (API) product highlighted in the ITI-ALC interface estimate may not be the same as on the SPARES program, it is assumed that a similar library can be found for each specific system.

6. Due to its proprietary nature, interfacing with the Depot Maintenance Management Information System (DMMIS) will be more costly than interfacing with other components of DMSS (based on discussions with individuals at the Joint Logistics Systems Center [JLSC] who are currently modifying DMMIS).

7. The costs associated with ITI-ALC Phase I and II research are not included in this Business Case.

8. Costs to interface ITI-ALC to the Automated Parts Distribution Systems (APDS) will be absorbed by the owning organization of the APDS. There will be no additional cost associated with changing any of the APDS systems so they can interface with ITI-ALC, except for the cost of connecting APDS to the ITI-ALC wireless network.

9. Costs to interface support equipment and tools to ITI-ALC will be absorbed by the organizations developing the support equipment and tools.

10. Costs to interface parts and reparables to ITI-ALC will be absorbed by the managing organization of the parts and reparables.

11. Costs to interface aircraft systems to ITI-ALC will be absorbed by the developing organization of the aircraft.

12. TurboBPR2 is the software used to depict the baseline, alternatives, risks, sensitivities, and cost elements. Refer to Appendix D for more information on TurboBPR2.

1.5.6 Software

1. Requirements from the ITI-ALC SSS and the design from the *ITI-ALC System/Segment Design Document* (SSDD) (SRA, February 1996) were used to derive the cost of the ITI-ALC system.

2. The Technical Architecture Framework for Information Management (TAFIM), the DoD target information management structure, is the specified infrastructure for the ITI-ALC system.

3. The ITI-ALC system will be based on a client/server architecture.

4. DoD standard systems will be operational before the first installation of the ITI-ALC system. This assumption does not include any demonstration system that may be installed as part of the ITI-ALC Phase II effort.

5. Function point analysis (Appendix I) is an acceptable technique for estimating software development.

6. For software estimation analysis, the ITI-ALC system was classified in the following manner (refer to Appendix I):
   - Nature: New Program Development.
   - Scope: Major System.
   - Class: External - Government Contract.
   - Type: Hybrid - 70% Interactive Database Application, 30% Scientific/Mathematical.
   - Complexity: 9.
   - System software uses a programming language level of 4.5 (Ada).
   - The software development process used in the estimate was MIL-STD-2167A.
   - The project team profile used in the estimate was equivalent to SEI level 3.

1.5.7 Hardware

1. Hardware unit costs were derived from best-of-market rough orders of magnitude estimates adjusted for time. The capabilities of the hardware item will increase but the cost of the item will be similar to today's costs.

2. Hardware costs were based on volume discounts.

3. Equipment will be purchased, not leased. All user PCs and similar equipment will be replaced every six years.

4. The hardware items used in this cost analysis will not necessarily be the specific hardware used for the ITI-ALC system. Examples are for illustration in this Business Case.

5. A combination of Non-Developmental Items (NDIs), modified NDIs, and specialized items will be used to construct the ITI-ALC system. NDIs will be obtained from both government and Commercial-Off-The-Shelf (COTS) sources. COTS items will be used wherever possible.

1.5.8 Simulations

1. Dynamic simulations will be used to conduct what-if analyses to determine the effects changes are likely to have.

2. The simulations explore the effects of process improvements, specifically in the activities associated with the following:
   - Acquiring parts.
   - Using technical data.
   - Developing enhancements to maintenance plans.

3. The simulations explore the effects of the improvement proposals on the maintenance process.

4. Using simulations provides a test of the engineering assessment and helps define a range of benefit possibilities.

5. The simulations used performance data collected from the ALCs and validated by functional experts and potential ITI-ALC system users.

6. Three types of data were used in the simulations:
   - Duration time to complete a process.
   - Frequency of occurrence of a process or product.
   - Delay or response time for specific exceptions.

2. THE CURRENT PDM PROCESS

This section discusses the following:

- An overview of the current PDM process.
- Objectives, measures, and targets.
- Output and costs of PDM for SM-ALC and WR-ALC.
- Operating expense and flow day baseline for SM-ALC and WR-ALC.

2.1 DEPOT MAINTENANCE IN CONTEXT

Approximately $12 billion per year is spent on depot maintenance, which makes it a significant business process within the DoD. Each year, maintenance is performed on thousands of items such as aircraft, ships, tanks, circuit boards, trucks, and ground power units to name only a few. Organic aircraft PDM is only one of the requirements of depot maintenance. In this Business Case, PDM is defined as the traditional view of visits to the depot maintenance facility based on time or cycles, as well as major modification programs accomplished during depot visits, analytical condition inspections, and major time- or condition-phased aircraft inspections.

Maintenance performed organically and by contractors is shown in Figure 2-1. Virtually all organic maintenance is performed at one of the five ALCs. Many types of aircraft are in various stages of work during each day of the year. By way of illustration, during the period March 1994 through February 1995, AFMC produced 641 aircraft that had undergone the organic PDM or modification process. Table 2-1 includes the quantities and flow days for each Mission Design Series (MDS).

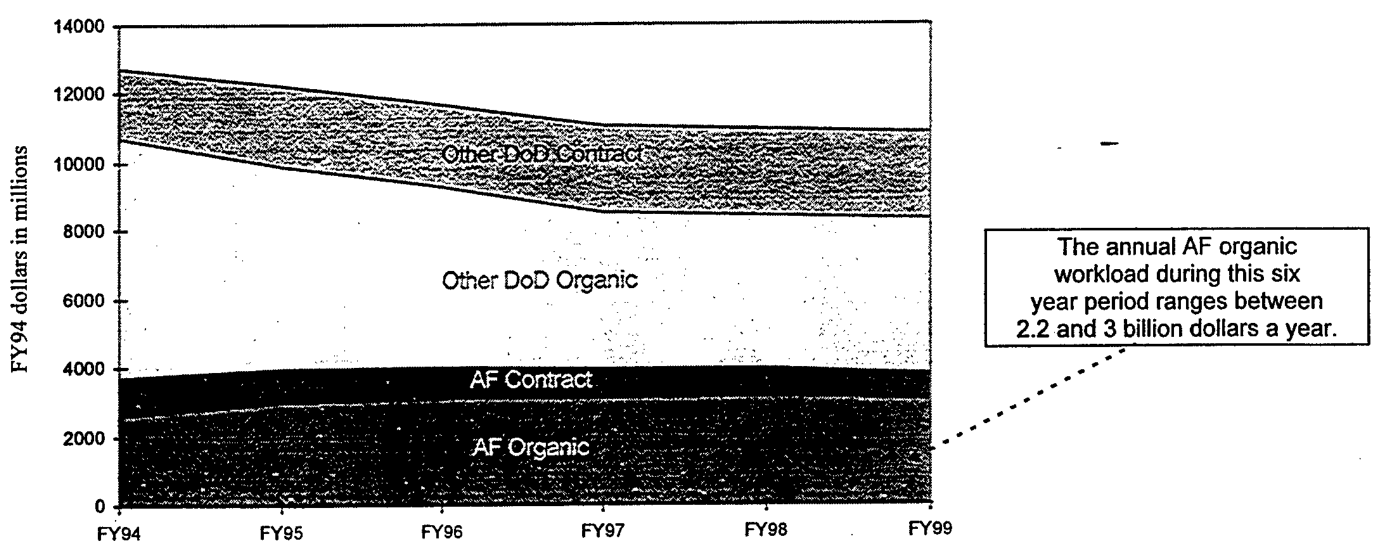


Figure 2-1. Estimate of Depot Maintenance Organic and Contract Budgets[1]

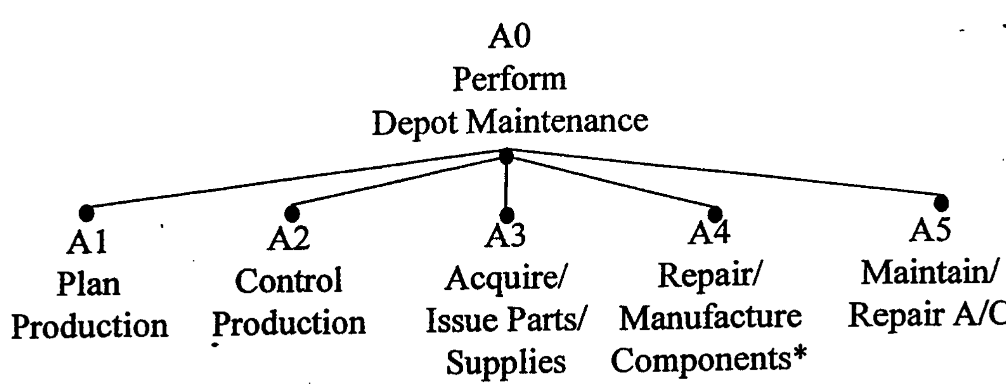
[1]O&M inflation conversion factor for FY95, 1.051; FY96, 1.083; FY97, 1.115; FY98, 1.148; FY99, 1.183; FY00, 1.218; FY01, 1.255; FY02, 1.293; FY03, 1.331.

Table 2-1. AFMC Aircraft Production March 1994 through February 1995

		Reported Flow Days per Aircraft	
MDS	**Aircraft Produced**	**Scheduled**	**Actual**
A-10	42	71	70
B-1	21	146	139
B-52	20	155	154
F-15 (SM)	23	123	124
F-15 (WR)	73	106	104
F-16	188	110	108
F-18	35	138	215
F-111	33	287	283
E-3	11	145	145
C-5A	10	246	298
C-5B	9	145	147
C-130 (OO)	46	133	130
C-130 (WR)	17	171	176
KC-135 (SM)	20	243	265
C-135 (OC)	43	218	218
C-141	50	195	232
TOTAL	**641**		

2.2 CURRENT ORGANIC AIRCRAFT PDM

This Business Case uses the current organic aircraft PDM process as the foundation on which to build process improvements. The current PDM process is described in the following paragraphs and in the ITI-ALC "AS-IS" Functional Model. Figure 2-2 is the top-level activity hierarchy from the "AS-IS" Functional Model, and provides an overview of the current PDM process. Refer to Appendix E for a complete list of applicable activities from the "AS-IS" Functional Model, as well as the results of the data collection efforts that yielded information about the activities.



*The ITI-ALC "AS-IS" Functional Model does not emphasize component repair.

Figure 2-2. Top Level Activity Hierarchy

In the Plan Production activity (A1), the plans are developed for the items to be maintained. This activity defines aspects of the work to be performed including expected resource and material requirements and flow days (number of days an aircraft is in maintenance at the depot), but does not include specific dates when the work will be done.

Control Production (A2), activities are accomplished to ensure the depot is capable of performing the maintenance so items are completed on time. A detailed schedule is also developed based on the work plan. Parts requests are created, the schedule is implemented, and the work and resources are managed to complete the planned work on time.

For Acquire/Issue Parts and Supplies (A3), personnel provide material projections to the material support center and obtain parts and supplies status.

Repair/Manufacture Components (A4), was represented in the ITI-ALC "AS-IS" Functional Model to foster process integration in the development of the "TO-BE", but did not consume PDM resources.

The final activity, Maintain/Repair Aircraft (A5), involves work plan operations that range from individual aircraft induction through maintenance, flight test, and production of a serviceable aircraft (see Figure 2-3). This activity uses most of the dollars, labor, and materials spent on organic aircraft PDM.

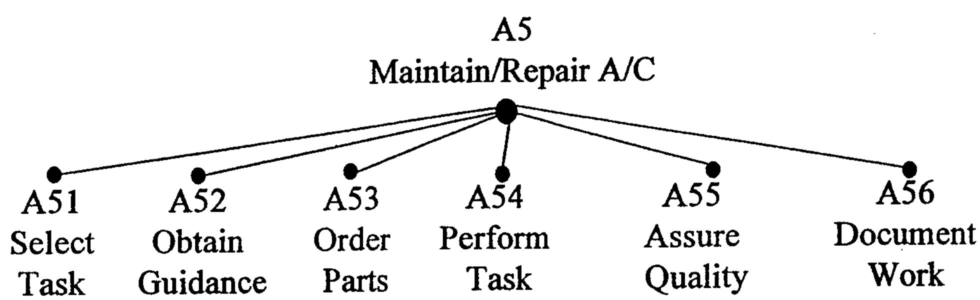


Figure 2-3. Maintain/Repair Aircraft (A5 Activity)

During the Maintain/Repair A/C (A5) activity, the mechanic will do the following:

Select Task (A51): mechanics either select or are given one of many tasks that are ready to be worked based on the status of the aircraft and the skill requirements of the task.

Obtain Guidance (A52): mechanics can request guidance on performing a particular task while referencing engineering drawings, technical orders, and other related technical information.

Order Parts (A53): mechanics order parts that are not immediately on-hand.

Perform Task (A54): the mechanic performs the assigned task as well as identifies additional tasks that may need to be performed.

Assure Quality (A55): mechanics take measures to ensure the quality of the process, product, and work.

Document Work (A56): mechanics document their work throughout the task.

2.3 OBJECTIVES, MEASURES, AND TARGETS

2.3.1 Linking Improvements with Objectives

Studies (Appendix B) have indicated that previous information technology projects in both government and business were not as successful as they might have been if the early focus included an understanding of the organizational and process objectives, measures, and targets. The ITI-ALC team approach included a step to accommodate this consideration.

As a result of the data collection effort, the ITI-ALC team understood the vision, objectives, measures and targets of the customers of organic aircraft PDM and those performing PDM work. This understanding helped determine which parts of the process required support in the future to achieve long-range depot maintenance objectives. This understanding also linked the objectives throughout the hierarchy of activities. The objectives begin with the customer, then move to the customer's major supplier in AFMC, the Integrated Weapon Systems Manager (IWSM). At each level, the objective of depot maintenance is apparent—to produce a quality product while reducing the customers' out-of-pocket expense and reducing the amount of time aircraft spend in maintenance.

Objectives from IWSMs and the depot maintenance planning sessions are noted in the following sections. An additional discussion of objectives is contained in Appendix F.

2.3.2 Integrated Weapon System Manager Objectives

During the data collection efforts, it became clear that IWSMs were working toward AFMC objectives and the Air Force vision of managing their organizations with a customer focus (refer to Appendix F). These objectives were obtained from the IWSM plans for some of the front-line aircraft systems in the Air Force (Warner-Robins Air Logistics Center, 1994):

- For the C-141, reduce actual flow days by 5% for each of the next three fiscal years.
- For the Special Operations Forces, maximize aircraft availability by combining modification and maintenance schedules.
- For the C-130, improve aircraft availability by minimizing aircraft in depot status, reduce operating expense, improve due date performance by preloading work requirements, and reduce unpredictables.
- For the F-15, continue aircraft flow day reductions (now 174 days).

2.3.3 Depot Maintenance Planning Objectives

The Joint Logistics Commanders (JLCs) developed objectives for depot maintenance locations of all the services. The JLC Joint Policy Coordinating Group (JPCG) stated depot maintenance needs to do the following (1993):

- Increase throughput.
- Reduce operating expenses.
- Improve capital investment effectiveness.
- Increase schedule compliance.
- Reduce process time.
- Improve financial planning.
- Reduce the labor hour cost index.

2.3.4 ITI-ALC Program Objectives

The ITI-ALC team analyzed the government's objectives for ITI-ALC and the objectives for depot maintenance. The team found that the ITI-ALC program objectives supported the objectives of depot maintenance. ITI-ALC encompasses the reordered processes and information technology required to meet these objectives:

- Integrate multiple maintenance information sources into a single, easy-to-use information system.
- Tailor information to meet the specific needs of the task and the mechanic.
- Eliminate time-consuming paperwork and tasks.
- Improve product quality and maintenance performance by taking advantage of the computer's ability to interact with and support the mechanic.
- Enable maximum efficient use of available manpower resources by providing information in standard, generic formats independent of the information system and by supporting general technical capabilities at various skill levels.
- Link to the Integrated Maintenance Information System (IMIS) at Organizational-level (O-level) maintenance to implement a more effective transfer of information between O-level and Depot-level (D-level) maintenance.
- Provide the capability to support maintenance performance in future scenarios such as lean logistics, total asset visibility, and two-level maintenance.

2.3.5 Performance Measures and Targets

Successful process improvement efforts in both the public and private sector have clearly defined objectives and targets to measure progress toward those objectives (GAO, 1995). This section recommends performance measures and targets to achieve the program, IWSM and depot maintenance objectives discussed above.

2.3.5.1 Performance Measures

Valid measures share several common characteristics:

- They are easily understood and do not require extensive calculation or explanation.
- They are important and valid to the leaders and workers involved in evaluating them.
- They concentrate on outputs controlled by the depot maintenance business area.
- They reflect doing things right (efficiently) as well as doing the right things (effectively), and are responsive to actions taken by the depot maintenance business area.
- They are cost efficient by using existing or easily gathered data and do not need to be measured with extreme precision. Business process improvement in the PDM process is of key importance. Measures need to be good enough to serve as the basis for that improvement.

The ITI-ALC team collected information on pertinent metrics and measures currently used in the depot maintenance area, specifically—organic aircraft PDM. During data collection interviews of AFMC and ALC personnel, it was apparent that their focus was on customer support, with improved efficiency and effectiveness the goal. Maintaining high levels of weapon system readiness was paramount, with meeting customer demands for timely delivery of repaired systems at reduced cost a close second. Additional measures such as mission availability, defect rate, stockage effectiveness, and supplier delinquency were also being used in some organizations.

Since it was not the intent of this project to develop new performance measures or to add additional data collection requirements, the ITI-ALC team attempted to locate measures that could be used to evaluate AFMC's organic aircraft PDM progress toward 1) becoming the customers' supplier of choice by meeting cost, schedule, and performance baselines; and 2) enhancing competitiveness while reducing cycle time by improving throughput and decreasing inventory and operating expenses for all functions.

These measures were not explicitly available in the documents containing the logistics vision or objectives, nor were they available in the AFMC objective documents that were reviewed. The measures did begin to appear in some of the IWSM plans, but their definitions varied substantially between aircraft systems and locations.

The team found measures that, at first, appeared to adequately gauge AFMC's organic aircraft PDM progress toward becoming the customers' supplier of choice and enhancing competitiveness. These measures are called Depot Maintenance Operations Indicators (DMOIs). The DMOIs were developed by the JLCs to 1) inform them how well logistics, at a macro level, was doing, 2) identify areas for improvement, and 3) help determine what courses of action are better than others. The JLCs approved the Joint Policy Coordinating Group's *Depot Maintenance Operations Indicators Handbook* (1993). The handbook defined seven indicators (measures) that the services and Defense Logistics Agency (DLA) use to provide inputs to the DMOI system. These indicators, presented in Table 2-2, reflect the performance of depot maintenance on a wide array of systems and components from aircraft to ships to armored vehicles. Each ALC reports the indicators to AFMC/LGP and the JPCG twice a year.

Table 2-2. JPCG Depot Maintenance Indicators and Goals

Indicators	*Goals*
Throughput	Increase throughput.
Operating Expense	At a given level of throughput, reduce operating expense.
Capital Investment Effectiveness	Improve capital investment effectiveness.
Schedule	Complete products as scheduled.
Process Days	Reduce the amount of time required between induction and completion.
Net Operating Results	Develop and adhere to the financial plan.
Labor Hour Cost	Reduce labor hour cost index.

The ITI-ALC team reviewed these indicators and their definitions in the DMOI handbook, and judged how well each one supported PDM customers. The team concluded that the focus of the indicators was macro-oriented and that none of them focused directly on organic aircraft PDM and operating expense.

The first three indicators—throughput, operating expense, and capital investment effectiveness—exclude direct material. Throughput reflects depot maintenance revenue minus direct material, operating expense is a gross measure for all workload at a depot, and capital investment effectiveness includes throughput in its calculation. Since direct material is a significant component of cost, and parts are a significant controllable component of the depot maintenance process, the ITI-ALC team wanted to include a direct material consideration.

The DMOI calculation for schedule and process days allowed room for manipulation. The schedule indicator is an index of a depot's ability to produce more than 26,000 different items as scheduled, and the process days indicator is based on a sample selected by the organization doing the reporting.

The net operating results and labor hour cost indicators are indices that reflect how well a depot achieved a target. Net operating results is defined as the ability of a depot to meet forecast revenue and not incur additional costs for a period of time. The handbook acknowledged the net operating results index is largely affected by factors beyond the control of the depot or AFMC. The labor hour cost indicator attempts to reflect how well the work plan is accomplished with the planned labor hour cost. The handbook acknowledges that variations in workload, geographic locations, and cost allocation practices make the labor hour cost indicator difficult to use.

While the ITI-ALC team could not directly use the DMOIs to measure the change resulting from this project, the team did discover data that allowed them to construct the following two measures.

$$\textbf{Operating Expense} = \textbf{Select Site Total Actual Expense for Repair Group Category A\&B}^{2}$$

$$\textbf{Flow Days} = \frac{\textbf{For Each MDS, } \sum \textbf{Number of Days Between the Date an Aircraft is Inducted and Date it is Produ}}{\textbf{Number of MDS Units Produced in Repair Group Category A\&B for that Period}}$$

These measures met the ITI-ALC program and depot maintenance objectives of reducing customers' expenses and flow days at a select site.

2.3.5.2 Targets

After selecting operating expense and flow days as the measures, the ITI-ALC team looked for reasonable targets against which to apply these measures. Targets, in this Business Case, are the desired changes in the values of the two performance measures which the depot maintenance will work toward.

2.3.5.2.1 Operating Expense

Since 1986, depot maintenance has had to reduce operating expense (the sum of direct labor, direct material, production overhead, and General and Administrative [G&A] expense) without adversely affecting customers. At the same time, depot maintenance organizations have been faced with issues outside of their control. Many of these issues are described in Appendix B in GAO reports published during 1992, 1993, and 1994. These reports describe the constraints under which depot maintenance operates and the potential for reducing operating expense if some of these constraints could be removed or adjusted by integrating information requirements and production.

There is clear evidence in the literature that reductions in operating expense beyond 2 or 3% per year are clearly possible. There is also clear evidence that government process improvement programs that propose timid targets are not viable.

Based on a preliminary analysis of the "AS-IS" FM and the information gleaned from the literature search on depot maintenance (refer to Section 3, paragraph 3.3.2.7), the ITI-ALC team concluded that, considering potential labor and material savings, a 40% reduction in operating

[2] Repair Group Category A and B include aircraft PDMs and other major aircraft work performed organically at the ALCs.

expense[3] is a reasonable target if the process improvements described in Section 3 are implemented. Sections 5.3 and 5.4 describe how close to this target it is possible to move.

2.3.5.2.2 Flow Days

While the IWSMs were working toward small reductions in flow days, the ITI-ALC team's activity analysis, benchmarking visits to commercial activities, and simulations revealed flow days could be reduced significantly in order to increase aircraft availability.

During the data collection phase, the ITI-ALC team learned that commercial airlines (including Delta, US Air, American, United, and TWA) encounter problems similar to those in organic aircraft PDM. The team visited commercial airlines to determine how they performed maintenance activities similar to those reflected in the ITI-ALC "AS-IS" Functional Model, and to capture improved practices being applied to maintenance processes. The airline approach to heavy maintenance has also been documented by separate Air Force studies (Air Force Logistics Management Agency, 1994). The ITI-ALC team captured best practices from both sources.

The commercial airlines have an activity called a Heavy Maintenance Visit (HMV), similar to organic aircraft PDM in work scope and labor hour expenditures. For example, a Delta airlines 727 HMV consumes approximately 20,000 person-hours of effort. A current C-130 PDM consumes approximately 13,000 person-hours. A current F-15 basic PDM work effort involves 7,000 person-hours. An F-15 Multi-Stage Improvement Program (MSIP), a major modification program, includes another 8,000 person-hours.[4]

At Delta and the other airlines, aircraft downtime is kept to an absolute minimum to minimize the loss of revenue per aircraft. For example, Delta regularly completes a full HMV on a 727 in 20 days. To complete the HMV, Delta uses three 40-person crews working around the clock only after confirmation that technical data, parts, support equipment, and facilities are on-hand to support that level of intensity.

Based on its data collection efforts, and analysis of the "AS-IS" Functional Model the ITI-ALC team concluded that a reasonable target for organic aircraft PDM should be a 30% reduction in flow days (refer to Table 2-3).

Table 2-3. Potential Reductions in Operating Expense and Flow Days

Performance Measure	Source	Baseline Value	Potential Reductions
Operating Expense	DMBA Report	Operating Expense Baseline	40%
Flow Days	ALC Production Information	Number of Flow Days Reported for Each MDS in FY94	30%

[3]The source of operating expense data is the *Depot Maintenance Business Area (DMBA) Repair Group Category Report* for repair group categories A and B (aircraft). This report is produced by the HO36 System at the completion of each fiscal year, and is available through AFMC/FMM.
[4]Data collection at WR-ALC.

2.4 SM-ALC BASELINE

After defining the appropriate PDM activities, the ITI-ALC team focused on outputs and activity-based costs for SM-ALC, one of the select sites for this Business Case. Those are described below.

2.4.1 Output and Cost of PDM for SM-ALC

For the 12 months ending February 1995, SM-ALC had an output of 118 aircraft, as shown in Table 2-4.

Table 2-4. SM-ALC Organic Aircraft PDM Output (March 1994 - February 1995)[5]

MDS	Production Quantity	Flow Days
KC-135	20	265
A-10	42	70
F-111	33	283
F-15	23	124

During FY94, the aircraft workload at SM-ALC accounted for approximately 21% of the direct labor hours expended. Information obtained from SM-ALC during the interviews indicated that approximately the same percentage would continue into the future.[6]

To achieve FY94 production, SM-ALC spent $131,568,523 (DMBA, 1994) on aircraft maintenance. Table 2-5 focuses on the reported costs for repair group categories A and B (those associated with aircraft repair).

Table 2-5. SM-ALC Operating Expense for Repair Group Categories A and B (FY94)

LABOR/REPAIR GROUP CATEGORY	DIRECT LABOR ($)	DIRECT MAT'L ($)	OTHER DIRECT ($)	OPERATIONS/ OVERHEAD ($)	G & A ($)	TOTAL COSTS ($)
Repair Group Category A	33,676,496	40,030,929	-0-	32,455,899	13,600,803	119,764,127
Repair Group Category B	2,943,355	3,430,608	-0-	4,304,341	1,126,092	11,804,396
Grand Total Repair Group Categories A & B	**36,619,851**	**43,461,537**	**-0-**	**36,760,240**	**14,726,895**	**131,568,523**

[5]This was the most recent data at the time this Business Case was developed.
[6]Data collection at SM-ALC.

The information listed in Table 2-5 is summarized as follows:

Areas Consuming Resources	Percentage of $131,568,523 Spent
Direct Labor[7]	28%
Direct Material	33%
G&A	11%
Operations Overhead[8]	28% (60% labor, 20% material, and 20% other)

Labor and material, both direct and indirect, significantly consumed resources. The ITI-ALC team focused on finding which *activities* within these two areas were consuming resources and to what degree.

Although there were no direct matches between the depot maintenance financial management system and the activities in the ITI-ALC "AS-IS" Functional Model, the ITI-ALC team derived links between resources and activities by following the methods discussed in DoD and business publications. This approach is summarized below and discussed in more detail in Appendix E.

The team obtained manpower documents, position descriptions, and supporting detail from SM-ALC. Based on information from the ITI-ALC team's review of those documents[9] and information produced by the Air Force Occupational Measurement Squadron, the ITI-ALC team identified the cost of labor for the SM-ALC aircraft directorate associated with the activities in the ITI-ALC "AS-IS" Functional Model. SM-ALC aircraft directorate personnel perform virtually all of the work represented in the model. Identifying the link between activities and cost was important for two reasons: 1) the activities that were the greatest consumers of labor resources were identified, and 2) the significant consumption of labor resources apart from the direct maintenance task, Perform Task (A54), began to appear.

The team's findings indicated that 4% of the SM-ALC aircraft directorate labor was consumed in planning production (A1), an additional 10% was consumed to control production (A2), and approximately 0.4% was consumed in interfacing with the material support center (A3). The largest consumer of resources (85.6%) was the Maintain/Repair Aircraft (A5) activity, with three subactivities—Order Parts (A53), Perform Task (A54), and Assure Quality (A55)—consuming a significant amount of those resources.

[7]AFMCM 173-264 notes that direct labor 1) increases the value or utility of a product by altering the composition, conformation, or construction of the product or provides service directly to the customer rather than in support of other direct labor; 2) can be accurately, consistently, and economically identified to a product or service or customer; 3) is supported by official work requests; 4) is applied to the product or group of products of a customer outside of the Directorate of Maintenance. AFMCR170-10 identifies G&A as the actual cost for labor, material, and other services furnished to the depot maintenance service. Those costs not identified as direct or production overhead costs are classified as G&A overhead costs. These include the costs of management and support organizational units serving the entire depot maintenance activity as well as costs that could be charged as production overhead but cannot be economically identified to specific areas of direct production effort. Direct Material includes those materials incorporated into the end item being maintained or consumed by direct labor in the process of maintenance.

[8]SM-ALC IF-4A worksheets provided by analysts at SM-ALC.

[9]Refer to Appendix E for a summary of SM-ALC/LA manpower assignments-15 February 1995, and the explanation for its use.

The ITI-ALC team concluded that of the $62 million currently spent on labor, 30% is consumed by activities that do *not* directly repair aircraft (see activities A1, A2, A3, A51, A52, A53, A55, and A56 in Figure 2-4. Values do not sum to 100% due to rounding). The ITI-ALC team then focused its analysis on the significant resource-consuming activities and the information relationships to the Perform Task (A54) activity. This analysis is discussed in Section 3.

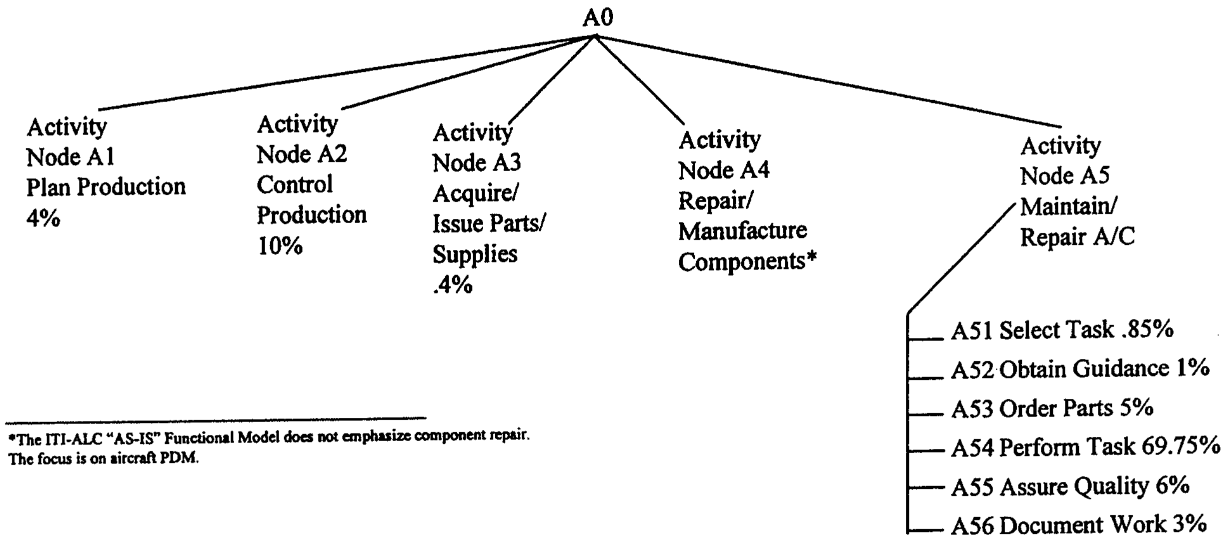


Figure 2-4. Percentage of SM-ALC Labor Associated with Activities in the ITI-ALC "AS-IS" Functional Model

2.4.2 Operating Expense Baseline for SM-ALC

The ITI-ALC team established an operating expense baseline for the organic aircraft PDM activity at SM-ALC, represented by the ITI-ALC "AS-IS" FM. The baseline is an estimate. It is the benchmark against which to measure alternatives to improve the process. It will be used later to measure the real impact of changes as they are implemented.

The operating expense baseline was calculated by determining the FY94 organic aircraft PDM cost per Direct Product Earned Hour (DPEH) for SM-ALC's direct labor, direct material, operating overhead, and G&A costs for repair group categories A and B.

The result ($116 per hour) was applied to the SM-ALC estimated workload for organic aircraft PDM for FY95 through FY98.[10] Since workload forecasts beyond FY98 were not available, the ITI-ALC team relied on DoD depot maintenance functional cost baseline information contained in the *Depot Maintenance Functional Economic Analysis* (Joint Logistics Systems Center, 1994). That document indicated a relatively steady state for DoD organic depot maintenance from FY98 through FY03. Therefore, the ITI-ALC team estimate for FY98 continued through FY04 at the same level.

[10]Planned labor application hours were obtained from SM-ALC/FM during the data collection visit in March 1995. These hours do not reflect the March 1995 announcement of F-111 aircraft retirements from the Air Force inventory.

This operating expense baseline includes all estimated expenses to accomplish organic aircraft PDM at SM-ALC. These expenses are listed below and shown in Figure 2-5:

- Aircraft mechanics working daily on the aircraft.
- Materials used by mechanics and the support staff.
- Support structure at SM-ALC that provides planning and scheduling, materials expediting, management, and supervision.

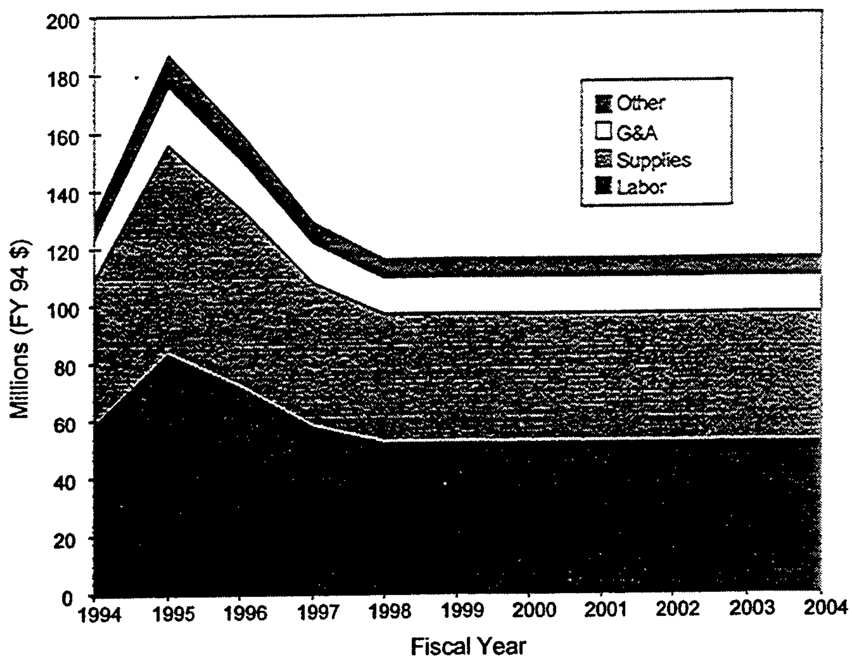


Figure 2-5. SM-ALC Organic Aircraft PDM Operating Expense

SM-ALC operating expense is summarized in Table 2-6 (values do not sum to 100% due to rounding, but the rounding is insignificant to the final outcome).

Table 2-6. SM-ALC Operating Expense Summary

Component	% of FY94 Operating Expense	FY94 Dollars Spent
Labor	44.7%	$58.4 million total ($36.8 million in direct labor; $21.6 million in production overhead labor)
Supplies*	38.7% (14.2% of which is spent on production overhead supplies)	$50.5 million total ($43.3 million in direct material; $7.2 million in production overhead materials)
Other	16%	$22.6 million total ($14.9 million in G&A; $7.7 million in production overhead "other" such as base operating support, fire and police support, and the like)

*Supplies consists of direct materials and the materials component of indirect accounts, such as production overhead.

The importance of this baseline is evident when placed in the context of the benefits equation described in the next section, paragraph 3.3.1.

2.5 WR-ALC BASELINE

The information associated with the WR-ALC baseline is included in this section. Two of the most important differences between WR-ALC and SM-ALC are: 1) WR-ALC has three PDM lines and 2) WR-ALC's capacity is approximately twice that of SM-ALCs.

2.5.1 Output and Cost of PDM for WR-ALC

During FY94 and FY95, WR-ALC produced aircraft within the flow days listed in Table 2-7.

Table 2-7. WR-ALC Organic Aircraft PDM Output (FY94 and FY95)

MDS	Production Quantity	Flow Days
	FY94	
F-15	63	153
C-130	18	145
C-141	31	209
	FY95	
F-15	68	143
C-130	15	176
C-141	50	280

WR-ALC expended $275,475,459 for FY94 production and $332,805,630 for FY95 production. Table 2-8 focuses on the reported costs for repair group categories A and B (those associated with aircraft repair) for each year.

Table 2-8. WR-ALC Operating Expense for Repair Group Categories A and B (FY94 and FY95)

MDS/REPAIR GROUP CATEGORY	DIRECT LABOR ($)	DIRECT MAT'L ($)	OTHER DIRECT ($)	OPERATIONS/ OVERHEAD* ($)	G & A ($)	TOTAL COSTS ($)
			FY94			
Repair Group Category A	45,691,388	45,593,319	-0-	74,043,257	6,961,188	172,289,152
Repair Group Category B	21,172,278	49,133,196	561,890	28,951,180	3,367,763	103,186,307
Grand Total Repair Group Categories A & B	**66,863,666**	**94,726,515**	**561,890**	**102,994,437**	**10,328,951**	**275,475,459**
			FY95			
Repair Group Category A	64,715,168	67,000,911	-0-	96,051,481	11,235,412	239,002,972
Repair Group Category B	17,525,658	51,900,277	461,881	20,778,518	3,136,324	93,802,658
Grand Total Repair Group Categories A & B	**82,240,826**	**118,901,188**	**461,881**	**116,829,999**	**14,371,736**	**332,805,630**

The information listed in Table 2-8 is summarized as follows:

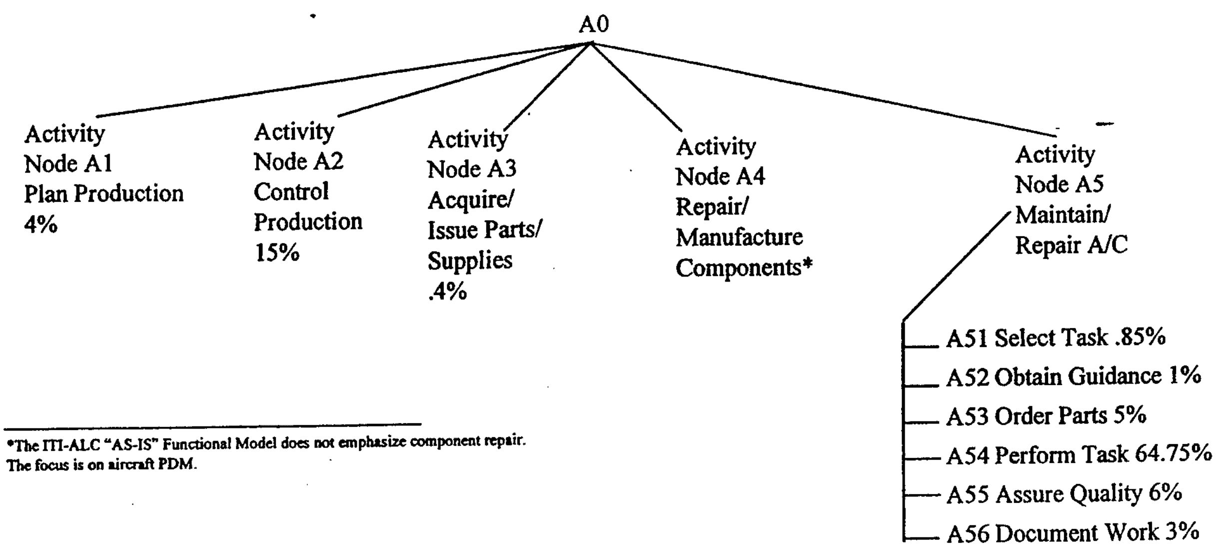
Areas Consuming Resources	Percentage of Dollars Spent	
	FY94	***FY95***
Direct Labor	24%	25%
Direct Material	35%	36%
G&A	4%	4%
Operations Overhead	37%	35%

As at SM-ALC, labor and material consumed the bulk of the dollars. The ITI-ALC team focused on finding which *activities* were consuming those resources and to what degree.

The depot maintenance financial management system at WR-ALC is very similar to the system at SM-ALC. As a result, there were no direct matches between that system and the activities in the ITI-ALC "AS-IS" Functional Model. The ITI-ALC team followed the methods discussed in DoD and business publications to develop links as described in Appendix E.

Four percent of WR-ALC labor was consumed in planning production (A1). Fifteen percent was consumed to control production (A2). Approximately 0.4% was consumed in interfacing with the material support function (A3). The Maintain/Repair Aircraft (A5) activity, with three subactivities—Order Parts (A53), Perform Task (A54), and Assure Quality (A55)—consumed the largest amount of labor.

From this review, it was apparent that 35% of the labor dollars are consumed by activities that do ***not*** directly repair aircraft (see activities A1, A2, A3, A51, A52, A53, A55, and A56 in Figure 2-6). The ITI-ALC team focused its analysis on these the relationships to the Perform Task (A54) activity. This analysis is discussed in Section 3.



*The ITI-ALC "AS-IS" Functional Model does not emphasize component repair. The focus is on aircraft PDM.

Figure 2-6. Percentage of WR-ALC Labor Associated with Activities in the ITI-ALC "AS-IS" Functional Model

2.5.2 Operating Expense Baseline for WR-ALC

The ITI-ALC team following the same approach used at SM-ALC established an operating expense baseline for the organic aircraft PDM activity at WR-ALC, represented by the ITI-ALC "AS-IS" FM. It is an estimate of what the organic aircraft PDM activity at WR-ALC will cost, if the process does not change. Alternatives to improve the process will be measured against this baseline.

The team determined the operating expense baseline by calculating the FY94 organic aircraft PDM cost per DPEH for WR-ALC's direct labor, direct material, operating overhead, and G&A costs for repair group categories A and B. The result was $87.

The team applied the cost per DPEH to the estimated workload for organic aircraft PDM for FY96 through FY00.[11] Workload forecasts beyond FY00 were not available. However, the ITI-ALC team obtained the DoD depot maintenance functional cost baseline information contained in the *Depot Maintenance Functional Economic Analysis* (Joint Logistics Systems Center, 1994). That document indicated a relatively steady state for DoD organic depot maintenance from FY98 through FY03. Therefore, the ITI-ALC team estimate continued through FY04 at the same level.

This operating expense baseline includes aircraft mechanics working on the aircraft, materials used by mechanics and the support staff, and the structure of personnel, information systems, facilities and other resources that provides planning and scheduling, materials expediting, management, and supervision.

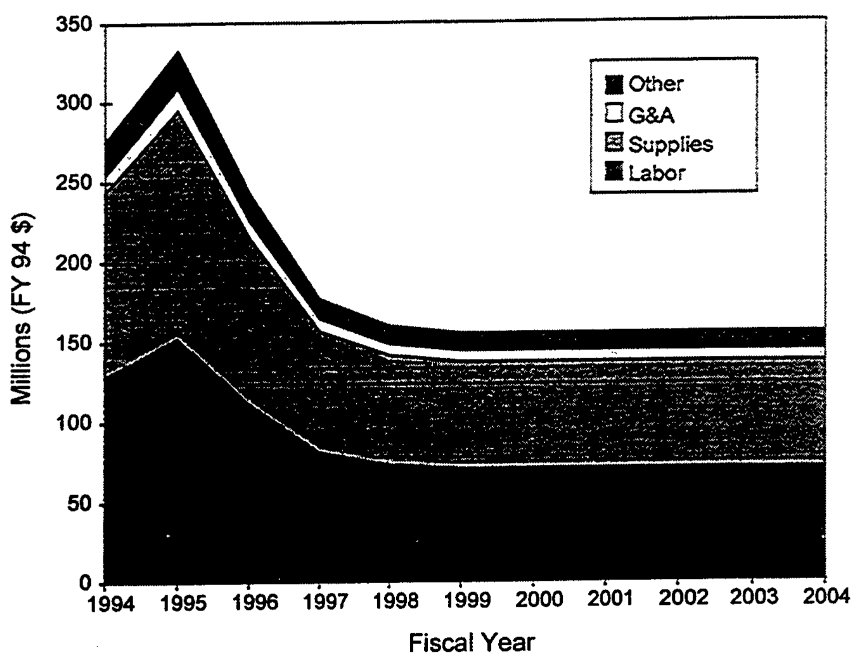


Figure 2-7. WR-ALC Organic Aircraft PDM Operating Expense

[11]Planned labor application hours were obtained from WR-ALC/FM during data collection in January 1996.

WR-ALC operating expense is summarized in Table 2-9 (values do not sum to 100% due to rounding).

NOTE: There is a slight difference in the "mix" compared to SM-ALC.

Table 2-9. WR-ALC Operating Expense Summary

Component	% of FY94 Operating Expense	FY94 Dollars Spent
Labor	46.7%	$128.66 million total ($66.86 million in direct labor; $61.79 million in production overhead labor)
Supplies*	41.8% (18.0% of which is spent on production overhead supplies)	$115.32 million total ($94.73 million in direct material; $20.59 million in production overhead materials)
Other	11.4%	$31.49 million total ($10.33 million in G&A; $21.16 million in production overhead "other" such as base operating support, fire and police support, and the like)

*Supplies consists of direct materials and the materials component of indirect accounts, such as production overhead.

3. *PDM PROCESS IMPROVEMENTS AND PROPOSALS*

This section discusses the following:

- Business Process Improvements (BPIs).
- Process Improvement Proposals (PIPs).
- Estimated benefits of PIPs based on engineering assessments and simulations.

3.1 INTRODUCTION

After analyzing activities performed in the PDM process and creating measures for operating expense and flow days, the ITI-ALC team developed BPIs that would meet the objectives of the ITI-ALC program and improve depot maintenance. BPIs are suggested changes in the process which affect the efficiency and effectiveness of the resources consumed in programmed depot maintenance. These BPIs are described in detail in Appendix C and in the *ITI-ALC Architecture Report* (SRA, June 1995).

The team developed four stand-alone implementation strategies called PIPs, labeled A through D. The goal of PIP A is to implement as great a part of each BPI as possible, with the minimum amount of additional resources and no additional technology. The goal of each successive PIP is to implement greater portions of each BPI than its predecessor. In order to achieve this, each PIP after PIP A requires increasing levels of technology and procedural change to enable greater process change. PIP D enables the greatest potential for reducing operating expense and reducing flow days. PIP D fully implements each of the BPIs, fully integrates depot maintenance information requirements.

The following sections discuss how PIPs are related to BPIs and the relative contribution each BPI makes to a PIP when compared to PIP D. Also discussed are the anticipated benefits of PIP D as determined by engineering assessment and BPI and PIP simulations. The equation presented at the conclusion of Section 2 is then populated with the values expected from PIP D. The benefits expected from PIP D are then used to derive the benefits for each of the other PIPs.

3.2 SUMMARY OF PIPs

Instead of creating only one proposal for achieving organization objectives, the ITI-ALC team created multiple solutions that took into account the level to which the organization could implement changes in its PDM process.

Based on its' knowledge of the depot maintenance process, the ITI-ALC team logically grouped slices from each BPI into packages, or PIPs, that would enable ALCs to move toward or achieve their targets. Table 3-1 summarizes these PIPs.

Table 3-1. PIP Summary

PIP	*Description*
PIP A (Process Improvements Only, No ITI-ALC Technology)	Implements a slice from BPIs within the current "AS-IS" paradigm that can begin now, demonstrate the new activity, and is more effective and efficient, though it does *not* include ITI-ALC technology.
PIP B (Introductory System)	Implements a slice from BPIs within the current "AS-IS" paradigm that produces more improvements in effectiveness and efficiency than PIP A. Some ITI-ALC technology is introduced to provide on-line access to individual databases and a single interface to core depot maintenance systems. This PIP does not integrate data. Technical data is not organized in IETM format. This PIP can move the PDM process closest to the performance targets without requiring policy changes outside of the maintenance process.
PIP C (Integrated Data)	Implements a slice from BPIs that provides integrated information, introduces IETM data, incorporates more portable ITI-ALC technology, establishes the infrastructure for O-level to D-level information sharing, and allows a major breakout of the current process and a major breakthrough in the way the customer is served. Saves more by enabling the reallocation of resources to the direct maintenance effort. This PIP requires a paradigm stretch.
PIP D (Fully Developed ITI-ALC System)	Implements a slice from BPIs that incorporates full ITI-ALC technology, integrates all the required systems for depot maintenance functionality, provides artificially intelligent tools to support all the BPIs, produces information as a by-product of the work effort, and enables the final step toward achieving the objectives. This PIP will require a major paradigm shift.

Substantial benefits are derived from integrating BPIs; thus, the ITI-ALC team did not evaluate implementation of a single BPI except as it supported integrated process improvements. The PIPs offer a range of improvement, and each PIP offers some advantage over the PDM process as it currently exists. However, the impact should be measured against the objectives of substantially reducing organic aircraft PDM operating expense and flow days. PIP D offers the greatest ability to achieve those objectives. PIP A offers the lesser ability to achieve those objectives.

3.2.1 Level of BPI Implementation

The ITI-ALC team expects to achieve the maximum benefit from PIP D, which is a fully developed and implemented ITI-ALC system. PIP D is the combination of BPIs against which the other PIPs are measured. Lower levels of benefits are expected from the other PIPs. Table 3-2 indicates the percentage of the total potential effect the team expects to achieve in PIP D

(100%), PIP C (68%), PIP B (29%), and PIP A (11%). These percentages were derived using engineering assessment and validated using simulations. The percentages are used to determine the potential benefit in dollars for PIPs. The costs associated with the PIPs are discussed in Section 4.

Table 3-2. PIP to BPI Correlation Matrix[12]
(Percent Impact of Implementing BPI in PIP)

BPI	*PIP A*	*PIP B*	*PIP C*	*PIP D*
Process and Terminology Coordination	30	40	75	100
Planning Process Enhancement	<10	40	75	100
Acquire Parts	30	50	80	100
Data Sharing Among All Levels of Maintenance	<10	<10	75	100
Production Responsibility Centers	30	30	75	100
Parts Acquisition Policy Changes	0	30	75	100
Visibility into Part Availability	<10	50	75	100
Electronic Signatures	0	50	80	100
Performance Metrics Based on Actual Data	<10	<10	50	100
User Technical Information Presentation System	0	<10	80	100
Preplanned Over and Aboves/Unpredictables	<10	<10	75	100
Planning Responsibility Centers	<10	50	75	100
Automated and Integrated Technical and Diagnostics Information	0	<10	50	100
Multi-skilled Mechanics	30	30	75	100
Percent Total Potential Impact Achieved by PIP	**11**	**29**	**68**	**100**

Table 3-2 summarizes the level of implementation of each BPI in the individual PIPs, and indicates the level of benefit each BPI offers as compared to PIP D benefits. As an example, the Electronic Signatures BPI (refer to Appendix C, paragraph C.1.8) is not available in PIP A since it requires introducing technology, and PIP A implements only those BPIs that do not require technology but provide a benefit. This BPI is implemented in PIP B, but is not part of an integrated data system; therefore, it does not support substantial benefits. However, as it is implemented in PIP C, the maintenance experts on the ITI-ALC team estimated that 80% of the expected impact from this BPI is achieved. As another example, the Data Sharing BPI (refer to Appendix C, paragraph C.1.4) is available at a low-level in PIP A and PIP B but achieves less than 10% of the effect anticipated in PIP D. When this particular BPI is implemented in PIP C, 75% of its impact is achieved. In PIP D, 100% of the potential impact from that particular BPI is achieved. As a final example, the Acquire Parts BPI (refer to Appendix C, paragraph C.1.3) in PIP A keeps the parts currently available at the depot close to where the mechanic is working. The time saved by the mechanic is the benefit achieved. However, since less than 50% of the required parts are currently available at the depot, the full benefit cannot be expected in PIP A or PIP B. The full benefit seen in PIP D groups all parts at the mechanic's location as each task is required to be done.

[12] The Three Shifts of Effort BPI is an additional BPI to consider. It provides no benefit in PIPs A and B, a less than or equal to 10% benefit in PIP C, and a 100% benefit in PIP D.

3.3 ANTICIPATED BENEFITS FROM PIP D FOR SM-ALC

Since PIP D represents the greatest likelihood of reaching the targets of reduced operating expense and flow days, the ITI-ALC team focused on that PIP. After PIP D benefits were baselined, the results of the analysis summarized in Table 3-2 were used to determine the potential benefits for the other PIPs. The team performed an engineering assessment and BPI and PIP D simulation to estimate how close to the targets, identified in Section 2.3.5.2, the depot maintenance process could move. The engineering assessment was used to obtain early results in the process and the simulations validated the assessments for PIP D. Before the engineering assessment was started, an equation reflecting benefits was derived.

3.3.1 Equation Reflecting Benefits at SM-ALC

Identifying baseline operating expense components (as was done in Section 2) is important because their performance targets should be significantly influenced by the development of process improvements. Process improvements were evaluated by their ability to reduce the baseline operating expense as depicted in the following equation:

$$\mathbf{F_D \Delta\% = L + S + O \pm U}$$

where $\mathbf{F_D \Delta\%}$ is the change in final operating expense in dollars, **L** is the change in Labor, **S** is the change in Supplies (both direct and indirect), **O** is the change in the Other category (G&A and other expenses), and **U** is uncertainty due to unknowns and estimate errors. **L**, **S** and **O** can be further defined as the following:

L = Labor component of the total cost multiplied by the percent of benefit derived from analysis, or $\mathbf{T_L * B_L}$.

S = Supplies component of the total cost multiplied by the percent of benefit derived from analysis, or $\mathbf{T_S * B_S}$.

O = Other component of the total cost multiplied by the percent of benefit derived from analysis, or $\mathbf{T_O * B_O}$.

The areas of labor that will be most effected by changes due to the implementation of ITI-ALC BPIs and technologies, are those represented by the ITI-ALC "AS-IS" Functional Model activities A1, A2, and A5. Resources consumed by the Acquire/Issue Parts (A3) activity are insignificant in this context, and the Repair/Manufacture Components (A4) activity does not consume PDM resources. Given this, the variable $\mathbf{B_L}$ can be further defined with expressions for each of the three impacted activities.

Combining and adding these ideas to the equation gives the following:

$$\mathbf{F_D \Delta\% = T_L * (B_{A1} + B_{A2} + B_{A5}) + T_S * B_S + T_O * B_O \pm U}$$

Like **L**, **S** and **O**, the three expressions for $\mathbf{B_L}$ do not represent a "total." Given this, the equation must include normalization factors to ensure correctness. By adding these factors, the equation becomes:

$$\mathbf{F_D\Delta\% = T_L\left[(T_{A1} * A1_D\Delta\%) + (T_{A2} * A2_D\Delta\%) + (T_{A5} * A5_D\Delta\%)\right] + T_S(B_S) + T_O(B_O) \pm U}$$

Where $\mathbf{T_X}$ is used to normalize the benefit realized in the activities A1, A2 or A5 to the total for all labor within depot maintenance (A0). Furthermore, $\mathbf{AX_D\,\Delta\%}$ represents the change due to implementation of ITI-ALC BPIs and technologies for the given activities (A1, A2, or A5).

As described earlier in this section, the Labor component is 44.7% ($\mathbf{T_L}$) of the total operating expense, the Supplies component is 38.7% ($\mathbf{T_S}$), and the Other component is 16% ($\mathbf{T_O}$). At the ALCs, there is a relationship between the amount of labor consumed in PDM and the level of other expenses associated with it. Because of this, it is to be expected that changes in labor will be reflected in the same rate of change in the Other component of the equation. As a result, $\mathbf{B_O}$ will be equal to $\mathbf{B_L}$. In addition, there is little uncertainty about the current operating expense and its components. When projecting operating expense of the current PDM process into the future or when estimating the benefits of changes to the PDM process, additional uncertainty may appear. With the values identified above, the equation for SM-ALC can be represented as follows:

$$\mathbf{F_D\Delta\% = .447\left[(T_{A1} * A1_D\Delta\%) + (T_{A2} * A2_D\Delta\%) + (T_{A5} * A5_D\Delta\%)\right] + .387(B_S) + .16(B_O) \pm U}$$

As described in Section 2.4.1, the Plan Production (A1) activity is 4% ($\mathbf{T_1}$) of the labor resources included in the total operating expense, the Control Production (A2) activity is 10% ($\mathbf{T_2}$), and the Acquire/Issue Parts (A3) and Repair/Manufacture Components (A4) activities are minimal to nonconsuming and do not affect the operating expense total. The Maintain/Repair Aircraft (A5) activity is 85% ($\mathbf{T_5}$) of the labor resources included in the total operating expense. With that information, the final derivation of this equation for SM-ALC can be represented as follows:

$$\mathbf{F_D\Delta\% = .447\left[(.04 * A1_D\Delta\%) + (.10 * A2_D\Delta\%) + (.85 * A5_D\Delta\%)\right] + .387(B_S) + .16(B_O) \pm U}$$

3.3.2 Estimated Benefits Based on Engineering Assessment

The functional experts and the information analysts assigned to the ITI-ALC team performed an engineering assessment to determine the potential for change in the PDM process as a result of PIP D. Their assessment was based on a review of the ITI-ALC "AS-IS" Functional Model, important information obtained during data collection at SM-ALC, and functional expertise. In the following paragraphs, the estimated benefits for each high-level activity in the ITI-ALC "AS-IS" Functional Model are discussed.

3.3.2.1 Plan Production – Activity A1

The Plan Production activity consumes approximately 4% of the 1595 personnel in the SM-ALC aircraft directorate. This is an extremely intensive activity for the industrial engineers and industrial engineering specialists performing the activity and for the managers and supervisors of mechanics who support them. The process is improved in PIP D to remove redundancies in activities such as assigning tasks, compiling labor requirements, merging tasks, identifying required parts, and compiling material requirements. Data collection efforts revealed redundancies in assigning tasks so the ITI-ALC team created the Planning Process Enhancement BPI to reduce duplication of effort among planners, production managers, mechanics, and the mechanics' managers and supervisors. This BPI incorporates a feedback mechanism that uses knowledge gained from developing and executing previous plans in order to refine future plans. Using previous plans to build on reduces the amount of effort for compiling labor requirements, combining and ordering tasks, identifying parts requirements, and acquiring labor and parts resources. In addition, a knowledge base is established as planning occurs so the results are readily available for subsequent use. These types of changes free the equivalent of approximately 38 personnel to perform other duties. Per the engineering assessment and simulation, implementing these changes results in a 60% reduction in labor, G&A, and other resources necessary to accomplish this activity.

3.3.2.2 Control Production – Activity A2

The Control Production activity consumes approximately 10% of the 1595 personnel in the SM-ALC aircraft directorate whose job it is to manage the uncertainty created by maintenance production (e.g., lack of material and equipment availability). The Control Production activity regulates the production process, attempting to reduce the impact of maintenance production problems. The amount of effort consumed in this activity is directly related to the amount of uncertainty that exists in the maintenance process. As uncertainty is reduced, the resources to manage it can also be reduced. With the introduction of PIP D, work requirements are integrated well in advance with the external information systems that provide parts and labor data. The number of parts that are available should increase from the current 35% to 85%, and the number of rob-backs should fall substantially because required parts are available. Most of the currently performed over and above tasks (discrepancies that must have a technical solution defined, approved, and funded) become preplanned over and aboves (discrepancies with a predefined technical solution but must be funded). Additional work-arounds will virtually disappear. The equivalent of half of the time the mechanics from all maintenance specialties, the production controllers, and the supervisors spend on the Control Production activity becomes available for direct maintenance tasks. These types of changes free approximately 50% of the production controllers, industrial production managers, mechanics, and supervisors for other duties.

3.3.2.3 Acquire/Issue Parts/Supplies – Activity A3

The Acquire/Issue Parts/Supplies activity consumes a small portion of the 1595 personnel in the SM-ALC aircraft directorate, which is the equivalent of 6 personnel. Based on data collection and the engineering assessment, the ITI-ALC team anticipates no substantial change in the number of individuals (6) required by this activity.

3.3.2.4 Repair/Manufacture Components – Activity A4

Since the ITI-ALC "AS-IS" Functional Model does not emphasize component repair, the ITI-ALC team anticipates no substantial change in the resources required by the Repair/Manufacture Components activity.

3.3.2.5 Maintain/Repair A/C – Activity A5

The Maintain/Repair Aircraft activity (see Figure 3-1) consumes approximately 85% of the 1595 personnel in the SM-ALC aircraft directorate. Maintaining and repairing aircraft produces serviceable aircraft from reparable aircraft through the performance of a set of maintenance task assignments specified in the work control plan.

Activity
Node A5
Maintain/
Repair A/C

- A51 Select Task .85%
- A52 Obtain Guidance 1%
- A53 Order Parts 5%
- A54 Perform Task 69.75%
- A55 Assure Quality 6%
- A56 Document Work 3%

Figure 3-1. Maintain/Repair Aircraft (A5) Subactivities

With the introduction of PIP D, activities A51, A52, A53, and A56 consume significantly less labor and support resources, because the process has been changed. In activity A51, selection of the task becomes a simple operation presented to the mechanic by a support tool, accompanying the mechanic, derived from the ITI-ALC SSS (SRA, October 1995). Trips to pick up parts are eliminated because the necessary parts for the task are located in the mechanic's work area. The mechanic learns immediately from the support tool which task to select, which task is supported with parts, and which task has tools available. The mechanic obtains guidance (activity A52) on line as the task is selected. Ordering parts (activity A53) is done less often due to the process improvements in PIP D for preplanning and pre-positioning parts. PIP D results in 85% of the required parts being available for the mechanic rather than the 35% available today. In PIP D, documenting the work performed (activity A56) occurs as a by-product of the work the mechanic does. The ITI-ALC SSS describes the mechanism which allows this to occur.

The portions of activity A54 that relate to debriefing, diagnosing failures, referencing guidance materials, obtaining parts, and turning in routed parts will be greatly simplified or will no longer need to be accomplished. This will allow approximately 25% of the supply technicians, industrial engineering technicians, production controllers, maintenance supply support technicians, mechanics, and the mechanics' supervisors to focus on other tasks. Activity A55 involves the effort of mechanics, their supervisors, production controllers, and supervisory QA specialists. The ITI-ALC team determined this activity will require 30% less labor since the tasks they perform will be greatly enhanced in PIP D in the area of planning functional check flights and conducting debriefings.

As a result of the change in process in activity A5, the engineering assessment concluded there will be a 34.8% change in the amount of labor required to accomplish the work. As discussed in Section 2, paragraph 2.4.2, on "Other" cost, there is a direct relationship between labor and other cost. As a result, the same level of change, in all the activities of the "AS-IS" FM, is expected in the "Other" category. This is reflected in the equation in Section 3, paragraph 3.3.2.7.

3.3.2.6 Reductions Due to Supply Savings

The ITI-ALC team discovered during the literature review that the DoD was successfully implementing alternative supply support techniques (refer to Appendix B). Based on these findings, the ITI-ALC team determined that if PIP D were implemented, it would be reasonable to expect a savings on the order of 10% of the supplies currently included in operating expense. This should occur because there is substantially more confidence in the results of the material requirements process. There will be substantially fewer backorder cancellations and the potential for significant reductions in surcharges as the result of sharing data via an interface with supply information systems.

3.3.2.7 Summary of Estimated Benefits Based on Engineering Assessment

Substituting the values presented in the engineering assessment summary above in the benefits determination formula first discussed in Section 2, we conclude that implementing PIP D should reduce operating expense by 26%:

$$\mathbf{F_D\Delta\% = .447\left[(A1_D\Delta\% * .04) + (A2_D\Delta\% * .10) + (A5_D\Delta\% * .85)\right] + .387\,(B_S\%) + .16\,(B_O) \pm U}$$

$$\mathbf{F_D\Delta\% = .447\left[(.60 * .04) + (.50 * .10) + (.348 * .85)\right] + .387(.10) + .16(.60 * .04) + (.50 * .10) + (.348 * .85) \pm U}$$

$$\mathbf{.26 = .447\left[(.024) + (.05) + (.2958)\right] + .0387 + .0591 \pm U}$$

This result is consistent with information gathered from early literature reviews. One of those documents (GAO, 1993) indicated that in 1993, labor standards for 22 major maintenance tasks at repair organizations involving six types of aircraft could be reduced by 34% if work processes changed to permit more effective use of the resources. In addition, the study indicated that material standards were also inflated because maintenance personnel were not confident that the supply system would have the parts available when needed; therefore, they inflated the standards so more parts would be stocked.

An additional factor the ITI-ALC team considered was making judgments about the future. The purpose of this Business Case is to produce a rough order of magnitude estimate of the potential for improvement in the depot maintenance process. Thus, the data collection was structured to allow a reasonable degree of certainty for a rough order of magnitude (ROM) estimate. The team did take action to limit uncertainty in the information collected. The ITI-ALC data collection effort was structured. Interview questions were developed and previewed in advance of the interviews. Official documents were used as source material when available. Interviews of functional experts were conducted by multiple member teams. Interviews were conducted again when clarification of answers was needed after analysis identified areas of doubt. Furthermore, multiple levels of validation were performed on the data and on the artifacts derived from the data. As a result, uncertainty was limited to ±10% in the engineering assessment of PIP D. When the ITI-ALC team used SRA's TurboBPR2 software to apply benefits to cost and operating expense, uncertainty at the level of ±10% was taken into account (refer to Section 4).

The ITI-ALC team proposed to test this engineering assessment with dynamic simulation, requiring additional data collection and analysis time. Discussed below are the results of the BPI and PIP simulations.

3.3.3 Estimated Benefits Based on Simulation

The team used dynamic simulations to conduct "what-if" analyses to determine the effects BPIs and PIPs are likely to have. The use of dynamic simulations explored alternative approaches without requiring expensive and extensive on-site experiments. The simulations provided a validation of the engineering assessment in addition to suggesting other possible arrangements and benefits from BPIs.

The simulations used performance data collected from the ALCs and previously conducted Air Force studies, identified in Appendix G. The data consisted of three types: 1) duration time to complete a process; 2) frequency of occurrence of a process or product; and 3) delay or response time for specific exceptions (e.g., the time between generation of a part order and the actual delivery of the part, the time between the submittal of an over and above task and the receipt of the approval or disapproval of the over and above task).

In the process of data collection and analysis, it became apparent that certain conditions represented in the data needed to be accounted for in the simulation of BPIs and PIPs. Those conditions occurred in several areas and are fully discussed in Appendix G. One example is discussed here.

The team found the data at the parent activity level was, on occasion, a better representation of the time to perform the group of lower level activities than the consolidation of individual times identified at the lowest level activities. For example, the data indicated that the times required to perform the Order Parts activity (A53) ranged from 0.2 hours to 1.5 hours, yet the consolidation of the times to perform the three subactivities of Order Parts ranged from 0.45 hours to 6 hours. These times did not seem to be restricted to ordering parts but overlapped other data dealing with obtaining the parts. For this reason, the range of data collected at the parent activity, Order Parts, was used in the simulation. However, the resource utilization and variance considerations (e.g., the probability of occurrence that consists of the parameters influencing a change in the process time or sequencing of the flow) collected at the lowest level activities were representative of PDM and were used in the "AS-IS" simulations without modifications.

3.3.3.1 BPI Simulations

Interviewees noted two major constraints to improving their performance: 1) the lack of parts availability, and 2) uncertainty of guidance material. Therefore, the initial simulations focused on the specific BPIs that addressed those issues as well as the Planning Process Enhancement BPI that has a ripple effect on the other BPIs. Table 3-3 presents the results of the BPI simulations. The change in completion time noted from the "acquire parts" and "automatic technical orders" simulations were combined to form the 33% change reflected in the equation in Section 3, paragraph 3.3.2.3. This change is reflected in the appropriate portions of the BPI simulation equation.

Table 3-3. Benefit Results from BPI Simulation

Activity Simulation	*Change in Completion Time from "AS-IS" to "TO-BE" Simulation*
Acquire Parts	17% Decrease
Automatic Technical Orders	16% Decrease
Planning Process Enhancement	64% Decrease

The network of activities in the simulations and the data supporting these simulations is included in Appendix G. Where BPI simulations were not possible, values were substituted from the engineering assessment.

3.3.3.2 PIP Simulation

The purpose of the PIP simulation was to obtain a more complete view of the results of the BPI changes. The ITI-ALC "AS-IS" Functional Model was used to construct a network. That "AS-IS" network was used as a baseline for evaluation of all PIP networks and for PIP D. That network was validated through review with the users and functional experts, and the results were tested using sensitivity analyses. Where possible, the results were compared to performance observed during data collection. The result, captured in the "TO-BE," is a simplified process. The process is easier to understand, permitting better planning and better execution. By increasing the performance of existing assets, the benefits of simplified processes are decreased throughput time, reduced work in process, improved quality and better adherence to the production schedules. The techniques for simplifying the processes were based on eliminating the sources of complexity in the process. As noted in a report on depot modernization, simplification of the process ought to be the first step in any process improvement effort. "One consideration is reducing the complexity of the work routing, another centers on reducing the variability of the inputs by knowing when and in what condition items will enter the depot, increasing the quality of the repair parts, and making the supply of repair parts more predictable."[12]

The results of the PIP D simulation indicate a 30% reduction in the number of labor-hours to be consumed in the Maintain/Repair Aircraft (A5) activity. This value is used to populate the

[12] *Simplify First: A Modernization Strategy for DoD Maintenance Depots,* Report AL704R2, August 1988, Logistics Management Institute, Bethesda, MD, 20817.

appropriate portions of the PIP equation in Section 3.3.2.3. In addition, there is a 31% reduction in the number of flow days for an aircraft undergoing PDM. There are also substantial reductions in parts delays, Engineering Assistance Requests (EARs), and many other components of the work flow. Table 3-4 presents the benefit results from the simulations.

Table 3-4. PIP Maintenance Simulation Results

(A5 only for "AS-IS" Network -- A4 only for "TO-BE" Network)

Metrics	"AS-IS" Results	PIP-A Results	PIP-A Percent Improvement over "AS-IS" as a Function of PIP-D	PIP-B Results	PIP-B Percent Improvement over "AS-IS" as a Function of PIP-D	PIP-C Results	PIP-C Percent Improvement over "AS-IS" as a Function of PIP-D	PIP-D Results	PIP-D Percent Reduction from "AS-IS"
Initial Tasks	8000	8000		8000		8000		8000	
Flow Days	219	212	10%	196	34%	169	74%	151	31%
Labor-hours	13096	12638	12%	11929	30%	10256	73%	9195	30%
Rob-backs	503	515	-4%	393	39%	335	59%	220	56%
Over & Aboves Approved	673	663	-10%	741	71%	734	64%	769	-14%
Routed Tasks	560	533	11%	456	43%	421	57%	316	44%
Number of Part Delays	2077	1923	16%	1804	28%	1311	78%	1089	48%
Mechanic Delays to Obtain Parts	1103	808	36%	604	60%	415	83%	274	75%
Labor Hours Obtaining Parts	3845	3367	31%	2838	65%	2512	86%	2300	40%
Number of Guidance Delays	870	879	-1%	583	39%	318	74%	125	86%
Mechanic Delays to Obtain Guidance	1766	1783	-1%	1751	1%	966	63%	503	72%
Number of EARs	856	817	10%	774	22%	719	36%	478	44%
Labor Hours Obtaining Guidance	3874	3895	-0%	1234	71%	351	95%	146	96%

NOTE: Benefits are represented as percent improvements from the "AS-IS" and improvements for PIP A, B, and C are a function of PIP D.

They validate the estimated benefits shown in Table 3-2. The PIP A network very closely follows the ITI-ALC "AS-IS" Functional Model since few changes were made to the process in that PIP. However, the networks for PIP B and C are closer to the network developed for PIP D, as reflected in the ITI-ALC "TO-BE" Functional Model.

3.3.3.3 Summary of Estimated Benefits Based on Simulations

The values from the BPIs, the PIP D simulation, and the results from the engineering assessment for those cost components not simulated are combined as follows:

$$F_D\Delta\% = .447\left[(A1_D\Delta\% * .04) + (A2_D\Delta\% * .10) + (A5_D\Delta\% * .85)\right] + .387\,(B_S\%) + .16\,(B_O\%) \pm 10$$

BPI Simulation Benefit Result

$$.250 = .447\left[(.64 * .04) + (.50 * .10^{*}) + (.33 * .85)\right] + .387(.10^{*}) + .16(.33) \pm 10\%$$

PIP D Simulation Benefit Result

$$.239 = .447\left[(.64 * .04) + (.50 * .10^{*}) + (.30 * .85)\right] + .387(.10^{*}) + .16(.331) \pm 10\%$$

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*Obtained from engineering assessments

3.3.4 Summary of Expected Benefits for SM-ALC

As summarized in the previous section, after PIP D implementation, the anticipated result from the engineering assessment is a 26% reduction in PDM operating expense for SM-ALC. Using the BPI simulations, the result is 25.0%. The results of the PIP D simulation indicates a 23.9% reduction. The potential reductions are consistent for both the engineering assessment and the simulations, indicating the results should be very close to what will actually be obtained.

The potential cost of achieving the benefits are discussed in Section 4.

3.4 ANTICIPATED BENEFITS FROM PIP D FOR WR-ALC

3.4.1 Equation Reflecting Benefits at WR-ALC

WR-ALC process improvements were evaluated by their ability to reduce the baseline operating expense using the same approach and basic equation previously derived for SM-ALC.

$$F_D\Delta\% = T_L * (B_{A1} + B_{A2} + B_{A5}) + T_S * B_S + T_O * B_O \pm U$$

As described earlier in this section on WR-ALC, the Labor component is 46.7% of the total operating expense (T_L), the Supplies component is 41.8% (T_S), and the Other component is 11.4% (T_O). As with SM-ALC, there is a relationship between the amount of labor consumed in PDM and the level of other expenses associated with it. Because of this, it is to be expected that changes in labor be reflected in the same rate of change in "Other." As a result, B_O will be equal to B_L. With the values identified above, the equation can be represented for WR-ALC as follows:

$$F_D\Delta\% = .467\left[(T_{A1} * A1_D\Delta\%) + (T_{A2} * A2_D\Delta\%) + (T_{A5} * A5_D\Delta\%)\right] + .418(B_S) + .114(B_O) \pm U$$

As described earlier in the section dealing with the output and cost of WR-ALC, the Plan Production (A1) activity is 4% of the labor resources included in the total operating expense (T_{A1}), the Control Production (A2) activity is 15% (T_{A2}), and the Acquire/Issue Parts (A3) and Repair/Manufacture Components (A4) activities are minimal to nonconsuming and do not affect the operating expense total. The Maintain/Repair Aircraft (A5) activity is 80% of the labor resources included in the total operating expense (T_{A5}). With that information, the final derivation of this equation for WR-ALC can be represented as follows:

$$F_D\Delta\% = .467\left[(.04 * A1_D\Delta\%) + (.15 * A2_D\Delta\%) + (.80 * A5_D\Delta\%)\right] + .418(B_S) + .114(B_O) \pm U$$

A major part of the ITI-ALC project methodology was to begin with a view of the current "AFMC" view of organic aircraft PDM; one that represented the functionality at all ALCs. In both the SM-ALC and WR-ALC cases, the ITI-ALC team reviewed the activities within the "AS-IS" PDM work process, the associated information requirements and how those information requirements were satisfied. Users confirmed that the ITI-ALC "AS-IS" FM reflects the work process at both locations. This fact cannot be over emphasized.

WR-ALC and SM-ALC have many similarities. The few differences relate more to volume of work and the organization of personnel than differences in the way work is accomplished. The number of aircraft on which work was performed is greater at WR-ALC. The number of man-hours expended and quantity of materials consumed at WR-ALC is greater and the type of aircraft is different. But, the functionality is the same. The activity, both direct and indirect, for both locations is the same and is represented in the "AS-IS" FM. The similarity in functionality and the larger volume at WR-ALC, indicates a greater potential for actual benefit in dollar terms.

In conjunction with the WR-ALC effort, the team reviewed the engineering assessments made for SM-ALC and checked their validity for WR-ALC using subject matter experts. In addition the team reviewed the application of BPI and PIP simulation to the WR-ALC analysis. The section of this report describing how simulation was applied to this project, discussed the fact that the simulation engine was built with data from all of the ALCs. Given this, results from the simulations should be indicative of results at any ALCs. To ensure the results from the simulations were valid for WR-ALC, cross-checks were accomplished using only data collected from WR-ALC. Team members reviewed that data and analyzed the potential effects on the simulations of individual BPIs and PIPs. The team did not detect significant variances and the simulation engine was validated for use in evaluating benefits at this ALC. In conclusions, the same level of business process improvements (as represented by percentages) are anticipated in each of the activities in the ITI-ALC "AS-IS" FM at WR-ALC. The benefits' summary is below.

Plan Production (A1): the BPI simulation discussed in paragraph 3.3.3.1 indicated that PIP D should result in a 64% reduction in labor, G&A, and other resources necessary to accomplish this activity at WR-ALC.

Control Production (A2): the benefits for WR-ALC are based on the engineering assessment done for SM-ALC. The types of changes identified in PIP D free approximately 50% of the time which production controllers, industrial production managers, mechanics, and supervisors currently spend on this activity for other duties.

Activities A3 and A4 have virtually no impact on this business case at either of the two locations. The Acquire/Issue Parts/Supplies (A3) consumes a very small portion of the aircraft production personnel at WR-ALC. Since the ITI-ALC "AS-IS" Functional Model does not emphasize component repair, the ITI-ALC team anticipates no substantial change in the resources required by the Repair/Manufacture Components (A4).

Based on the engineering assessment and PIP simulation, the ITI-ALC team determined that "AS-IS" FM Maintain/Repair A/C (A5) at WR-ALC will require 30% less labor, G&A, and other resources when depot maintenance is enhanced with the BPIs and technologies described in PIP D. This estimate is consistent with the results of the GAO study discussed in paragraph 3.3.2.7.

The previous paragraphs discussed benefits in the labor resource (hours, G&A, and other resources). However, savings in supplies should also occur at WR-ALC. The literature review of current DoD alternative supply support techniques (refer to Appendix B) and the engineering assessment suggested that if initiatives such as PIP D were implemented, savings on the order of 10% of the supplies currently included in operating expense, were reasonable. These savings will occur due to a continuing building confidence that the material requirements process will work to the advantage of the mechanics. As a result there will be substantially fewer backorder cancellations and overtime surcharges should fall as at each ALC.

3.4.1.1 Summary of WR-ALC Estimated Benefits Based on Simulation

The values from the BPIs, the PIP D simulation, and the results from the engineering assessment for those cost components not simulated are combined as follows:

$$F_D\Delta\% = .467\left[(A1_D\Delta\% * .04) + (A2_D\Delta\% * .15) + (A5_D\Delta\% * .80)\right] + .418\,(B_S) + .114\,(B_O)$$

BPI Simulation Benefit Result

$$.2533 = .467\left[(.64 * .04) + (.50 * .15) + (.33 * .80)\right] + .418(.10^*) + .114(.364)$$

PIP D Simulation Benefit Result

$$.2391 = .467\left[(.64 * .04) + (.50 * .15) + (.30 * .80)\right] + .418(.10) + .114(.34)$$

*Obtained from engineering assessments

3.4.2 Summary of Expected Benefits for WR-ALC

Because both PDM locations are represented in the "AS-IS" FM, the percentage anticipated benefits are very similar. After PIP D implementation, the anticipated benefits at WR-ALC in reduced operating expense as determined using the BPI simulations, was 25.3%. The results of the PIP D simulation indicates a 23.9% reduction. The potential reductions are consistent for both the analysis methods, indicating the results should be very close to what will actually be obtained. These benefits are used to construct the comparison of costs and benefits in Section 5. The potential cost of achieving the benefits are discussed in Section 4.

4. DATA AND SYSTEM COST ANALYSIS

This section discusses the following costs associated with implementing PIPs:

- Software,
- Hardware,
- System maintenance,
- Training,
- Installation, and
- Data conversion and interfacing systems changes at SM-ALC and WR-ALC.

4.1 OVERVIEW

This section provides a cost analysis of the data and information system changes for each PIP. The cost analysis is at a level of detail to support a life-cycle management review of the information system.

The costs are associated with one ITI-ALC system, hosted at one ALC, to support one PDM process. The cost profile, associated with the time period over which benefits are expected, is described in detail in Section 5. The numbers are then extrapolated to include the cost of the ITI-ALC system for the four PDM (4 weapon systems) lines at SM-ALC and the three PDM lines for WR-ALC.

Appendix H provides the data management and information system strategy the ITI-ALC team proposes; a summary description of the ITI-ALC system for PIPs B, C, and D; and a description of the changes that should be made to external systems to which ITI-ALC will interface. The cost estimate for the ITI-ALC system was derived using a function point analysis technique and the CheckPoint® estimating tool. Appendix I includes a short description of the function point technique and background information on the project description used for CheckPoint data. The function point estimates were derived from the requirements in the ITI-ALC SSS (October 1995), from the ITI-ALC SSDD (February 1996), and from the ITI-ALC System Model presented in the ITI-ALC Architecture Report (June 1995). Appendix J includes further details on hardware cost estimates.

4.2 COST SUMMARY

4.2.1 Cost Summary for SM-ALC

A cost summary for the four PIPs, relative to SM-ALC, are shown in the following tables. PIP A does not include changes in current technology or require software and hardware development. However, PIP A does require training of personnel to accomplish the BPIs. These training

Table 4-1. SM-ALC PIP A Summary (FY94 dollars in millions)

	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FYXX
Training	2.000	1.000	1.000	1.000	1.000	0.300	0.300	0.900

Table 4-2 summarizes the cost for PIP B. Table 4-3 summarizes the cost for PIP C. Table 4-4 summarizes the cost for PIP D. The last year in each of these tables (FYXX) indicates where the cost of the system remains the same for each year after FY01. The numbers in the FYXX column of the two Total rows are the cost of the system starting in FY02 through FY04 (until the end of the 10-year life cycle used in the cost analysis in this document).

Table 4-2. SM-ALC PIP B Summary (FY94 dollars in millions)

	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FYXX
Software	3.000	3.000	3.000	3.000	0.774	-	-	-
Hardware*	-	1.468	1.468	1.468	1.468	-	-	-
Maintenance	-	-	-	-	0.834	0.778	0.547	0.512
Training	-	-	-	0.549	0.549	-	-	-
Installation	-	-	0.290	0.290	0.290	-	-	-
Data Conversion and I/F System	-	-	-	0.044	0.044	0.022	-	-
Total for one PDM line	**3.000**	**4.468**	**4.758**	**5.357**	**3.959**	**0.800**	**0.547**	**0.512**
Hardware for three more PDM lines	-	0.141	0.141	0.141	0.141	-	-	-
Total for four PDM lines at one ALC	**3.0**	**4.6**	**4.8**	**5.5**	**4.1**	**0.8**	**.55**	**.51**

* Hardware development costs plus one PDM line recurring costs

Table 4-3. SM-ALC PIP C Summary (FY94 dollars in millions)

	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FYXX
Software	4.000	4.000	4.000	4.000	2.935	-	-	-
Hardware*	-	1.807	1.807	1.807	1.807	-	-	-
Maintenance	-	-	-	-	1.424	1.324	1.101	1.028
Training	-	-	-	0.749	0.749	-	-	-
Installation	-	-	0.417	0.417	0.417	-	-	-
Data Conversion and I/F System	-	-	-	0.064	0.064	0.032	-	-
Total for one PDM line	**4.000**	**5.807**	**6.224**	**7.037**	**7.396**	**1.356**	**1.101**	**1.028**
Hardware for three more PDM lines	-	0.168	0.168	0.168	0.168	-	-	-
Total for four PDM lines at one ALC	**4.0**	**5.9**	**6.4**	**7.2**	**7.6**	**1.4**	**1.1**	**1.0**

* Hardware development costs plus one PDM line recurring costs

Table 4-4. SM-ALC PIP D Summary (FY94 dollars in millions)

	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FYXX
Software	5.046	5.046	5.046	5.046	5.046	-	-	-
Hardware*	-	1.834	1.834	1.834	1.834	-	-	-
Maintenance	-	-	-		1.998	1.727	1.597	1.357
Training	-	-	-	0.980	0.980	-	-	-
Installation	-	-	0.540	0.540	0.540	-	-	-
Data Conversion and I/F System	-	-	-	0.068	0.068	0.034	-	-
Total for one PDM line	**5.046**	**6.880**	**7.420**	**8.468**	**10.466**	**1.761**	**1.597**	**1.357**
Hardware for three more PDM lines		1.056	1.056	1.056	1.056	-	-	-
Total for four PDM lines at one ALC	**5.0**	**7.9**	**8.4**	**9.5**	**11.5**	**1.8**	**1.6**	**1.4**

* Hardware development costs plus one PDM line recurring costs

4.2.2 Cost Summary for WR-ALC

A WR-ALC cost summary for PIPs A, B, C, and D, is shown in the following tables. PIP A does not include changes in current technology or require software and hardware development. However, PIP A does require training of personnel to accomplish the BPIs. These training dollars are shown in Table 4-5. The last column, FYXX, indicates where the system cost remains the same for each year after FY01. These cost are relative to the size of the staff at the two ALCs, so the WR-ALC numbers are approximately twice as large as the numbers shown in Table 4-1 for SM-ALC.

Table 4-5. WR-ALC PIP A Summary (FY94 dollars in millions)

	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FYXX
Training	4.000	2.000	2.000	2.000	2.000	0.600	0.600	1.800

Table 4-6 summarizes the cost for PIP B at WR-ALC. Table 4-7 summarizes the cost for PIP C at WR-ALC. Table 4-8 summarizes the cost for PIP D at WR-ALC. The last year in each of these tables (FYXX) indicates where the cost of the system remains the same for each year after FY01. The numbers in the FYXX column of the two Total rows are the cost of the system starting in FY02 through FY04 (until the end of the 10-year life cycle used in the cost analysis in this document).

Table 4-6. WR-ALC PIP B Summary (FY94 dollars in millions)

	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FYXX
Software	3.000	3.000	3.000	3.000	0.774	-	-	-
Hardware*	-	1.468	1.468	1.468	1.468	-	-	-
Maintenance	-	-	-	-	0.834	0.778	0.547	0.512
Training	-	-	-	0.962	0.962	-	-	-
Installation	-	-	0.290	0.290	0.290	-	-	-
Data Conversion and I/F System	-	-	-	0.044	0.044	0.022	-	-
Total for one PDM line	**3.000**	**4.468**	**4.758**	**5.764**	**4.372**	**0.800**	**0.547**	**0.512**
Hardware for two more PDM lines	-	0.094	0.094	0.094	0.094	-	-	-
Total for four PDM lines at one ALC	**3.0**	**4.5**	**4.8**	**5.8**	**4.4**	**.80**	**.55**	**.51**

* Hardware development costs plus one PDM line recurring costs

Table 4-7. WR-ALC PIP C Summary (FY94 dollars in millions)

	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FYXX
Software	4.000	4.000	4.000	4.000	2.935	-	-	-
Hardware*	-	1.807	1.807	1.807	1.807	-	-	-
Maintenance	-	-	-	-	1.424	1.324	1.101	1.028
Training	-	-	-	1.324	1.324	-	-	-
Installation	-	-	0.417	0.417	0.417	-	-	-
Data Conversion and I/F System	-	-	-	0.064	0.064	0.032	-	-
Total for one PDM line	**4.000**	**5.807**	**6.224**	**7.612**	**7.971**	**1.356**	**1.101**	**1.028**
Hardware for two more PDM lines	-	0.112	0.112	0.112	0.112	-	-	-
Total for four PDM lines at one ALC	**4.0**	**5.9**	**6.4**	**7.7**	**8.1**	**1.4**	**1.1**	**1.0**

* Hardware development costs plus one PDM line recurring costs

Table 4-8. WR-ALC PIP D Summary (FY94 dollars in millions)

	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FYXX
Software	5.046	5.046	5.046	5.046	5.046	-	-	-
Hardware*	-	1.834	1.834	1.834	1.834	-	-	-
Maintenance	-	-	-		1.998	1.727	1.597	1.357
Training	-	-	-	1.718	1.718	-	-	-
Installation	-	-	0.540	0.540	0.540	-	-	-

Table 4-8. WR-ALC PIP D Summary (FY94 dollars in millions)(Continued)

	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FYXX
Data Conversion and I/F System	-	-	-	0.068	0.068	0.034	-	-
Total for one PDM line	**5.046**	**6.880**	**7.420**	**9.206**	**11.204**	**1.761**	**1.597**	**1.357**
Hardware for two more PDM lines	-	0.703	0.703	0.703	0.703	-	-	-
Total for four PDM lines at one ALC	**5.0**	**7.6**	**8.1**	**9.9**	**11.9**	**1.8**	**1.6**	**1.4**

* Hardware development costs plus one PDM line recurring costs

4.3 COST OF SOFTWARE

Using the CheckPoint® analysis tool, the ITI-ALC team developed a Rough Order Magnitude (ROM) estimate of the software development cost for each of the three PIPs that include ITI-ALC technology (PIPs B, C and D). The following paragraphs summarize the effort months, calendar months and cost for each of these three PIPs, with both a low-end and high-end estimate. The difference in these numbers represents the error associated with the estimation process. Appendix I includes the assumptions made in developing these estimates and the pertinent data for each CheckPoint® analysis. For the ROM estimate desired for this document, there is no significant difference in the cost of software development between SM-ALC and WR-ALC. The two cost estimates are "stand-alone."

All estimates were based on an ITI-ALC system implementation schedule between FY95 and FY99.

The software estimates do not include the following costs:

- Hardware,
- Maintenance,
- Training,
- Installation, and
- Data conversion and changes to interfacing systems.

These items are included in subsequent sections of this document.

4.3.1 Cost of Software for PIP B

For PIP B, the effort to develop the ITI-ALC system is calculated to be 1146.9 to 1277.4 effort months for 33 to 54 months. Assuming development labor is approximately $10,000 per effort month, the low estimate for software development is $11,469,000 (in FY94 dollars). The high estimate for software development is $12,774,000 (in FY94 dollars). This estimate is for a software system sized at 1782 function points or the equivalent of 165,000 lines of Ada code.

4.3.2 Cost of Software for PIP C

For PIP C, the effort to develop the ITI-ALC system is calculated to be 1740.8 to 1893.5 effort months for 33 to 57 months. Assuming development labor is approximately $10,000 per effort month, the low estimate for software development is $17,408,000 (in FY94 dollars). The high estimate for software development is $18,935,000 (in FY94 dollars). This estimate is for a software system sized at 2484 function points or the equivalent of 229,000 lines of Ada code.

4.3.3 Cost of Software for PIP D

For PIP D, the effort to develop the ITI-ALC system is calculated to be 2362.7 to 2523.0 effort months for 37 to 60 months. Assuming development labor is approximately $10,000 per effort month, the low estimate for software development is $23,627,000 (in FY94 dollars). The high estimate for software development is $25,230,000 (in FY94 dollars). This estimate is for a software system sized at 3159 function points or the equivalent of 292,000 lines of Ada code.

4.4 COST OF HARDWARE

This section includes only a summary of hardware costs for the ITI-ALC system. Appendix J includes itemized lists of hardware items with more detailed assumptions for the cost estimation. The hardware cost estimates for PIPs B, C, and D are based on the hardware configuration items identified in the ITI-ALC SSDD. The hardware estimates support one PDM line for all of the system requirements specified in the ITI-ALC SSS. Although these numbers are extrapolated to include the cost of the ITI-ALC system for the all PDM lines at an ALC, some development numbers do not recur from installation to installation. Appendix J features each hardware item, an example from today's market of that class of device, the vendor who supplies the hardware item, the number of units to support one ALC's PDM effort, the unit cost, the total cost, and comments on how the estimates were derived. It also includes both recurring costs and development costs. The number of units required is based on the existing F-15 PDM staff at each of the ALCs modified to include changes due to the BPIs. Unit costs were derived from best-of-market rough orders of magnitude estimates adjusted for time. A major assumption driving the development cost estimates is that unmodified COTS hardware items will be used whenever possible.

For the ROM estimate desired for this document, there is no significant difference in the cost of hardware between the two ALCs. The two cost estimates for hardware development are "stand-alone." Recurring hardware costs have been estimated for each ALC based on number of units required.

NOTE: The hardware examples used will not be the specific hardware used for the ITI-ALC system. The examples are for costing purposes only.

Table 4-9 presents a rough order of magnitude estimate for the total recurring and development hardware costs for the ITI-ALC system for PIPs B, C, and D. Recurring costs are for each PDM line.

Table 4-9. Hardware Cost Summary for PIPs B, C, and D

PIP	Per PDM Recurring Cost	Development Cost
B	$188, 400	$5,680,900
C	$223,992	$5,984,892
D	$1,407,560	$7,333,460

NOTE: The installation of hardware is included in the system installation cost estimate shown in Section 4.7.

4.5 COST OF SYSTEM MAINTENANCE

The cost of system maintenance is included in this Business Case to provide a complete estimate of the total cost of an ITI-ALC system. Table 4-10 is the rough order of magnitude estimate of the potential system maintenance cost associated with PIPs B, C, and D. This estimate was derived from the CheckPoint® analysis tool. There is no significant difference in a ROM estimate of maintenance costs for the two ALCs.

Table 4-10. ITI-ALC System Maintenance Cost for PIPs B, C, and D

	FY99	FY00	FY01	FY02	FY03	FYXX
PIP B						
- Staff	10	10	9	8	8	8
- EM*	83.4	77.8	54.7	51.2	51.2	51.2
- Cost (millions)	0.834	0.778	0.547	0.512	0.512	0.512
PIP C						
- Staff	17	16	14	13	13	13
- EM	142.4	132.4	110.1	102.8	102.8	102.8
- Cost (millions)	1.424	1.324	1.101	1.028	1.028	1.028
PIP D						
- Staff	23	21	18	16	16	16
- EM	199.8	172.7	159.7	135.7	135.7	135.7
- Cost (millions)	1.998	1.727	1.597	1.357	1.357	1.357

*EM = Effort Month

4.6 COST OF TRAINING ON THE ITI-ALC SYSTEM

4.6.1 Cost of System Training for SM-ALC

Table 4-11 presents the cost estimate for providing training to personnel at SM-ALC who will use the ITI-ALC system. This estimate was derived from the CheckPoint® analysis tool. These costs assume all users (approximately 500) will be trained.

Table 4-11. ITI-ALC Training Cost for PIPs B, C, and D

	TRAINING PLAN	TRAINING MATERIAL	CONDUCT TRAINING	TOTAL TRAINING COSTS
PIP B				
- EM*	1.5	25.8	3.3/20 students	
- Cost	$15,000	$258,000	$825,000	$1,098,000
PIP C				
- EM	2.0	32.9	4.6/20 students	
- Cost	$20,000	$329,000	$1,150,000	$1,499,000
PIP D				
- EM	2.6	45.9	5.9/20 students	
- Cost	$26,000	$459,000	$1,475,000	$1,960,000

*EM = Effort Month

4.6.2 Cost of System Training for WR-ALC

Table 4-12 presents the cost estimate for providing training to personnel at WR-ALC who will use the ITI-ALC system. This estimate was derived from the CheckPoint® analysis tool. These costs assume all users (approximately 1000) will be trained.

Table 4-12. WR-ALC ITI-ALC Training Cost for PIPs B, C, and D

	TRAINING PLAN	TRAINING MATERIAL	CONDUCT TRAINING	TOTAL TRAINING COST
PIP B				
- EM*	1.5	25.8	3.3/20 students	
- Cost	$15,000	$258,000	$1,650,000	$1,923,000
PIP C				
- EM	2.0	32.9	4.6/20 students	
- Cost	$20,000	$329,000	$2,300,000	$2,649,000

Table 4-12. WR-ALC ITI-ALC Training Cost for PIPs B, C, and D (Continued)

	TRAINING PLAN	TRAINING MATERIAL	CONDUCT TRAINING	TOTAL TRAINING COST
PIP D				
- EM	2.6	45.9	5.9/20 students	
- Cost	$26,000	$459,000	$2,950,000	$3,435,000

*EM = Effort Month

4.7 COST OF INSTALLATION

The potential installation date of the ITI-ALC system is FY98 (although preparation for the installation will start in FY97). The cost is for one system, hosted at a single ALC, for one PDM process. This estimate was derived from the CheckPoint® analysis tool. Table 4-13 presents the ITI-ALC system installation cost for PIPs B, C, and D. There is no significant difference in a ROM estimate of "cost-to-install" for the two ALCs. So the numbers shown in Table 4-13 are used for both ALCs.

Table 4-13. ITI-ALC Installation Cost for PIPs B, C, and D

	PIP B		PIP C		PIP D	
INSTALLATION ITEMS	EM*	Cost	EM	Cost	EM	Cost
Maintenance Manual	17.7	$177,000	26.6	$266,000	35.3	$353,000
Installation Guide	1.1	$11,000	1.6	$16,000	2.0	$20,000
Programmers' Guide	12.7	$127,000	17.8	$178,000	24.4	$244,000
Operator s' Manual	17.0	$170,000	25.6	$256,000	32.5	$325,000
System Programmers' Guide	7.9	$79,000	11.0	$110,000	15.1	$151,000
Software Installation	1.9	$19,000	2.6	$26,000	3.3	$33,000
Hardware Installation	7.5	$75,000	8.5	$85,000	10.5	$105,000
Document Reviews	21.2	$212,000	31.3	$313,000	39.0	$390,000

*EM = Effort Month

4.8 COST OF DATA CONVERSION

This section provides the cost to convert data present today in the depot into data that can be used by the ITI-ALC system. Section 4.8.1 discusses the cost of converting all data except technical manuals. Section 4.8.2 provides an example of the costs for converting existing technical manuals into IETM data. For the ROM required for this document, there is no significant difference between SM-ALC and WR-ALC.

4.8.1 ETM and Legacy Data Conversion Estimate

While accomplishing the data collection interviews for this project, the team encountered a Joint Logistics Systems Center (JLSC) team conducting a study to determine the potential cost to convert ETM and legacy data for the Depot Maintenance Standard System. That estimate was subsequently approved for use by the JLSC and a summary is included here.

The cost to convert ETM and legacy data is based on the factors used for DMSS as referenced in DMSS Cost Element Data Sheet CES No. 1.6.9.2 (JLSC, 1995). The factors include costs for items such as initially developing build routes (a list of operations required to overhaul a specific item or part), checking and verifying bills of material, loading and checking the data, and converting operating instructions. The cost shown below includes transferring and creating data from the depot's current systems into the DMMIS/Materiel Requirements Planning (DMMIS/MRP II) system. Although this is not a perfect fit with the ITI-ALC system, it does represent a good rough order of magnitude estimate for converting non-IETM data and for creating the ITI-ALC system database. This cost is nonrecurring; that is, done only once per ALC. According to the DMSS cost element data sheet, an ALC site load is estimated at 75,719 hours. Assuming a GS-11 performs the task at a rate of $29.28 per hour, the cost would be $2.217 million. An estimated 2.5 years would be needed to complete the task with allocation of cost per year being 40%, 40%, and 20%.

4.8.2 IETM Data Conversion Consideration

It is assumed MMSS will be in place by the time ITI-ALC becomes operational, and it will have performed all the conversion required to turn paper technical manuals into IETM data. Given this assumption, this Business Case does not include a cost estimate for converting technical manuals into IETM data.

However, the algorithm used on the IMIS project is described below to provide insight into the cost associated with converting technical manuals into IETM data (Armstrong Laboratory, 1994). The primary review of the technical manual conversion was conducted by AL/HRGO and MACAIR to support the IMIS demonstration for the F-18. The effort to convert 800 pages of technical manual data (649 pages of text and 151 pages of graphics) consisted of 4.5 effort months, excluding graphic preparation. The graphic preparation was estimated at between two to three hours per illustration. A cost per page factor and algorithm were developed for both text and graphics. If this algorithm were to be used with all default values, the cost of converting technical manuals for the ITI-ALC system would be equal to $54,579,530. This would be a recurring cost realized for each PDM line the ITI-ALC system would support. The algorithm used for the IMIS project is as follows:

$$CONVRATES\$ = (\%TEXT * TEXT\$) + (\%GRAPH * GRAPH\$)$$
$$TOTCONV\$ = CONVRATES\$ * TOTPGS$$

where *CONVRATES$* is the average rate to convert a technical manual page, *%TEXT* is the percentage of text pages contained in an average technical manual (default = 60%), *TEXT$* is the cost per page to convert a text page (default = $64.37), *%GRAPH* is the percentage of pages containing graphics in an average technical manual (default = 40%), *GRAPH$* is the cost per page to convert graphics (default = $140.65), *TOTPGS* is the total technical manual pages (default = 575,248), and *TOTCONV$* is the total cost to convert paper technical manuals into IETM data.

4.9 COST FOR CHANGES TO EXTERNAL SYSTEM INTERFACES

The cost associated with changing the external systems that interface with the ITI-ALC system is based on changes to the systems identified in Appendix H. After analysis of data collected at the two ALCs, there is no significant difference in a ROM estimate of the cost of changes to external system interfaces for the two ALCs.

Table 4-14 summarizes the cost for each system interfacing with ITI-ALC for PIPs B, C, and D. The totals listed below are allocated across 2.5 years at 40%, 40%, and 20% per year (refer to Tables 4-2, 4-3, 4-4, 4-6, 4-7, and 4-8 for allocation).

Table 4-14. Cost for Changing External Systems for PIPs B, C, and D

SYSTEM	PIP B	PIP C	PIP D
DM-HMMS	$10,000	$10,000	$10,000
IMDS	-	$40,000	$40,000
DM-FEMS	$10,000	$10,000	$10,000
FSS	-	$10,000	$10,000
MMSS	$30,000	$30,000	$30,000
DM-PDMSS	-	-	-
DM-DMMIS	$50,000	$50,000	$50,000
APDS	-	-	$10,000
PAC	-	-	-
DM-TIMA	$10,000	$10,000	$10,000
Base Network	-	-	-
Support Equipment and Tools	-	-	-
Parts/Reparables	-	-	-
Aircraft Interface	-	-	-
External Printer	-	-	-
TOTAL	**$110,000**	**$160,000**	**$170,000**

5. CONCLUSIONS

This section discusses the following:

- Base and accelerated PIP implementations.
- Comparison of PIP implementations.
- Conclusions for SM-ALC and WR-ALC.

5.1 OVERVIEW

The major objective of the ITI-ALC program is to identify proposals for improving the performance of available manpower resources by integrating multiple information sources into a single, easy-to-use system. In this Business Case, the ITI-ALC team identified specific process improvements that accomplish this objective and as a result:

- Significantly reduce operating expense for organic aircraft PDM.
- Reduce aircraft flow days.

In addition, the ITI-ALC project has produced several significant products that support the DoD maintenance community of the future:

- ITI-ALC Architecture Report.
- ITI-ALC System/Segment Specification.
- ITI-ALC System/Segment Design Document.

5.2 COMPARISON OF PIP IMPLEMENTATIONS AT SM-ALC

This Business Case has provided four proposals for implementing process improvements. Some of the PIPs can be implemented in one of two ways, either using the base implementation or the accelerated implementation. The two ways are based on high and low estimates of software development by CheckPoint as shown in Section 4.3. Table 5-1 provides a comparison of each PIP implementation. This table contains four decision parameters; for each of six implementations: 1) Risk Adjusted Discounted Cash Flows Savings (RADCF), 2) Return on Investment (ROI) for each year, 3) Risk Adjusted Return on Investment (RAROI), and 4) the Discounted Payback (in years). A summary of each is included here. A more detailed explanation is included in Appendix D.

RADCF is a summary measure of annual cash flows using discounting to convert to present value. It includes both investments and benefits. This measure uses risk analysis to reflect possible deviation from expected costs or savings. The alternative with the greatest savings in millions of dollars is the preferred alternative.

ROI answers the question, "What do I get back for my investment in a specific year?" It is an annual comparison, for each implementation, of that year's net present value of investment plus the net present value of the benefit, compared to the net present value of the investment in that year.

RAROI is a return on investment measure which also takes into account the uncertainty associated with potential costs and benefits. The discounted payback of a particular implementation is the number of years it takes before the total discounted cost impacts (benefits) equal the total discounted investments. In the ITI-ALC case, the implementation with the shorter payback and the largest RADCF savings is preferred. A brief description of each implementation is provided below.

5.2.1 Base PIP D (Fully Developed ITI-ALC System)

This implementation incorporates the investment stream as illustrated in Table 4-4. The majority of the investment occurs over a five-year period. Based on the analysis described in Section 3, it includes a 12% savings from current operating expense in the first year of operation (FY99) and 23.9% for each year thereafter. It also reduces flow days by 31% from the current measures. The potential savings, return on investment, and payback for this implementation are included in Table 5-1.

Table 5-1. Comparison of ITI-ALC PIP Implementations

	PIP D Base	PIP D Accelerated	PIP C Base	PIP C Accelerated	PIP B Base	PIP A Base
FY 94 $ (Millions)						
RADCF Savings Hi	70.11	116.26	45.51	77.04	13.09	13.78
RADCF Savings	65.32	110.16	42.18	72.81	11.35	13.02
RADCF Savings Lo	60.56	104.10	38.88	68.6	9.63	12.26
Percentage (%)						
ROI 1995 (%)	-100.00	-100.00	-100.00	-100	-100	-100
ROI 1996 (%)	-100.00	-100.00	-100.00	-100	-100	-100
ROI 1997 (%)	-100.00	-63.86	-100.00	-66.85	-100	-54.29
ROI 1998 (%)	-100.00	-5.08	-100.00	-12.13	-100	1.37
ROI 1999 (%)	-69.65	49.14	-72.48	38.34	-80.66	38.28
ROI 2000 (%)	-15.94	99.18	-23.00	84.91	-49.96	80.22
ROI 2001 (%)	32.31	145.46	21.74	127.99	-21.67	117.16
ROI 2002 (%)	79.21	188.35	65.16	167.9	5.65	149.91
ROI 2003 (%)	123.22	228.16	105.96	204.94	31.43	179.12
ROI 2004 (%)	164.58	265.18	144.32	239.38	55.76	205.29
Percentage (%)						
RA ROI Hi (%)	182.75	292.25	161.05	264.47	66.53	224.61
RA ROI (%)	164.58	265.18	144.32	239.38	55.76	205.29
RA ROI Lo (%)	147.67	240.44	128.76	216.45	45.75	187.31
Years						
Discounted Payback	6.32	4.09	6.51	4.24	7.79	3.97

These terms and the mathematics associated with their calculation are described in Appendix D.
RADCF = Risk Adjusted Discounted Cash Flow, ROI = Return on Investment, RA ROI = Risk Adjusted Return on Investment

5.2.2 Accelerated PIP D (Fully Developed ITI-ALC System)

This implementation has the majority of the development investment occurring over a three-year period (FY 95 through FY97). As a result, the system comes on line two years earlier. Based on the analysis described in Section 3, it includes a 12% savings from current operating expense in the first year of operation (FY97) and 23.9% for each year thereafter. It also reduces flow days by 31% from the current measures. The potential savings, return on investment, and payback for this implementation are included in Table 5-1.

5.2.3 Base PIP C (Integrated Data)

This implementation incorporates the investment stream as illustrated in Table 4-3. The majority of the investment occurs over a five-year period. Based on the analysis described in Section 3, it includes a 8% savings from current operating expense in the first year of operation (FY99) and 16% for each year thereafter. The potential reduction in flow days is shown on Table 3-4. The potential savings, return on investment, and payback for this implementation are included in Table 5-1.

5.2.4 Accelerated PIP C (Integrated Data)

This implementation has the majority of the development investment occurring over a three-year period (FY 95-97). This brings the system on line two years earlier. Based on the analysis described in Section 3, it includes a 8% savings from current operating expense in the first year of operation (FY97) and 16% for each year thereafter. The potential reduction in flow days shown on Table 3-4. The potential savings, return on investment, and payback for this implementation are included in Table 5-1.

5.2.5 PIP B (Introductory System)

This implementation incorporates the investment stream as illustrated in Table 4-2. The majority of the investment occurs over a five-year period. Based on the analysis described in Section 3, it includes a 4% savings from current operating expense in the first year of operation (FY99) and 7% for each year thereafter. As a result of the low level of potential savings, no alternative investment strategy is presented for this PIP B. The potential reduction in flow days is shown on Table 3-4. The potential savings, return on investment, and payback for this implementation are included in Table 5-1.

5.2.6 PIP A (Process Improvements Only, No ITI-ALC Technology)

This PIP does not introduce ITI-ALC technology, but institutes process improvements for reducing operating expense and improving flow days. This implementation incorporates the investment stream illustrated in Table 4-1. The investment occurs continually. Based on the analysis described in Section 3, it includes a 1.5% savings from current operating expense in the first year of operation (FY97) and 3% for each year thereafter. The potential savings, return on investment, and payback for this implementation are included in Table 5-1.

5.3 CONCLUSIONS FOR SM-ALC

Based on the engineering assessment and simulations, PIP D in either the base or accelerated implementation produces the greatest benefits in terms of dollars and reduced flow days. Figure 5-1 depicts the comparison of PDM operating expense for each PIP implementation at SM-ALC.

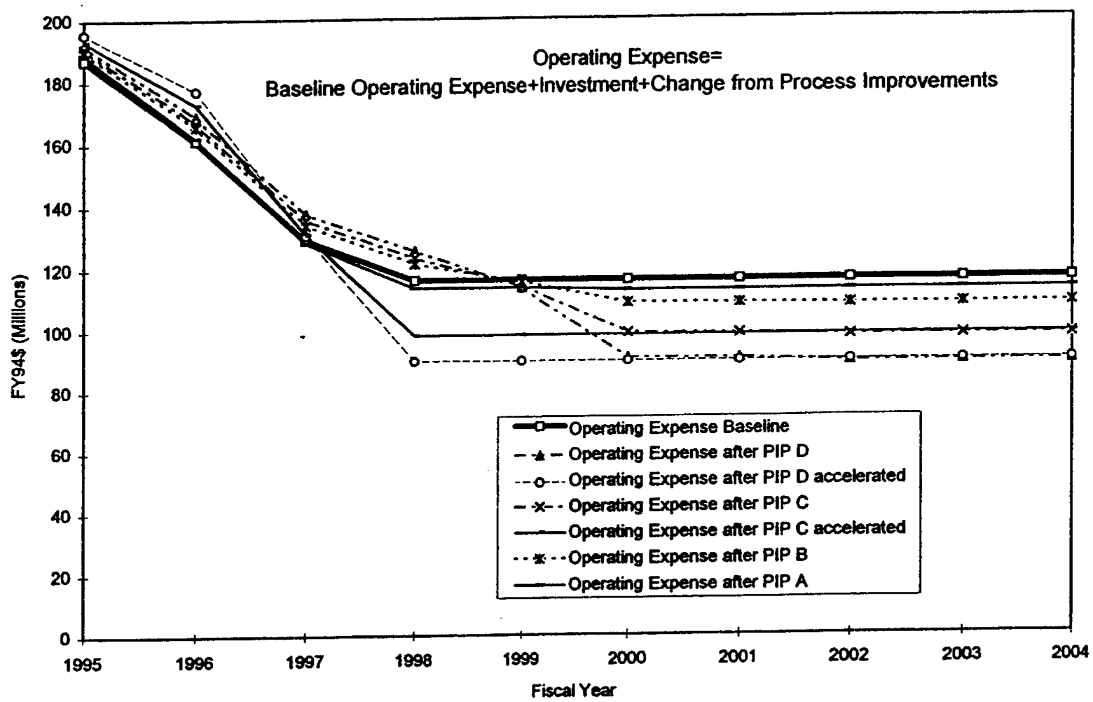

Figure 5-1. Comparison of PDM Operating Expense at SM-ALC

5.4 COMPARISON OF PIP IMPLEMENTATIONS AT WR-ALC

As at SM-ALC, one of the objectives of this business case was to provide multiple proposals for implementing process improvements. Two of the PIPs can be implemented in one of two ways, either using the base implementation or on an accelerated schedule. The two ways are based on high and low estimates of software development by Checkpoint as shown in Section 4.3. Table 5-2 provides a comparison of each PIP implementation. A brief description of each implementation is provided below.

5.4.1 Base PIP D (Fully Developed ITI-ALC System)

This implementation incorporates the investment stream as illustrated in Table 4-8. The majority of the investment occurs over a five-year period. Based on the analysis described in Section 3, it includes a 12% savings from current operating expense in the first year of operation (FY99) and 23.9% for each year thereafter. It also reduces flow days by 31% from the current measures. The potential savings, return on investment, and payback for this implementation are included in Table 5-2.

Table 5-2. Comparison of ITI-ALC PIP Implementations

	PIP D Base	PIP D Accelerated	PIP C Base	PIP C Accelerated	PIP B Base	PIP A Base
FY 94 $ (Millions)						
RADCF Savings Hi	106.41	170.08	69.36	112.62	23.62	14.44
RADCF Savings	100.45	162.50	65.21	107.33	21.52	13.28
RADCF Savings Lo	94.52	154.96	61.09	102.07	19.43	12.14
Percentage (%)						
ROI 1995 (%)	-100.00	-100.00	-100.00	-100.00	-100.00	-100.00
ROI 1996 (%)	-100.00	-100.00	-100.00	-100.00	-100.00	-100.00
ROI 1997 (%)	-100.00	-50.27	-100.00	-56.18	-100.00	-68.78
ROI 1998 (%)	-100.00	30.89	-100.00	16.94	-100.00	-30.56
ROI 1999 (%)	-59.50	103.51	-64.38	82.42	-74.74	-6.25
ROI 2000 (%)	11.98	170.53	-0.21	142.92	-34.60	21.62
ROI 2001 (%)	76.20	232.51	57.90	198.91	2.41	46.17
ROI 2002 (%)	138.71	289.93	114.26	250.83	38.13	67.94
ROI 2003 (%)	197.41	343.24	167.25	299.05	71.85	87.35
ROI 2004 (%)	252.60	392.79	217.09	343.91	103.68	104.74
Percentage (%)						
RA ROI Hi (%)	276.90	429.32	238.87	376.93	117.81	117.70
RA ROI (%)	252.60	392.79	217.09	343.91	103.68	104.74
RA ROI Lo (%)	230.01	359.41	196.83	313.76	90.56	92.69
Years						
Discounted Payback	5.83	3.61	6.00	3.76	6.93	5.22

These terms and the mathematics associated with their calculation are described in Appendix D.
RADCF = Risk Adjusted Discounted Cash Flow, ROI = Return on Investment, RA ROI = Risk Adjusted Return on Investment

5.4.2 Accelerated PIP D (Fully Developed ITI-ALC System)

This accelerated implementation has the majority of the development investment occurring over a three-year period (FY 95 through FY97) rather than five. As a result, the system comes on line two years earlier. Based on the analysis described in Section 3, it includes a 12% savings from current operating expense in the first year of operation (FY97) and 23.9% for each year thereafter. It also reduces flow days by 31% from the current measures. The potential savings, return on investment, and payback for this implementation are included in Table 5-2.

5.4.3 Base PIP C (Integrated Data)

This implementation incorporates the investment stream as illustrated in Table 4-7. The majority of the investment occurs over a five-year period. Based on the analysis described in Section 3, it includes a 8% savings from current operating expense in the first year of operation (FY99) and 16% for each year thereafter. The potential reduction in flow days is shown on Table 3-4. The potential savings, return on investment, and payback for this implementation are included in Table 5-2.

5.4.4 Accelerated PIP C (Integrated Data)

This accelerated implementation has the majority of the development investment occurring over a three-year period (FY 95-97). This brings the system on line two years earlier. Based on the analysis described in Section 3, it includes a 8% savings from current operating expense in the first year of operation (FY97) and 16% for each year thereafter. The potential reduction in flow days shown on Table 3-4. The potential savings, return on investment, and payback for this implementation are included in Table 5-2.

5.4.5 PIP B (Introductory System)

This implementation incorporates the investment stream as illustrated in Table 4-6. The majority of the investment occurs over a five-year period. Based on the analysis described in Section 3, it includes a 4% savings from current operating expense in the first year of operation (FY99) and 7% for each year thereafter. As a result of the low level of potential savings, no alternative investment strategy is presented for this PIP B. The potential reduction in flow days is shown on Table 3-4. The potential savings, return on investment, and payback for this implementation are included in Table 5-2.

5.4.6 PIP A (Process Improvements Only, No ITI-ALC Technology)

This PIP does not introduce ITI-ALC technology, but institutes process improvements for reducing operating expense and improving flow days. This implementation incorporates the investment stream illustrated in Table 4-5. The investment occurs continually. Based on the analysis described in Section 3, it includes a 1.5% savings from current operating expense in the first year of operation (FY97) and 3% for each year thereafter. The potential savings, return on investment, and payback for this implementation are included in Table 5-2.

5.5 CONCLUSIONS FOR WR-ALC

Based on the engineering assessment and simulations, PIP D in either the base or accelerated implementation produces the greatest benefits in terms of dollars and reduced flow days. Figure 5-2 depicts the comparison of PDM operating expense for each PIP implementation at WR-ALC.

5.6 ITI-ALC PROGRAM CONCLUSIONS

The eve of the 21st century marks more than a chronological milestone. Converging changes in technology and economics, and fundamental restructuring and downsizing of the military call for fresh thinking about how to harness information technology to provide tangible value to organizations and users. The challenge is to adapt organizations and processes to rapidly changing technologies and methodologies to achieve greater effectiveness and quality at reduced cost. Organizations that master change will realize their goals, while those who fail to reengineer their policies and practices will diminish in stature and gradually fade away.

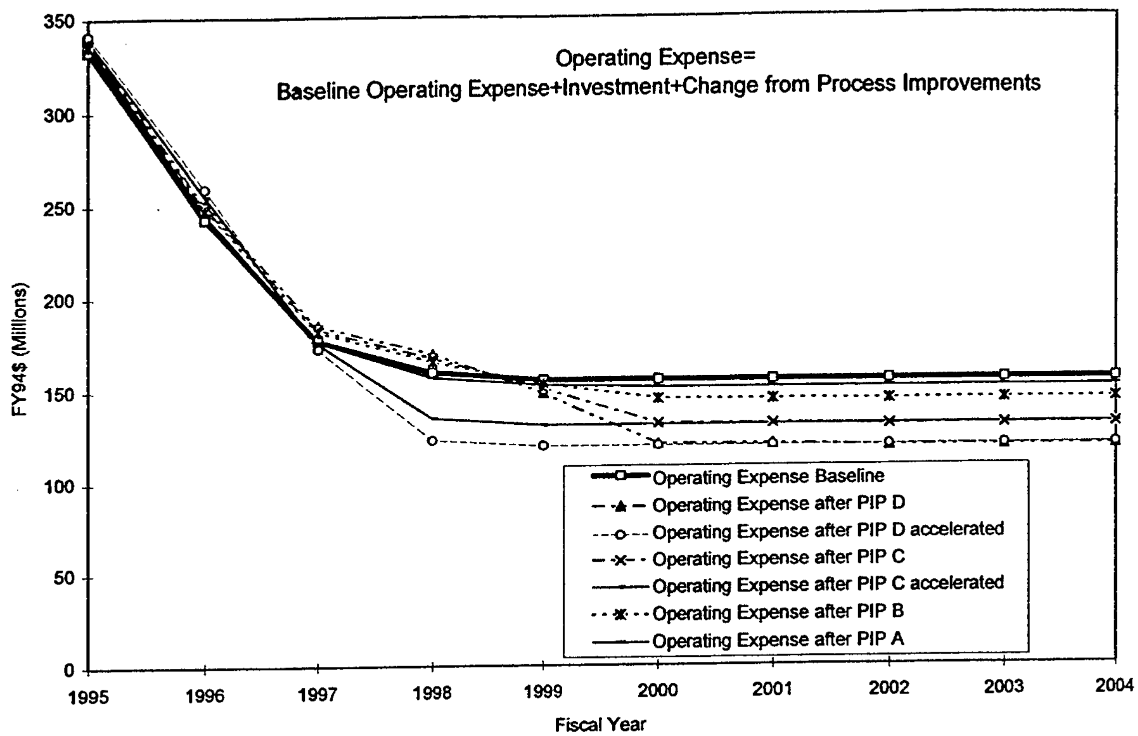

Figure 5-2. Comparison of PDM Operating Expense at WR-ALC

The ALCs are poised on the forward edge of military readiness. Budget realities demand that older and often heavily modified aircraft remain in the inventory longer; thus increasing the importance of cost-effective, improved depot maintenance. These improvements require that better, more timely, and seamlessly integrated information -- information currently resident in numerous systems -- be made available to the depot-level mechanics, managers, and planners.

The budget austerity that spawned the current emphasis on functional process improvements and reengineered business practices is not likely to abate. Managers in every organization must objectively rethink their current processes and challenge the status quo. Merely injecting technology without improving the underlying processes yields marginal, short-term improvements -- not the type of fundamental breakthroughs that are imperative if the ALCs are to do more for less. Only by reengineering its operations can the Air Force realize the hoped-for productivity and quality improvements that are needed to meet its mission.

The ITI-ALC program was established to address these objectives of integrating and delivering the information required in the depot maintenance process. The improved process and the ITI-ALC system referenced by this business case will help to standardize and integrate maintenance processes and information not only within a depot but also across the depots.

The conclusion of this project is that the cost of accomplishing organic aircraft programmed depot maintenance in two AFMC depots and the number of flow days an aircraft spends in work can be materially reduced by integrating the information requirements and production in those depots. Integrating the work and information needs, through an approach such as ITI-ALC reduces the uncertainty in the work process and focuses the time and effort of aircraft technicians and support personnel on the aircraft themselves, rather than the processes which result in their repair.

This business case identified specific process improvement proposals which, if implemented, can reduce the cost of organic aircraft PDM by almost 24% and at the same time, return valuable aircraft to their users in 30% less time.

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Appendix A

Site Selection

A.1 INTRODUCTION

The goal of the site selection process was to assist in identifying the ALC that would most likely support the successful demonstration of an ITI-ALC system, would provide useful cost and performance data, and further help develop a system capable of supporting all ALCs. The candidates were the five ALCs.

This appendix includes a summary of the site selection recommendation; an overview of the decision-making process; introduction to the Analytic Hierarchy Process (AHP); information on a decision support tool used in the process (Expert Choice®); and site selection criteria, scoring guidelines, and priorities for those criteria.

The final recommendation for site selection was a joint effort of the Government Program Manager (AL/HRGO), functional/domain experts, and system/software engineers.

Figure A-1 shows the results of the effort and the final score of each ALC. WR-ALC and SM-ALC scores indicate no significant difference between them using the criteria and approach outlined in the remainder of this appendix.

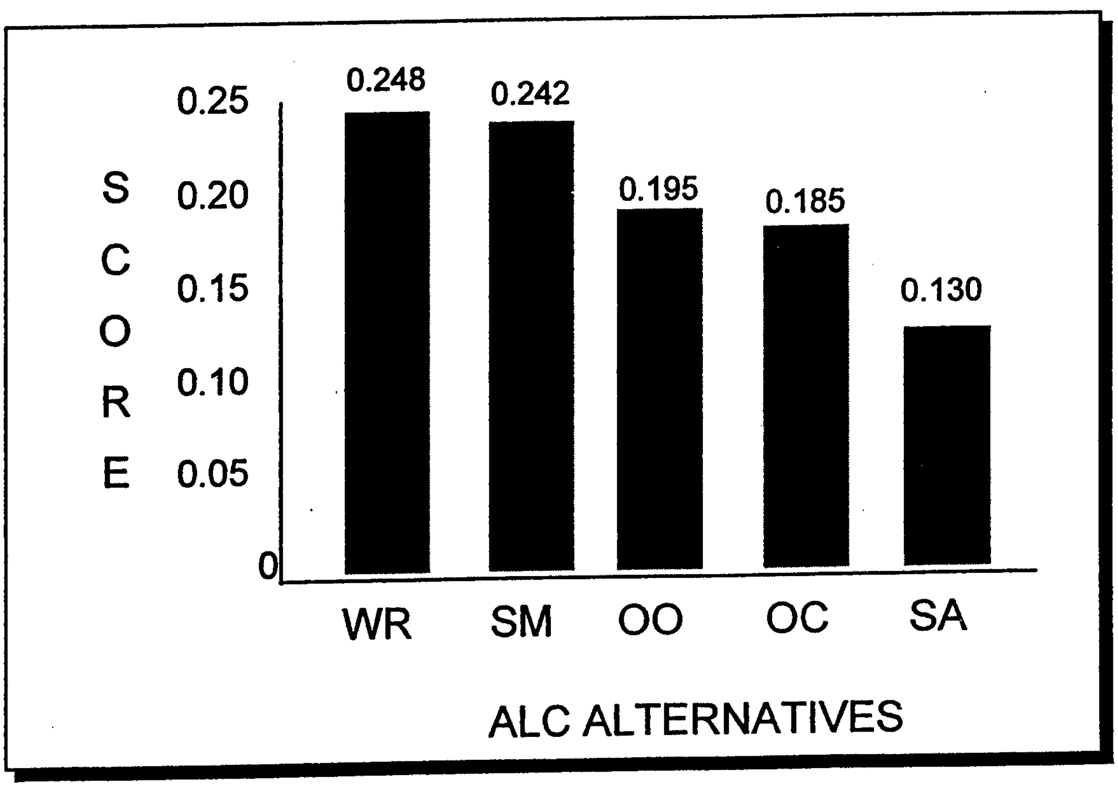

Figure A-1. Results of the AHP Site Selection Effort

A.2 PROCESS OVERVIEW

The selection process that works best with the chosen methodology (AHP) is based on work done by Herbert Simon (1990) and is outlined below:

1. Problem Definition and Research
2. Elimination of Infeasible Alternatives (low pass filter)
3. Evaluate Candidates
    a. Determine Selection Criteria
    b. Prioritize and Weight Criteria
    c. Make Comparisons (score alternatives)
    d. Synthesize Judgment (Expert Choice)
    e. Examine and Verify Results (sensitivity analysis, etc.)
4. Document the Decision

A.3 ANALYTIC HIERARCHY PROCESS

AHP uses the following three principles of analytical thinking: 1) structured hierarchies, 2) setting priorities, and 3) logical consistency.

In all decision making, the human mind will formally or informally break down a decision into its constituent parts and arrange those parts as a hierarchy of interdependencies. The most general elements are at the top of the hierarchy and the most concrete elements are at the bottom. The elements on a given level are influenced by the elements on the level above. AHP mimics this process in a very formal and rigorous manner.

The second principle of analytical thinking is the process of perceiving relationships among the things within a set, to compare pairs of similar things against certain criteria, and to discriminate between both members of a pair by judging the intensity of the preference for one over the other.

The third principle of analytical thinking used in AHP is logical consistency. This is the ability to establish a relationship among ideas in such a manner that they are coherent—that is, they relate well to one another and the relationship exhibits consistency. For this process, consistency means two things. First, that similar ideas are grouped according to homogeneity and relevance. Second, the intensities of relations among ideas based on a particular criterion justify each other in some logical way.

AHP incorporates judgments and personal values in a logical way. It depends on imagination, experience, and knowledge to structure the hierarchy of a problem and on logic, intuition, and experience to provide judgments. Once accepted and followed, the AHP shows us how to connect elements of one part of the problem with those of another to obtain the combined outcome. It is a process for identifying, understanding, and assessing the interactions of a system as a whole.

To define a complex problem and to develop sound judgments, the decision-making process must be progressively repeated, or iterated, over time; one can hardly expect instant solutions to complicated problems with which one has wrestled for a long time. AHP is flexible enough to allow revision—decision makers can both expand the elements of a problem hierarchy and change their judgments. It also permits them to investigate the sensitivity of the outcome to whatever kinds of change may be anticipated. Each iteration of the AHP is like hypothesis making and testing; the progressive refinement of hypotheses leads to a better understanding of the system.

Another feature of AHP is that it provides a framework for group participation in decision making or problem solving. Ideas and judgments can be questioned and strengthened or weakened by evidence that other people present. The way to shape unstructured reality is through participation, bargaining, and compromise. Indeed, the conceptualization of any problem by AHP requires one to consider ideas, judgments, and facts accepted by others as essential aspects of the problem. Group participation can contribute to the overall validity of the outcome, although perhaps not to the ease of implementation if the views diverge widely. Thus one could include in the process any information derived scientifically or intuitively.

A.4 EXPERT CHOICE DECISION SUPPORT TOOL

Expert Choice is a decision support tool that hierarchically organizes thought and intuition in a logical fashion. It allows the user to analyze all options for efficient decision making. Expert Choice can compare tangible factors with intangible factors—for example: "cost of a project," vs. "viability of a project." Expert Choice tolerates uncertainty and allows for revision so individuals and groups can evaluate all their concerns.

When creating a decision model using the Expert Choice tool, the user first defines the decision problem as the goal. The user then structures the problem as levels of criteria related to that goal within a hierarchical framework. Once these criteria have been determined, the alternatives are placed at the bottom level of the hierarchy under each criterion. The flexibility of the hierarchic structure allows the user to build models that are very specific to the context of the problem. The tool leads the decision maker through a series of judgments between the alternatives under each criterion, and then between the criteria. The judgment process can be based on importance, preference, or likelihood.

The program provides verbal, numerical, and graphical comparison modes or lets the user enter data directly. The verbal mode allows the user to compare the criteria on a nine-level scale with levels ranging from "equal" to "extreme." For example, when choosing a car, one judgment may involve deciding between Car A and Car B with respect to style. This would be a preference judgment, and the user may decide that Car A is "strongly" preferred over Car B. This same judgment can be represented in the numerical mode with Car A preferred over Car B by a magnitude of five, and in the graphical mode using a bar chart or pie chart. The program's ratings utility, similar to a spreadsheet, lets the user compare literally thousands of alternatives under various criteria based on a user-defined scale. Through the comparison process, the tool develops a matrix of all of the judgments. This matrix is the basis for testing judgment consistency.

One important feature of the Expert Choice tool is its flexibility in terms of consistency of judgments. The software allows the decision maker to be inconsistent, but provides guidance toward more consistent judgments if necessary. This consistency analysis feature is valuable when working through complex decision problems that may require multiple iterations.

Once the inconsistency has been reduced to a reasonable level (generally below 10%), the Expert Choice tool synthesizes the judgments to obtain the best overall decision. It displays the various weights of the decision alternatives and the details of how they were derived. After synthesizing, the user can perform sensitivity analysis using Expert Choice's graphs, or use a what-if analysis to determine how changes made to one or more judgment weights affect the overall weights in the decision.

A.5 EVALUATING CANDIDATE SITES

The remainder of this appendix illustrates how the AHP methodology and Expert Choice tool assisted in evaluating candidate demonstration sites.

A.5.1 Criteria/Scoring and Priorities/Weights

The decision problem, or goal, is to select the most desirable ALC to demonstrate ITI-ALC. The alternatives are all five ALCs. The only low pass filter at this time is if the ALC would be closed before the time frame of the demonstration (within five years). Given this, the alternatives to evaluate are as follows:

- Oklahoma City (OC-ALC)
- Ogden (OO-ALC)
- San Antonio (SA-ALC)
- Sacramento (SM-ALC)
- Warner Robins (WR-ALC)

The site selection criteria and how they relate to the goal are shown in Figure A-2. Figure A-3 indicates the score or weight of each of the criteria after the Prioritize/Weight Criteria step was conducted. The remaining sections more fully describe the criteria.

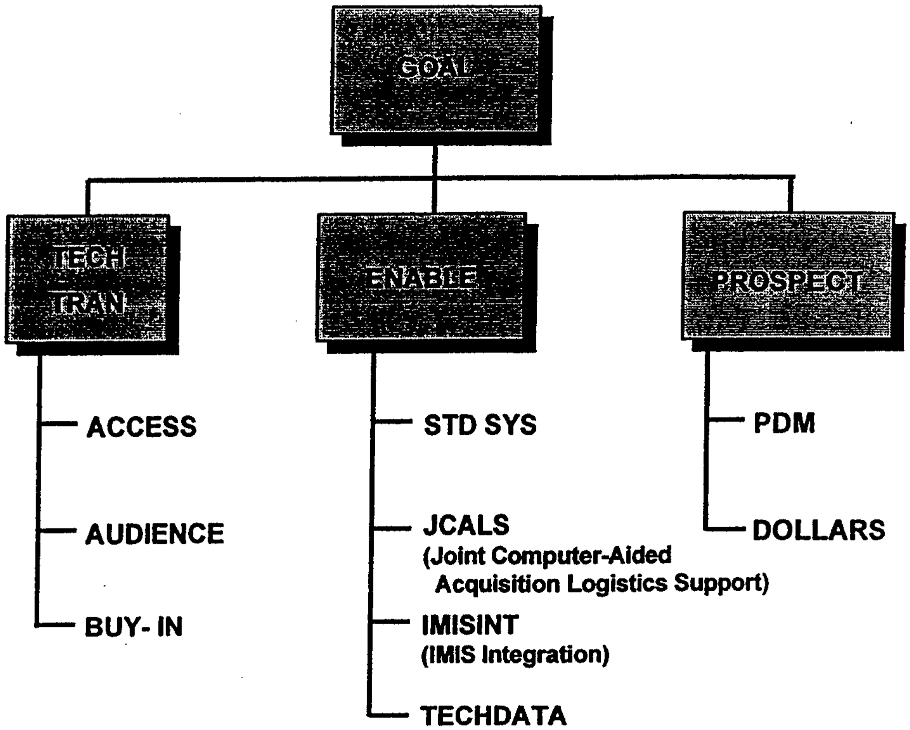

Figure A-2. Overview of All Selection Criteria

CRITERIA	POINTS
TECH DATA	56
PDM	49
DOLLARS	49
AUDIENCE	44
IMIS INTEGRATION	43
BUY-IN	41
STANDARD SYSTEMS	28
JCALS	26
ACCESS	24

Figure A-3. Ordered List of Criteria by Priority

A.5.2 TECH TRAN: Technical Transfer

How easy will it be to transfer the results of the demonstration to user organizations? This major criterion is made up of three subcriteria: access, audience, and buy-in.

A.5.2.1 Access

How accessible will the demonstration be if it is at the given site? This is a collective subjective opinion of how discernible the demonstration would be if it was hosted at a given site versus any of the other four sites. This is critical to the success of the demonstration because the less visibility it receives from key individuals and organizations, the less its potential influence on the transfer of leading edge technology and ideas. Points should be given to the site that has features that could highlight the demonstration (some event or occasion, weather conditions, easy geographical access by key personnel, and the like). The site that is most accessible receives 10 points, the next receives 8 points, and so on with the least visible site receiving 2 points.

A.5.2.2 Audience

How much interest is there in the weapon systems supported by the ALC? Program support is important to the success of any project. Therefore, the number of organizational units (audience) that will have weapon systems maintained by the selected ALC is a quantitative indicator. The following aircraft are under consideration based on this criteria: F-15, F-16, KC-135, A-10, C-130. Each unit is worth 1 point.

A5.2.3 Buy-In

How willing is site management to host the demonstration? This is a collective subjective opinion of the group on the level of site-specific commitment to ITI-ALC. Having a receptive host for the demonstrations will greatly lower the risk involved in getting the demonstration set up and will therefore contribute to the success of the demonstration. Some things that should be taken into account when building the consensus is how well the site supported the data collection teams, how often the ALCs sent representatives to formal and informal ITI-ALC reviews, how positive are the comments made by representatives of the ALCs about ITI-ALC, support during Support and Industrial Operations (S&IO) board meetings, and how enthusiastic the mechanics were during the interviews. The site that is most committed receives 10 points, the next receives 8 points, and so on with the least committed site receiving 2 points.

A.5.3 Enable

Are there characteristics about the site to help implement and conduct the demonstration? The four subcriteria comprising the Enable criterion are STD SYS, JCALS, IMISINT, and TECH DATA.

A.5.3.1 STD SYS - Standard System

How far into the migration path for the standard system is the site? The closer a site is to having a fully implemented "standard system," the closer the environment at that site will be to the operational environment for a production ITI-ALC system. The amount to which the standard system must be emulated to illustrate aspects of the ITI-ALC system will be reflected proportionally in the implementation costs of the demonstration with a greater probability that the demonstration software will be discarded when the standard system is fully implemented. This is an objective indicator of whether the information systems at a site have already gone through conversion to the standard system and for how many years that standard system has been in place. At the projected time of the demonstration, no site will have the complete standard system in place. Consequently, the number of modules in place will be used as the indicator.

A.5.3.2 JCALS - Joint Computer-aided Acquisition Logistics Support

How close to a true open system architecture is the site? Both risk and cost to the Government are reduced at a site that is closer to an open architecture. This will be an objective indicator that evaluates for each site the number of Computer-aided Acquisition and Logistics Support (CALS) standards fulfilled by the information systems pertinent to an ITI-ALC demonstration (interfacing systems). The ranking will be based on "order of implementation" of the JCALS system for weapon systems either managed or maintained at the ALCs. If the JCALS system has been implemented at a site, there is a better chance of the ITI-ALC system demonstrating the interface between the two systems. The ALCs that are first for implementation will be ranked higher than ALCs that are lower on the implementation list.

A.5.3.3 IMISINT - IMIS Integration

How easy will it be to use parts of IMIS at the site? One of the purposes of the ITI-ALC project is to demonstrate the integration of Organizational-level (O-level) and Depot-level (D-level) maintenance data. A site that best represents this integration is preferred. The close proximity of a wing that has the potential of using IMIS technology would be something to consider. The site that has the most to offer in this area receives 10 points, the next receives 8, and so on with the last site receiving 2 points.

A.5.3.4 Tech Data

Is there electronic technical data available for the weapon systems at the site? This is important because the creation of technical data will be an extremely expensive part of the demonstration. Existing technical data should be leveraged if possible. This is an objective measure of how many weapon systems and programs with electronic technical data are associated with the site. The score for this criteria will be determined by adding up the site's involvement with each of these weapon systems and programs, and the site with the largest sum receives 10 points, the next largest 8 points, and so on with the lowest sum receiving 2 points.

A.5.4 Prospect

Are there characteristics of the site that will enhance the prospective benefits of the demonstration? The two subcriteria comprising the Prospect criterion are PDM and Dollars.

A.5.4.1 PDM

In this business case, PDM includes the traditional view of visits to the depot maintenance facility based on time or cycles, as well as major modification programs accomplished during depot visits, analytical condition inspections, major time or condition phased aircraft inspections, and the like. This criterion is for the number of MDSs at the site using organic aircraft PDM. Since organic aircraft PDM is the focal point for the project, the site with the most MDSs maintained using organic aircraft PDM would increase the chances of success for the ITI-ALC demonstration. In evaluating this criteria, the number of organic aircraft PDM weapon systems should be counted. This is an objective criteria that gives a measure of how easy it will be to conduct a demonstration at a site. The site with the largest number of organic aircraft PDM MDSs receives 10 points, the next receives 8 points, and so on with the site with the lowest number of organic aircraft PDM MDSs receiving 2 points.

A.5.4.2 Dollars

How many dollars are spent for organic aircraft PDM? This is an attempt to objectively evaluate the potential for savings at an ALC. At this point in the project, dollar savings cannot be estimated. However, the site with the greatest number of dollars estimated for organic aircraft PDM for the period 1995 through 2000 offers the highest potential for savings. The site with the largest dollar amount receives 10 points, the next receives 8 points, and so on with 2 points for the site with the lowest potential savings.

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Appendix B

Literature Search

B.1 INTRODUCTION

A significant amount of work has been done by others on identifying process improvement potential and on implementation issues within the federal government. This work is directly applicable to the depot maintenance activity. In order to leverage that work rather than duplicate it, the ITI-ALC team performed an ongoing literature review of reports, studies, and analyses that may contain suggestions the ITI-ALC program can apply.

This appendix contains summaries of those reports, studies, and analyses as they apply to the ITI-ALC program. The results have been incorporated into the ITI-ALC program.

GAO/IMTEC-87-19 **Air Force Computers: Development risks of logistics modernization program can be reduced**

The Air Force had not stated the expected benefits in sufficient detail to ensure the modernized systems would achieve expected benefits. Some specific comments are included below.

Air Force regulations require that all benefits be quantified and stated in sufficient detail to clearly define the extent to which they will correct deficiencies of the existing systems and improve the operation of the Command. Accordingly, benefits must be clearly linked to deficiencies. When feasible, benefit statements should identify specific budget line items that can be reduced once the proposed system becomes operational.

For example, a stated benefit of the command data management system was that it would provide "reduction of errors." This stated benefit is typical. It does not quantify the current error rate, does not identify an acceptable error rate, and does not identify the expected improvements that will result if the acceptable rate is achieved.

Defense directives require that projects be evaluated to ensure that established goals and objectives are attained. The criteria to make these evaluations must be clearly specified in the evaluation assessment.

The tangible and intangible benefits which the nine logistics management system components purported were:

- One time reduction in replenishment spares safety level.
- Increase in mission capability by 2% to 3%.
- 50% reduction in the time that LRUs are down.
- More efficient acquisition of spare parts by converting information from item management to weapon system management.
- A 50% to 75% reduction in time needed to perform cost avoidance analysis and weapon system readiness problem analysis.

- Recurring reduction in inappropriate procurements.
- Addition of 175 aircraft.
- Increased readiness equal to 107 additional aircraft.
- Manual resource allocation control.
- Improved data accuracy.
- Eliminates punch cards.
- Reductions in current AIS operations, communications and other support costs.
- Manual budget preparation and long range forecasting.
- Increased visibility of scheduling, material control and production functions.
- Manual data input, edit and system interfaces.
- Reduce data entry errors by 7%.
- Increase morale.
- Annual savings in "walk and wait time."
- Cost avoidance in reduced spare parts procurements.
- Cost avoidance due to the method of equipment replacement.
- Timely user access to needed information.
- Orderly transition from batch to on-line processing.
- Improved repair accuracy.
- Directive level management.
- Budget preparation (1 to 3 months vs. 6 to 9 months).
- Period of Maintenance preparation (1 to 3 months vs. 8 to 9 months).
- Item procurement and repair (7 to 10 days vs. 14 to 120 days).
- $17 million annually in improved buyer and analyst productivity.
- Improved pricing of spare parts.
- Provides MILSCAP capability.

GAO/IMTEC-89-7FS **Air Force ADP: Logistics systems modernization costs continue to increase**

A project cost and status report on a larger project which is looking at RDB, WSMIS, SC&D, DMMIS, EDCARS, CDMS, etc.

GAO/IMTEC-89-29 **Air Force ADP: Evaluations needed to substantiate modernization program benefits**

The report found that the Command could not substantiate all of the claimed benefits it originally projected for the LMS. When the program was initiated in 1984, the Command claimed the new systems would provide significant benefits in the form of readiness and logistics support improvements and over $12 billion in cost savings. The analysis showed that the Command could substantiate most of the mission improvements, but only about $1.9 billion of the estimated cost savings. The report also noted that the Command had not begun to evaluate what cost savings and other benefits had been achieved to date.

The Command derived about $8.7 billion of the $12 billion in estimated savings from the increased number of mission capable aircraft expected to be made available through the use of RDB and SC&D. The Command valued this benefit at the total procurement cost of new aircraft. The Air Force Audit Agency (AFAA) did not question the Command's available aircraft estimates, but did not accept the Command's evaluation of these benefits.

For example:

- The EA projected a 5% increase in fully capable aircraft (or 175 aircraft) as a result of using the RDB. According to the Command, these projected benefits were based on studies done by Logistics Management Institute (LMI) and other studies internal to the Command. However, these studies were not in the project files nor could personnel provide them.

- The EA projected SC&D would provide a cost savings of $14.4 million attributable to reduced aircraft spare parts and nearly $3.7 billion attributable to increased aircraft availability. However, neither the Logistics Management System Command (LMSC) nor Materiel Management (MM) officials could locate documentation supporting the assumptions that they made computing these savings estimates.

- The SC&D EA also said the Command expected the prioritization of depot-level repair decisions using SC&D would result in an annual reduction of 1,500 staff days of effort needed to resolve problems that reduced the mission capabilities of aircraft. The AFAA assessment of these benefit estimates substantiated a likely savings equivalent to 157 staff positions and the 1500 day reduction. Also the Command expected the new system to provide a 26 hour reduction in resupply Order & Ship Time with a corresponding increase in readiness equal to 107 aircraft. The AFAA found that with some minor adjustments all of the projected non-monetary benefits of the SC&D were supported.

GAO/IMTEC-89-36 **Automated Information Systems: Schedule delays and cost overruns plague DoD Systems**

A review of the why of the delays and cost increases for such programs as RDB, DMMIS, and so forth.

GAO/IMTEC-89-42 **ADP Acquisition: Air Force logistics system modernization projects**

An update on Cost and Schedule increases for RDB, CDMS, and DMMIS.

GAO/T-IMTEC-91-13 **Tax Systems Modernization: Progress mixed in addressing critical success factors**

This testimony talked to eight factors which the Comptroller General felt were critical to the success of this AIS program. Those are vision, planning, tracking mechanism, technological readiness, procurement management, systems development, managerial and technical expertise, and security and privacy.

- VISION – a clear statement of how the IRS intends to do business in the future and how technology will contribute to achieving this vision.
- PLANNING – among others, a comprehensive strategy for how current and planned systems were to be integrated, including standards to ensure they would work together, and a transition plan describing how business functions would change from the currently slow, largely manual way of operating to the modernization's more rapid electronic methods.
- TRACKING – a mechanism to know the costs, benefits, schedules, and responsibilities for the project.
- TECHNOLOGICAL READINESS – The level of use that the IRS anticipates placing on optical character recognition technology is beyond anything demonstrated in the economy, yet the IRS has no fall back position. Using this technology prematurely runs the risk of 1) high error rates that necessitate frequent operator intervention, 2) propagation of error in downstream processing, 3) delays in returns processing, and 4) high costs relative to benefits. Their current fall back plan is to continue to process returns manually. The GAO suggested other alternatives such as moving maturing technologies forward (such as electronic filing, which the IRS had been operationally and successfully testing for several years) .
- PROCUREMENT MANAGEMENT – IRS had been criticized for its inability to direct and control procurement processes in previous AIS programs.

- SYSTEMS DEVELOPMENT – without careful disciplined development, systems are not likely to meet agency needs and are not likely to be delivered within budgeted costs or on schedule. The IRS has that framework in place, but several AIS indicate the framework is not implemented.
- MANAGERIAL AND TECHNICAL EXPERTISE – the agency needs to have a well thought out strategy for hiring, training, and retaining personnel possessing the expertise required for modernization.
- SECURITY AND PRIVACY – these two issues need to be recognized as a discrete issue with special application in the case of the IRS.

GAO/T-NSIAD-91-16 **Defense Inventory: DoD needs to continue efforts to improve its Requirements Determination and Ordering Process**

This testimony highlighted continuing problems in the DoD requirements determination and ordering process. Those included 1) inaccurate or unsupported data in the requirements system caused misstated inventory requirements, 2) management personnel overrode computational models used to determine inventory requirements, 3) item essentially was not properly considered when ordering spare parts, 4) unnecessary or excess on order quantities were not canceled when appropriate, and 5) management action to correct these conditions did not result in their correction.

Many of these were caused by one data system being unaware of balances available in other systems and inaccurate data.

The testimony made five recommendations: 1) stop buying items so far in advance of need, 2) terminate orders for unneeded materials, 3) change the organizational culture so they will have an efficient supply system and will not need to rely on overstocking to ensure being able to fill orders, 4) rapidly increase the use of commercial practices in all the areas where commercial supply systems are well-established, and 5) clear the warehouses of old, obsolete, and unneeded items.

GAO/IMTEC-91-29 **FAA Registry Systems: Key steps need to be performed before modernization proceeds**

The Federal Aviation Administration (FAA) had not adequately defined the needs of the internal and external users, even though improving support to those organizations was the justification for the modernization. The FAA used inadequately defined and documented functional requirements, a limited alternative systems design and configuration analysis and a flawed cost/benefit analysis. The FAA did not identify performance standards toward which they were working.

GAO/IMTEC-91-35 — **Defense ADP: Corporate Information Management Initiative faces significant challenges**

Accomplishing CIM will be a continuing process. It needs a long term and near term implementation strategy. However, the effort continues to be driven by functional expertise with little strategic direction from the OSD level. Senior service officials are concerned that while their budgets are being cut based on CIM, the initiative will not produce standard systems for 8 to 10 years. As a result they have been reluctant to stop their own systems development.

GAO/AFMD-91-40 — **Financial Management: Uniform policies needed on DoD financing of repairable inventory items**

Identified the fact that the Services are taking different approaches to the financing of repairable items through their respective stock funds.

GAO/IMTEC-91-41FS and — **Tax System Modernization: Status of on-line files initiative telecommunications**

This report provides status on several IRS AIS projects.

GAO/IMTEC-91-43 — **FAA Information Resources: Agency needs to correct widespread deficiencies**

Inadequate definition of requirements and consideration alternatives, failure to sufficiently test systems, ineffective management of computer capacity, and unreliable data have impeded FAA's ability to achieve it's missions. The problems are beginning to be addressed by the Administrator. This includes a continuing FAA Strategic Plan, and action to educate the appropriate individuals in the Agency on the principals of information resources management.

GAO/IMTEC-91-44 — **SSA Computers: Long range vision needed to guide future systems modernization efforts**

The Social Security Administration (SSA) has yet to establish a clear long-range vision to guide its development and application of information technology. Basically SSA has been automating existing business practice in a piecemeal fashion. While it has achieved some immediate benefits in some cases, over the long term it will need to explore more fundamental improvements in its work processes if it is to meet the enormous challenges caused by the large increase of social security recipients, that the next century holds. Those immediate benefits have been good. For example, the time required to issue a social security card has been reduced from 42 days to 10 days. The time needed for cost of living allowance calculations has been reduced from 3 weeks to 24 hours. The error rate for retirement payments has been reduced by 60%.

GAO/NSIAD-91-201 **Air Force Requirements: Requirements computations for aircraft consumable items can be improved**

Recommended changes to the quantities which the AFLC considers in requirements computation.

GAO/T-AFMD-92-8 **Financial Management: Defense Business Operations Fund (DBOF) Implementation Status**

Testimony on a report on the state of DBOF. Refer to GAO/AFMD-92-79 below.

GAO/T-NSIAD-92-11 **Defense Inventory: DoD needs to continue efforts to improve management and reduce stocks**

Virtually the same as GAO/T-NSIAD-91-16.

GAO/AFMD-92-12 **Financial Audit: Aggressive actions needed for Air Force to meet objectives of the CFO Act**

A lack of integrated financial systems generated unreliable information. Found the ALC inventory records were unreliable because 1) errors were made when recording transactions in perpetual inventory systems, 2) computer programming errors resulted in duplicate reporting of inventories, 3) internal controls designed to prevent, identify and detect errors were not operating as intended, etc.

GAO/AFMD-92-15 **Financial Management: DoD faces implementation problems in stock funding repairable inventory items**

DoD continues to experience problems in 1) accurately accounting for repairable items that customers returned to the stock fund, and 2) billing customers for items provided to them. These problems are caused by activities making data entry errors, bases not properly returning reparables to the depot, depots not promptly and adequately resolving in-transit discrepancies.

GAO/AFMD-92-57 **Financial Management: Army conventional ammunition production not effectively accounted for or controlled**

Discussion of the manufacture of conventional ammunition and the Army's inability to account for and control conventional ammunition and components parts. These problems stemmed from the fact that the Army has three separate sets of records to account for and control inventory in the ammunition manufacture area. These three separate systems represent activities within the manufacturing process, but their information is not integrated.

GAO/GGD-92-65 **Program Performance Measures: Federal agency collection and use of performance data**

Included many federal departments and agencies; in DoD, the Department of Army, Navy, Air Force, Defense Logistics Agency (DLA), and two others. The general application of program performance is discussed. In DoD, Unit Cost Resourcing is included.

GAO/AFMD-92-79 **Financial Management: Status of the Defense Business Operations Fund**

A report on the state of the DBOF

GAO/AFMD-92-82 **Financial Management: Immediate actions needed to improve financial operations and controls**

Report on the first time audit of the Army under the new Chief Financial Officers Act of 1990. The problems was caused by one major problem, a lack of integrated systems. The report recognized some areas where significant improvement could be made within the existing systems and processes. In this area two suggestions were made 1) improve the quality of the data, by investigating obvious errors, performing counts of items on hand, and making corresponding corrections to the items records, 2) integrate the inventory operations with the financial management function.

GAO/NSIAD-92-105 **Organizational Culture: Techniques companies use to perpetuate or change beliefs and values**

Report to Senator Glenn which begins with "In a series of reports on managing defense inventories, we have noted continuing operational problems. A consensus developed among the DoD, your office and us, that to fully correct the problems, DoD needs to change its inventory management culture so that more value and emphasis are given to economy and efficiency." This report documents the views of experts in the private sector on the techniques they used in changing or perpetuating an "organizational culture." The private sector includes Federal Express, Johnson & Johnson, 3M, AT&T, Corning, DuPont, Ford, IBM, and Motorola. These organizations indicated among other points that culture change takes 5 to 10 years.

GAO/NSIAD-92-112 **Defense Inventory: Cost factors used to manage secondary items**

Discussed the cost factors which the DoD used for ordering and holding stock of secondary items.

GAO/NSIAD-92-136 **Defense Inventory: DoD actions needed to ensure benefits from supply depot consolidation efforts**

Reviewed the consolidation efforts ongoing in the San Francisco Bay area. Lessons learned for ITI-ALC included: 1) Estimated consolidation savings were inaccurate since they were based on workload remaining constant, 2) some anticipated savings used to justify the consolidation were actually also counted as savings for the justification for another program, 3) unit cost data was not consistently developed since the Services developed it in different ways, and 4) application of performance indicators was attempted and drew kudos, however, indicators to measure the effects of consolidation on mission readiness and new performance measures were required.

GAO/NSIAD-92-152 **Operation Desert Storm: Increased workloads at Army depots created supply backlogs**

Report reviewed New Cumberland and Red River Army Depot performance. The report included these broader lessons: 1) oversight and control of materiel ended when it reached the port of embarkation, 2) manual requisition processing of high priority needs reduces efficiency at both ends of the system, and 3) Reductions-in Force (RIFs) in process, during conditions noted during Operation Desert Storm, should be suspended immediately.

AFLMA/LGM LM912069 **Unit Level Technical Order (TO) Management**

This report was published in January 1992. Current unit level management of technical information accounts is largely a manual process. A program exists for the local distribution office, but doesn't help unit level TO account managers. Development programs are underway to improve technical information management for acquiring, stocking, and distributing centers, but stop short of describing tools for unit level account management. Other programs are developing ways to provide technical information to users using electronic display devices, but managing local libraries with this kind of information is largely undefined. This project recommends changes to requirements documents that would provide tools to manage unit level accounts. Benefits may be derived from having the account managers directly involved in managing system information pertaining to their accounts. Improvements in accuracy and reliability would provide a more efficient distribution system. Reducing frustrations would improve morale. Timely TO system support and improved information accuracy would result in better weapon system support and improved safety for technicians.

This report includes a short description of the application of technical orders in these weapons or administrative support systems; ATOMS, ATOS, AFTOMS, JUSTIS, ADS, B-2 ITDS, C-17 AGILE, F-22 AIMS, JSTARS's CTOS, LANTIRN's PLAD/CBTOS.

It summarizes the types of data contained in a TO; A, B, B+, and C.

- "A" type data is technical information contained in paper documents. Information is page and document oriented. Information redundancies exists throughout. The current TO state is "A" type data.

- "B" type data is technical information contained digitally in computer files. Use of these TOs requires a delivery system. The information may be displayed on a screen or may be printed and used as "A" type TOs. Information is page oriented and redundancies still exist. In effect, these are files of information scanned in from paper TOs.

- "B+" type data is a step beyond "B" type data. Information is no longer presented page by page, but is frame oriented. Each TO is still a separate document. Information is tagged and linked to provide the ability to jump to pertinent sections, but redundancies still exist where the same information is stored in more than one place.

- "C" type data is technical information contained digitally in computer files. Information is stored in neutral databases and displayed in a frame oriented manner. This is accomplished by gathering information for display as required for the portion of the task being accomplished. Data are stored only once, called upon as required, and tailored to the need. Technical information is no longer document-oriented. Type "C" is used in a highly interactive environment.

The report uses IMIS as a system that will describe "C" type data.

Scenario: The technician begins a task by requesting pertinent technical information from the system library. IMIS would review maintenance information in the CAMS and supply task information tailored to the configuration of the aircraft and the skills of the technician. The technician no longer has to worry about configuration control and affective information. The technician then starts to perform the task while interacting with the PMA. If parts are required, the system provides a method for requesting them. If stock is available the system informs the technician of the estimated delivery time. This interaction continues until the task is completed. All the while, the IMIS records information about the task such as how long it took, what parts were consumed, and feeds other information systems with the results.

AFAA Project 92062004 Local Manufacturing at the Air Logistics Centers

This report by the Air Force Audit Agency reviewed the management and maintenance of depot maintenance facilities and equipment by the base civil engineer and the plant maintenance division at each of the ALCs. The report concluded that the plant management functions could more economically support the industrially funded activities by consolidating with the base civil engineering function. Consolidation would reduce personnel, equipment and vehicle costs without affecting the mission of either group's customers.

AFAA Project 92062006 Local Manufacturing at the Air Logistics Centers

This report said that duplicate local manufacturing operations were established even though the same capabilities already existed locally or at other ALCs. Reductions in cost were possible, without affecting support, by consolidating operations, thereby saving personnel and equipment costs.

GAO/AFMD-93-5 Air Force Depot Maintenance: Improved pricing and financial management practices needed

This report includes many of the problems which managers experience as a result of unreliable data. It reviews Air Force attempts to project workload and productivity changes in the declining era.

It referred to the first annual AFMC Depot Maintenance Business Plan, dated April 26, 1991. The GAO said this plan included a strategy to save $1.1 billion during fiscal year 1991 through 1995. $391 million of those savings would be achieved by 1) reducing overhead labor positions, 2) improving materiel management practices, and 3) discontinuing depot maintenance operations at an overseas depot. In addition some $719 million will be achieved by implementing a public/private competition program.

However, it is unlikely to achieve these savings. One reason is that work force productivity has been adversely affected by frequent changes in the size and the mix of the workload. In addition, DMIF managers do not have accurate data on how much specific types of repairs should and do cost and thus cannot effectively identify and improve inefficient operations. Another reason is that the AFMC plan relies heavily on questionable assumptions about the savings that can be achieved by having the public and private sector compete. DMIF managers do not have the information they need to effectively manage.

Points to Ponder:

OSD reduced DMIF's cost projection for FY93. For example, part of the reduction was based on an assumption that implementation of DBOF would result in a 1% reduction in DMIFs projected costs for FY93, even though DoD officials acknowledge that DBOF implementation is expected to have minimal impact on DMIF. DMIF actual productivity has been lower than budgeted productivity for every year since at least 1988. The difference between budgeted and actual productivity was considerately less in FY91 than it was in FY90 and the first half of FY92. The ***Comparison of DMIF projected and actual output per paid man-day for fiscal years 1988 through 1992*** is shown in Table B-1.

Table B-1. Budgeted vs Actual Productivity

	1988	1989	1990	1991	1992
Budget Projection	4.05	3.94	3.95	3.97	4.17
Actual	3.84	3.87	3.70	3.91	3.82[a]

[a]Actual data for the first 6 months of fiscal year 1992

GAO/T-NSIAD-93-13 **Depot Maintenance: Issues in management and restructuring to support downsized military**

DoD spends about $13 billion on depot maintenance activities. About 67% goes to work accomplished in DoD facilities and the balance to work done by contractors. This report is testimony the Comptroller General provided on depot capacity in the DoD and what the alternatives are to resolve the issue of excess capacity.

GAO/NSIAD-93-15 **Weapons Acquisition: A rare opportunity for lasting change**

An assessment of the method which the DoD uses to acquire its weapon systems. It identifies many problems in that arena and makes suggestions about how the approach needs to be changed. Some of those problem areas apply to all programs. Those problem areas include 1) insufficient examination of alternatives, 2) questionable affordability, 3) excessive concurrency, 4) insufficient attention to producibility, and 5) cultural optimism.

GAO/NSIAD-93-38 **Air Force Requirements: Cost of buying aircraft consumable items can be reduced by millions**

Discussed the administrative Air Force practice of reserving assets in the Item Manager's account for depot maintenance use.

GAO/NSIAD-93-70 **Financial Systems: Weaknesses impede initiatives to reduce Air Force Operations and Support Costs**

The Air Force does not have accounting systems in place to accumulate and account for all operations and support costs applicable to an aircraft wing. Although the Air Force has a centralized operations and support cost data collection system to help identify and manage the cost of operations, the data collected by the system are not sufficiently accurate, timely or comprehensive for this purpose. An interesting graphic was included on page 16 of the report. The Air Force's efforts to better manage the cost of aviation fuel, reparable parts, and depot maintenance and repair are being adversely affected by a lack of accurate and complete cost information.

The report cited that systems at WR-ALC did not provide accurate cost data on repairing and modifying individual F-15 aircraft.

In response the Air Force said that "deficiencies noted in the GAO report have been corrected through systems updates and procedural improvements. The Warner Robins job order cost system ensures that costs for modifications and repair work reflect actual work performed by tail number. Corrections of the procedural and systemic deficiencies outlined herein ensures that data is accurate.

GAO/NSIAD 93-110 DoD Food Inventory: Using private sector practice can reduce costs and eliminate problems

DoD's multiple layers of warehouses between producers and end users encourage large inventories at all levels. Many of the costs incurred by DoD for holding, handling, and transporting large quantities are not necessary because the existing network of private sector full-line distributors could supply food to DoD more efficiently.

GAO/NSIAD-93-112 Defense Inventory: Applying commercial purchasing practices should help reduce supply costs

1) Lack of reliable data affects the purchase of secondary items. 2) Is it rational that AFMC depots should be customers for the same items consumed by retail customers? 3) Review the methodology for computing acquisition and holding costs.

GAO/NSIAD-93-155 Commercial Practices: DoD could save millions by reducing maintenance and repair inventories

Discussed commercial practices which could reduce the inventory of secondary items, thereby saving the costs associated with their stock, storage and issue, while not affecting the ultimate readiness of the DoD. The suggestions included reducing inventory requirements at each center, establishing electronic ordering, invoicing, and bill-paying functions between vendors and DoD facilities, using supplier parks near DoD facilities that use the supplies, and eliminating the need to store supplies in the DLA depot system.

GAO/NSIAD-93-173 Military Bases: Analysis of DoD's recommendations and selection process for closures and realignments

Provided potential lessons learned for ITI-ALC. 1) Do not confuse potential savings from ITI-ALC with potential savings which have already been applied to other program actions or workload changes. 2) If ITI-ALC results in forced personnel reductions, consider any additional compensation paid to those forcibly separated. 3) There was no agreement between the Services on common measures of cost comparability.

AFLMA/LS 922128 **Analysis of the Depot Repair Process**

This report was published in July 1993 by the AF Logistics Management Agency. It provided an overview and descriptive analysis of the depot repair process. Using the D041 requirements model as a starting point, the study defines and describes each of the components of the depot repair cycle: base processing days, reparable in-transit days, supply to maintenance days, shop flow days, and serviceable turn-in time. For each of the segments, the study includes a basic process description, measured times for that segment, and the times reflected in the D041. Some key repair cycle issues covered are the Reparable Items Management and Control System (RIMCS) process, the D041 computation of depot repair cycle time and standard shop flow days, management of unserviceable assets, and the requirements and production forecasting. The analysis of the RIMCS process revealed possible transmission disconnects between the wholesale system and the bases. The findings also suggest that the priority reflected in the wholesale system does not always appear to be appropriate. In computing depot repair cycle time, the D041 includes excessive time in the repair cycle when reparable carcasses are available at the depot. Further, the standard shop flow values the D041 currently uses for shop flow days (applicable to about 25% of the items) appears to be inflated. Using a sample D041 tape and a more representative shop flow standard value, the new shop flow standard decreased from 27.4 days to 8 days. The effect of this decrease in shop flow could reduce their repair response times if repair shops had greater freedom to remove and repair component parts from unserviceable carcasses in order to create a readily available supply of serviceable components. And finally, the study found that D041 provides a reasonable forecast of future demand in a stable or even declining environment, but it is not reliable for new items or items with erratic failure rates.

GAO/GGD-94-3 **National Archives (NARA): A more systematic customer focus needed**

This report determined how the NARA identified its customers and their needs and how NARA responds to those needs.

GAO/AIMD-94-14 **Defense IRM: Management commitment needed to achieve Defense data administration goals**

This January 1994 report says that Defense has made little progress toward reaching its corporate data administration goals. Specifically Defense has not determined what data it needs to manage on a department wide basis. CIM principles call for senior functional managers to first document their business requirements (that is, business goals, methods, and performance measures) and then determine the data they need to support these requirements. These requirements have not been set.

Rather, Defense has engaged in activities that do not promote its data administration goals. It has issued data element standardization procedures without first issuing guidance on the preliminary steps for developing data element standards (that is, developing, validating, integrating, and approving the data models from which data standards are derived). This will likely result in the Department standardizing data elements that do not meet its corporate needs. In addition, Defense has developed and implemented a data dictionary system, the Defense Data Repository System (DDRS), that cannot meet its needs. This system is incapable of providing required capabilities such as the storage of data models, and has been loaded with information of questionable quality about nonstandard data elements. As a result, DDRS may actually aggravate the general problem of unreliable and incompatible data.

The report stated that we believe that ignoring the strategic component of the CIM model, that is, conducting process and data modeling activities without first determining business objectives, methods, and performance measures, Defense has no assurance that data elements derived from its modeling activities will ultimately meet its corporate needs.

A report prepare by the Information Technology Association of America on the same subject, also endorsed the need to link improvement efforts to strategic mission objectives, observing that without such linkage an organization will be unable to tie its information requirements to its stated mission objective.

In addition the report pointed out that Defense's November 1993 report on business process improvement identified the linkage of process improvement objectives to strategic business plans as a critical success factor for such efforts.

Emmett Paige responded with some rationale which provides an inside view of that perspective. This is a valuable piece.

GAO/RCED-94-20 **Air Pollution: EPA/s progress in determining the costs and benefits of clean air legislation**

Beginning in 1992, Congress mandated that GAO review the costs and benefits of 1990 amendments to the Clear Air Act. The GAO discovered that Environmental Protection Agency (EPA) was conducting a similar effort and used this report to discuss the methodology and status.

GAO/T-NSIAD-94-61 **Medical ADP Systems: Defense's tools and methodology for managing CHCS performance needs strengthening**

The Composite Health Care System (CHCS) is an automated medical information system for the DoD. Its stated purpose is to improve the quality and reduce the cost of providing medical care to the military health care system. This report (focusing only on the system performance relating to execution of instructions on the hardware portion of the system, excluding human response to the system) concluded that the performance measurement tools DoD uses at its CHCS sites do not collect all data DoD needs to detect response-time problems, diagnose their causes, and determine their significance. In addition, DoD lacks state of the art analysis tools to determine the causes of performance problems and project the impact on response times of changes in workload or system configuration.

The report includes efforts DoD has made to measure and simulate performance changes. The report discusses current measurement and simulation tools on the market. The report also includes the opinion of the reviewers and suggestions on the metrics which the CHCS program official uses to measure system performance.

GAO/NSIAD-94-64 **Commercial Practices: Leading edge practices can help DoD better manage clothing and textile stocks.**

A review of how the department manages inventory of these stocks, valued at $1.3 billion in FY92. The report provided a comparison of practices between the DoD and commercial practice. It makes recommendations on alternatives the department should consider to reduce inventory and shorten material acquisition pipelines.

Several examples of the application of prime vendor relationships are presented including the comparison of DoD and prime vendor approaches to clothing and textile support requirements shown in Table B-2.

Table B-2. DoD vs Prime Vendor Approaches

Key Performance Measures	DoD	Prime Vendor
Wholesale Stock on Hand	2-10 years	60-120 days
Retail Stock held by clients	90-180 days	0 days
Stock Turnover	1 x every 2 years	1.8 x 4 every year
Standard Order fill time	24-28 days	1-3 days
Percent of items declared excess	8	0.5 - 1
Procurement Lead Time	400 days	2-60 days
Asset Visibility	Wholesale (partial)	Wholesale & Retail (100%)

GAO/AIMD-94-80 **Financial Management: Status of the Defense Business Operations Fund (DBOF)**

Depot maintenance is one of the industrial funds under the DBOF. This report talks about the problems being encountered in the application of the DBOF concept to reality. Among other issues, the report discusses the importance of performance measures linked to the industrial fund products.

GAO/AIMD/NSIAD-94-101 **Defense Management: Stronger support needed for Corporate Information Management Initiative to succeed**

Reviews the CIM initiative. It included the following points. 1) Efforts to improve Defense business processes were based more on individual initiatives rather than a deliberate, organizational approach to increasing effectiveness or reducing costs. 2) Performance measures are particularly important. No quantitative means exist to assess current processes or measure progress when changes are made. 3) Existing cost justification procedures, such as functional economic analyses, for making process and system investment decisions, combined with a post audit of benefits obtained are important tools for determining the economic outcomes of the initiative. 4) Most suggested improvements have focus on local functional improvements, rather than far-reaching change connected to the longer term strategic business process.

The report recommends, among others, that the principal staff assistants establish plans consistent with the DoD strategic plan goals and objectives. These plans should include performance measures to evaluate progress with their respective areas. These measures should be used to assess current operations and reengineered processes.

GAO/T-AIMD-94-105 **Defense Management Initiatives: Limited progress in implementing management improvement initiatives**

This testimony was given consistent with the report just prior. It does emphasize that the real potential for savings and efficiencies in DoD lie across functions rather inside of functions.

GAO/NSIAD-94-110 **Commercial Practices: DoD could reduce electronics inventories by using private sector techniques**

In most areas DoD has not streamlined its operations and continues to buy and store redundant levels of electronic items, valued at over $2 billion. It reviews the practices which several commercial enterprises have implemented to reduce their investment in inventory and cycle time, which are available to DoD.

GAO/AIMD/NSIAD-94-115 **Executive Guide: Improving missions performance through strategic information management and technology-learning from leading organizations**

This report identifies information management practices used by leading public and private sector organizations with demonstrated success in consistently applying information management and technology solutions to improve performance and program delivery outcomes. It is intended to serve as a guide for the strategic application of information technology in an integrated way.

GAO/AIMD/NSIAD-94-132 Defense Business Operations Fund: Improved pricing practices and financial reports are needed to set accurate prices

This report focuses on depot maintenance and supply management, the funds two largest business areas which will account for about $55 billion of the DBOF's estimated FY95 revenue of $77 billion.

The report concluded that the DBOF had not broken even since its inception in FY92. Various factors contributed: 1) planned productivity increases were not achieved, 2) changes in the estimated workload resulted in less revenue than had been planned in the price calculation, 3) workload was carried over from one fiscal year to the next and billed at the generally lower prices in effect when the work was ordered, and 4) ongoing depot closures resulted in additional costs and lower productivity than planned.

The report provides a short description of the process the depot maintenance business area uses to develop stabilized prices. It begins as long as two years before the prices go into effect, with each depot developing workload projections for the budget year. After the depot estimates its workload based on customer input, it 1) uses productivity projections to estimate how many people it will need to accomplish the work, 2) prepares a budget that identifies the labor, material, and other expected costs, and 3) develops prices that, when applied to the projected workload, would allow it to recover operating costs from its customers. Major commands review and consolidate individual depot budget estimates. Headquarters and OSD review the consolidated estimates before they are submitted to the Congress as part of the DBOF overview. Any changes made during this process are incorporated into the depot's prices before the start of the fiscal year.

Since 1991, prices charged have generally increased. [For the Air Force depot maintenance, the percentage changes in prices, beginning in 1991 through 1995 were 4.2, 6.2, 19.1, 9.6, and 20.5 respectively.] The GAO said business area price increases increased primarily for three reasons: 1) fund prices include costs, such as headquarters costs, that customers did not have to pay for previously, 2) prior year losses have to be recouped, and 3) depot maintenance activities are allocating their fixed overhead costs over a steadily declining workload.

The GAO advises that the price increases can be attributed to DoD's efforts to more accurately and completely charge Fund customers the total cost of providing goods and services. For example, the AFMC budget officials estimated that the additional cost categories that have been incorporated into AF depot maintenance activities' sales prices since FY91 account for $31.154, or 28% of the FY95 hourly composite sales price[1] (see Table B-3).

[1] A composite sales price is the average cost per direct labor hour for all work accomplished. Each depot has its own composite sales price and, within a depot, there will be a different composite sales price for different categories of work.

Table B-3. Air Force Depot Maintenance Sales Prices

Costs	FY added	Total Dollars (millions)	Impact on Composite Sales Price[a]
Military personnel	1991	$15.804	$.53
Injury Compensation	1991	26.783	.90
Hazardous Waste	1991	17.329	.58
Depreciation	1992	94.167	3.17
Depot Level Reparables	1993	690.424	23.22
Headquarters Cost	1994	7.099	0.24
JLSC	1994	51.600	1.74
Voluntary Early Retirement Program	1995	22.900	0.77
Total		$926.106	$31.15

[a]Based on a projected workload of 29,730,000 direct labor hours.

Efforts to downsize the military forces are causing the Fund's business areas to allocate their overhead costs over a steadily declining workload base. The magnitude of these workload reductions is illustrated by comparing overhead costs and production levels over time. For example, the Air Force depot maintenance activities overhead costs increased from $986 million in FY91 to a projected $1.11 billion in FY94--an increase of 12.6%. However, because of the large reduction in workload, the amount of overhead costs allocated to each direct labor hour of work increased even more--from $27.23 to $39.10, or 44%. One of the most critical challenges DoD currently faces is the need to reduce overhead and infrastructure costs in the face of shrinking budgets. According to the DoD Comptroller, DoD's inability to eliminate infrastructure as fast as customer budgets are being reduced is at the center of this dilemma.

GAO/GGD-94-154 **U.S. Postal Service: Proposed policy to accept credit and debit cards makes sense conceptually**

Discusses the potential application of these cards to Postal Service customers. Includes statistics on performance measures based on some work they did in the post offices. It includes several consideration which may have application to ITI-ALC.

GAO/T-NSIAD-94-160 **Military Readiness: Current indicators need to be expanded for a more comprehensive assessment**

This testimony discusses the SORTS and application of C ratings. It identifies a long known problem; that SORTS is a snapshot of one unit on a day and is not useful to signal impending changes in readiness.

GAO/T-NSIAD-94-161 **Depot Maintenance: Issues in allocating workload between the public and private sectors**

This testimony discusses the conceptual and practical issues associated with this issue. Good background to the public/private debate.

GAO/T-AIMD/NSIAD-94-170 **Financial Management: DoD's efforts to improve operations of the Defense Business Operations Fund**

This testimony is the latest update on the DBOF.

GAO/T-OCG-95-2 **Government Reform: Using reengineering and technology to improve government performance**

This testimony summarizes the Comptroller General view of the critical risks in federal information technology investments. The lessons learned from leading organizations is that the links between the mission, work processes, decisions, information, and technology are necessary for an integrated solution.

GAO/NSIAD-95-51 **Peace Operations: Heavy use of key capabilities may affect response to regional conflicts**

This report summarizes the impact that peace operations have on the status of the U.S. military forces, force structure limitations that may affect the military's ability to respond to other national security required while engaged in peace operations, and some of the options available to increase force flexibility and response capability.

GAO/NSIAD-95-54 **Acquisition Reform: Comparison of Army's commercial helicopter buy and private sector buys**

This report discusses the attempts which the Army has made to streamline its process to buy a commercial item, and the constraints which it had to deal with in the process.

GAO/AIMD-95-65 **Information Technology: A statistical study of acquisition time**

This report discusses how various factors, such as procurement size, contract type, and bid protests, affect the length of time to award a contract for federal information technology.

GAO/T-AIMD-95-101 **Business Process Reengineering: DoD has a significant opportunity to reduce travel costs by using industry practices**

Testimony which presents a review of the DoD effort to reform travel management within the department. DoD reported that it spent $3.5 billion for temporary duty travel in FY93. The department also estimated an additional 30% of that total, to process that travel. The report highlights the changes which the department is implementing based on best practices identified in industry.

GAO/T-NSIAD-95-117 **Military Readiness: Improved assessment measures are evolving**

This testimony concerns the effect on current and future military readiness of the level of current military operations, contingency operations, the shifting of funds to cover these operations and personnel turbulence.

The testimony also discusses the value of the Status of Resources and Training System, the JCS readiness reporting system.

GAO/T-NSIAD/AIMD-95-126 **Defense Infrastructure: Enhancing performance through better business practices**

This testimony updates the Congress on the DoD progress toward reducing defense infrastructure and improving financial management operations. It identifies opportunities for eliminating unnecessary overhead.

GAO/NSIAD-96-30 **Navy Maintenance: Assessment of the Public Private Competition program for aviation maintenance.**

Pursuant to a congressional request, GAO reviewed the Navy's aviation depot maintenance competition program, focusing on: (1) the nature and extent of past competitions; (2) whether savings resulted from the program; (3) the prospects for and impediments to future competitions; and (4) whether the program can be improved.

GAO/NSIAD-96-31 **Depot Maintenance: The Navy's Decision to Stop F/A-18 Repairs at Ogden Air Logistics Center**

GAO reviewed the Navy's analysis to support its decision to move F/A-18 depot maintenance work from the Air Force Ogden Air Logistics Center in Ogden, Utah, to the North Island Naval Aviation Depot in San Diego, California. This report addresses GAO's (1) review of the Navy's analysis and adjustments for cost and performance comparability used to justify the decision to move its F/A-18 repair activities from Ogden to North Island, (2) independent analysis using more current data than that available at the time of the Navy's decision, and (3) analysis of the adequacy of guidance regarding the conduct of merit-based analyses.

Appendix C

BPI Recommendations

C.1 BUSINESS PROCESS IMPROVEMENT RECOMMENDATIONS

This section contains a summary description of the BPI recommendations that will allow depot maintenance to make advancements to achieve the project objectives and be more competitive, supporting the defense mission in a more efficient manner. At the end of each BPI description is a short example of the part that BPI plays in the PIPs.

C.1.1 Process and Terminology Coordination

Standardize the terminology among the aircraft, engines, and component repair environments to improve, standardize, and streamline processes; databases; and system development and application among aircraft, engines, and component repair environments. Many of the differences currently perceived in functionality among these environments are actually due to the terminology variation used rather than functional differences.

Terminology for each of these environments, and at each ALC, has evolved relatively independently. Because the terminology varied, manual and automated support systems for these environments also evolved relatively independently. By establishing common terminology throughout the depot, the benefits from process streamlining and support system development can be maximized. Aspects of this process improvement include:

- A coordinated maintenance process description that looks beyond the artificial separations.
- A coordinated set of data and process terminology used within the various maintenance environments.
- A set of support systems based on the process similarities.
- Through the improvement of terminology coordination, the benefits received by the ALCs include:
  - A foundation on which to built a more integrated and streamlined depot maintenance process.
  - Reduced support system development and maintenance costs.
  - Reduced training requirements.
  - Increased benefit potential for future process improvement concepts.

To provide a basis for this process improvement, a common set of terms will be developed, as part of the ITI-ALC program. An initial list based on the definition and analysis of the generic depot maintenance process that extends across the maintenance environments as well as the various ALCs was developed as part of this program. The terminology currently used in the maintenance environments was then mapped to the common set of terms (see Table C-1). Column 1 of Table C-1 contains a partial list of terms proposed for ITI-ALC while the remaining columns contain one or more of the current terms used within depot maintenance environments that have the same or similar meaning as the standardized term. While reviewing Table C-1, the reader should note that while the team found common labels throughout the maintenance environment (e.g., Work Control Documents [WCDs], facility, or definitized list), these labels did not describe identical items. The team found planning WCDs, WCDs for specific serial number assets, historical WCDs, WCDs for specific complex tasks. Each were different representations of the state of different pieces of different information. Another label, facility, represented a specific building in one instance, a group of machining activities in another instance, and a group of buildings and machinery in another instance. A third label, definitized list, could represent items required to accomplish a planned WCD in one instance, a list of steps to be accomplished in a support task in another instance and a list of required items, facilities, and steps in another instance.

Table C-1. Terminology Coordination

ITI-ALC	Aircraft	Component	Engine
Asset Package	Package Brown Book Turnover Log	WCD AFMC Forms 958/959	WCD AFMC Forms 958/959
Asset Plan	Brown Book Work Deck AFMC Form 173s Package "Rack"	WCD AFMC Forms 958/959	WCD AFMC Forms 958/959
Cataloged Material	Part Reparable Component	Part Reparable Component	Part Reparable Component
End-item	Part Reparable Serviceable Component Exchangeable	Part Reparable Serviceable Component Exchangeable MISTR	Part Reparable Serviceable Component Module Exchangeable MISTR
Facility	Facility	Facility	Facility
Kit	Kit TCTO Kit Vitmar Part Serviceable Reparable	Kit TCTO Kit Part Serviceable Reparable	Kit TCTO Kit Part Serviceable Reparable
Maintenance Task	Work Operation AFMC Form 173 Definitized List	WCD AFMC Forms 958/959	WCD AFMC Forms 958/959
Major Job [The definitions for the three areas are different than for ITI-ALC.]	Major Job Maintenance Requirement TCTO	TCTO	Maintenance Requirement TCTO
Management Advice	OSHA Directives EPA Regulations etc.	OSHA Directives EPA Regulations etc.	OSHA Directives EPA Regulations etc.

Table C-1. Terminology Coordination (Continued)

ITI-ALC	Aircraft	Component	Engine
Operation Step	Definitized List	Definitized List	Definitized List
Regulation	Regulation Military Standard Manuals Technical Orders	Regulation Military Standard Manuals Technical Orders	Regulation Military Standard Manuals Technical Orders
Reparable	Reparable Serviceable Unserviceable Exchangeable Turn-in Carcass Item Part End-item Component Routable Recoverable (XD2)	Reparable Serviceable Unserviceable Exchangeable Turn-in Carcass Item Part End-item Component Routable Recoverable (XD2)	Reparable Serviceable Unserviceable Exchangeable Turn-in Carcass Item Part End-item Component Routable Recoverable (XD2)
Reparable Plan	Brown Book Work Deck AFMC Form 173	WCD AFMC Forms 958/959	WCD AFMC Forms 958/959
Replacement Part	Part Item Exchangeable Component Bits & Pieces	Part Item Exchangeable Component Bits & Pieces	Part Item Exchangeable Component Bits & Pieces
Requirement	Project Directive Negotiated Workload	D041 Requirement Repair Quantity Negotiated Workload	Project Directive Repair Quantity Negotiated Workload
Support Equipment	Special Tools AGE Tool Test Equipment	Special Tools AGE Test Equipment	Special Tools AGE Test Equipment
Technical Information	TOs Drawings Specifications Illustrated Parts Breakdown Process Orders HAZMAT TOs Operating Instructions	TOs Drawings Specifications Illustrated Parts Breakdown	TOs Drawings Specifications Illustrated Parts Breakdown
Work Operation	Form 173	WCD AFMC Forms 958/959	WCD AFMC Forms 958/959

Example of the part this BPI plays in the PIPs – During the analysis, the ITI-ALC team confirmed the functionality represented throughout the ITI-ALC "AS-IS" FM was truly representative of the work being done at the select site. Many organizations spoke of their unique work and their unique processes, accompanied by unique information requirements. In fact, the analysis revealed that a substantial portion of the functionality was the same. What was different were the labels that various organizations placed on the same information. By using common definitions for the same information, a substantial degree of the uncertainty could be removed from the current work processes. Subsection C.1.1 makes recommendations for the establishment of common terms. In PIP A, along with the other BPIs, the common terminology is introduced into the work process manually; individuals are taught the "new language." This combination will reduce the complexity and should allow some portion of the resources consumed in planning and controlling production to be released to other activities. If the BPI were incorporated into the higher level PIPs, automation would provide "translations" so that multi-skilled mechanics, moving from one work area to another using different terms could be immediately productive.

C.1.2 Planning Process Enhancement

Improving the completeness of the planning process not only increases the productivity of the planner and controller but also increases the productivity of the production managers and mechanics. The requirements for the Planning Process Enhancement are that the planner: 1) maximizes the use of previously developed plans, 2) fully defines the work operations, and 3) enhances the incorporation of lessons learned from previous plan implementations.

Each work operation in the plan includes a complete list of all parts, facilities, tools, technical information, personnel, and time required for work operation completion. By using this information, the controller ensures all resources are available when the mechanic initiates the work operation and reduces implementation conflicts among work operations. Because the planner produces a fully specified plan, and the controller assigns non-conflicting asset work packages, the production manager and mechanic reduce their time now spent completing or correcting plan and assignment deficiencies.

However, no matter how well the plan is established, variations between the plan and actual implementation will occur. These variations, or lessons learned, are captured and provided to the planner for use in the refinement of future plans. Currently, the feedback is primarily accomplished by having the production managers and mechanics directly involved with the planning process, thus spending some percent of their time away from their primary maintenance responsibilities. Using the enhanced planning process, the production managers and mechanics maintain a direct connection with the planning process without reducing their hands-on maintenance time. Aspects of this process improvement include:

- A standardized plan development process.
- More integrated information throughout the depot maintenance process.
- Improved data manipulation and presentation capabilities.

- The benefits to the ALCs provided by the planning process enhancement include:
  - Increased efficiency in plan development.
  - Increased reusability of previous plans.
  - Increased consistency of reparable plans.
  - Increased ease of plan implementation.
  - Reduced duplication of effort among planners, controllers, production managers, and mechanics.
  - Improved implementation feedback into the plans while reducing the production managers' and mechanics' direct involvement in planning.
  - More effective use of resources.
  - Improved inputs into the requirements determination process.

Example of the part this BPI plays in the PIPs – Even in the manual mode of PIP A, 10% of the benefit can be achieved by just better planning as discussed in Subsection C.1.2. This would include identifying materials, facilities, tools, and resource requirements for individual tail numbers, preparing more accurate sequencing information and adhering to the sequence for work operations. In the manual mode this is very difficult to accomplish. PIP B would provide electronic access to a database for planning information purposes. As the information integration occurs in PIP C, this information becomes totally integrated with the work on individual work operations and in fact becomes a continually learning knowledge base for application to the next tail number work operation. At the PIP D level this implementation would include the ability to do on-line what-if analysis, answering questions such as "how can I possibly person load this job better," based on up-to-the-minute information of resource availability, lessons learned on other tail numbers, and feedback from the parts availability systems.

C.1.3 Acquire Parts

Lack of spare parts at the right place and at the proper time was the primary concern expressed by the maintenance personnel interviewed. It is not unique to the ALCs. The same problem was the primary concern of the mechanics in the Naval Aviation Logistics System.[1] The Government policies/procedures that pertain to this BPI are AFMCR 66-53 and AFM 67-1. AFMCR 66-53 deals with when the "sale" of an item occurs and the policy on stock replenishment priority for DMSC. AFM 67-1 identifies how stockade in the DMSC is established.

In their report on how the aviation logistics system could improve materiel management to reduce turn-around as well as excess materiel in the system, RAND identified those actions which the logistics system personnel could take and those policies that would have to change, if progress were desired. Those included 1) timely and accurate Bills of Material (BOM), including not only how many parts, but where and on what day; 2) knowledge of where parts were located (both on and off station) and how long it would take to receive those at the mechanic station; 3)

[1] *An Approach to Understanding the Value of Parts*, MR-313-A/USN, RAND, Santa Monica CA, 1994.

improving the interaction between the aviation depot and the supply system; and 4) inventory management using part value and not cost of the part alone. Value is essentially how much the part contributes to shortening the repair time of the end-item that uses it.

The concept of kitting parts for all aircraft and component maintenance operations should be adopted as a process improvement to enable the mechanic to quickly obtain the parts needed to perform maintenance tasks. In addition, the routing of parts should be limited to only those parts which must be reinstalled on the parent item. This process improvement would greatly enhance the accuracy of usage history and ultimately the availability of spare parts.

The process of kitting would utilize a very accurate BOM along with the specific asset plan for the work to be accomplished. The asset plan, time phased based on the scheduled induction date, would allow for a very flexible kitting process. The kits could be built for a specific major task, for a specific period in the flow schedule, for a specific skill, or for an entire project. The extent and size of the kit would be locally determined based on factors such as amount of storage available and location of storage relative to the work site. The kit should include all known parts requirements including those with very low replacement percentages to minimize the number of times the mechanic has to order parts not included in the kit. The parts in the kit should be charged to the appropriate job at the time the part is used by the mechanic to ensure that accurate usage data is provided to the supporting supply systems. This would be accomplished by building up the kit in the supply area with a complete inventory and the parts being the property of the supply system. As each part is used by the mechanic, the parts would be charged to the appropriate job by processing a part order document. At the completion of the job the kit would be returned and an inventory taken to ensure that all parts used were properly recorded.

Limiting the routing of parts to only those that must be reinstalled on the parent item or those that do not have an established repair program would increase the accuracy of the data being provided to the supply system by ensuring that each part requirement is fully documented in the system.

The benefits of these process improvements would be:

- Reduced delays caused by the non-availability and subsequent ordering of parts.
- Increased accuracy of material usage resulting in more accurate requirements and stockage computations.
- Reduced non-credit returns by only processing orders for what is actually used.
- Improved accuracy in tracking and management of routed items.

<u>Example of the part this BPI plays in the PIPs</u> – This BPI works toward resolving one of the major constraints against achieving the objectives of the ALCs. Based on the data collection, if parts were immediately available to the mechanic at the work location, this would significantly enhance the efficiency of the mechanic for about 40% of the parts needed for an aircraft PDM. This is the immediate impact of incorporating this BPI through PIP A, placing the currently available parts at the work location by the mechanic. With PIP B, as the planning process enhancement of Subsection C.1.2 above is incorporated, because of better BOMs, more and more parts will be available and more and more parts can be included in the kitting package at the

work location by the mechanic. At this point, the parts suppliers become an active participant in the process. In PIP C the parts requirements are defined in a "super" accurate BOM, which indicates the actual day a work operation is planned and the parts and quantities required for that operation. The parts are brought forward when those work operations are due and the parts are immediately available to the mechanic. At PIP D, the strength of integration requires implementation of BPIs detailed in Subsections C.1.6, C.1.7, and C.1.12. As a result the knowledge base for parts requirements consists of real consumption information by tail numbers by work operations, with visibility of problem parts information from throughout the DoD.

C.1.4 Data Sharing Among All Levels of Maintenance

A key to improving the depot maintenance process is having all levels of maintenance (i.e., organizational and depot) aware of the status of the end-item under repair, be it an aircraft, engine, or component. The status includes:

- Current Configuration,
- Sensor Data,
- Failure History,
- Corrective Action,
- TCTO Status,
- Time Change Item Status, and
- Delayed Discrepancies.

ITI-ALC, in full-up configuration, would access all levels of maintenance history. The sensor data is the information collected and recorded about the aircraft and component operational environment. The failure history includes information about the operation of the end-item when failures occurred. For an aircraft the operating envelope would be identified, for a component the signals levels, supply voltages, etc. would be available. The corrective action history includes all actions performed on an end-item at all levels of maintenance. The TCTO status is the completed, pending, kit status and location, of all applicable TCTOs. The time change item status provides the status of all end-items requiring maintenance actions at specific operating or calendar intervals. The delayed discrepancies include maintenance actions that have been delayed for lack of material, time, or to be performed in conjunction with future scheduled maintenance activities.

Aspects of this process improvement include:

- Allow the end-users to perform trend analysis and identify potential future problems with a given end-item.

- Allow production managers to determine the optimum time to have an end-item enter the depot for maintenance rather that an average for all end-items.

- Allows all specialties, planners, schedulers, production managers, and mechanics to be aware of problem areas and take a proactive role in increasing the efficiency and productivity of the depot maintenance process.

The benefits to the ALCs provided by improved data availability include:

- Increased accuracy of supply requirements and reduced inventory and the costs associated with inventories.

- Decreased end-items time spent in the maintenance process.

- Reduced inspection time since the status is known and not something that must be inspected for at each maintenance level.

Example of the part this BPI plays in the PIPs – Even in the current configuration, the process could share data better, enjoying some 10% of the impact of this BPI even without introduction of technology. Advanced review of aircraft condition at the operating location by PDM personnel could capture information about the condition of the specific tail number which would enhance the ability of the ALC to turn the aircraft around quicker. With PIP B, an IMIS base level records access point could be provided to the mechanic to "see" tail number specific maintenance information. PIP C provides two way communication of data between the various levels of the maintenance effort, but significant paper records still exist. PIP D includes a total electronic aircraft records system.

C.1.5 Production Responsibility Centers

A PDM team (controller, aircraft managers, and mechanics) will be responsible for the completion of maintenance on a given aircraft by creating Responsibility Centers. The Production Responsibility Center concept regards the maintenance of a group of aircraft as a "project." Further, this concept makes the controller responsible for all the aircraft in the set, an aircraft manager, reporting directly to the controller, responsible for an individual aircraft in the set, and all the mechanics required to perform the PDM for the aircraft "assigned" to that project for the life of the project, or smaller time frame based on need. Aspects of this process improvement include:

- Clear chain of command from controller to aircraft managers to mechanics (no extraneous management to add impediments).

- Introduces the controller role, a production manager that takes an active role in the decision making and responsibility of performing the required maintenance on a set of aircraft.

- Eliminates "administrative" levels of management (e.g., scheduler, "flight" manager), replacing them with active participants in the process (see Figure C-1).

- Eliminates the artificial distinction among PDM, and backshop work, by including all of them under one streamlined organizational structure (see Figure C-1).
- Induction to final sell "ownership" by one aircraft manager for each aircraft.
- Daily (end-of-day) "set-up" or triage (e.g., allocation of resources, ensuring status, and others) of all work to be done in the next day for an aircraft.

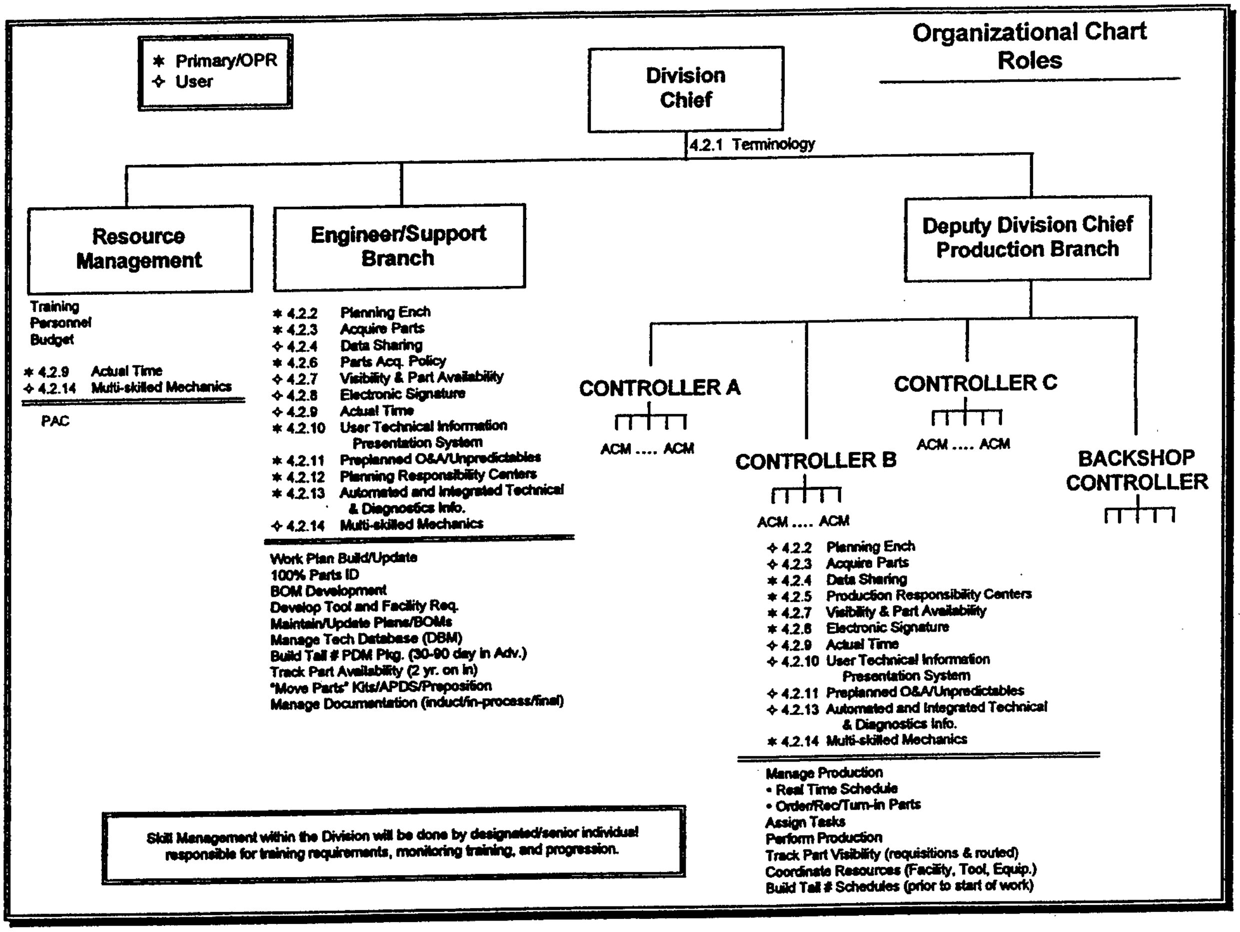

Figure C-1. "TO-BE" Division Organization

The benefits to the ALCs provided by this process improvement would include fewer "flow days" and more productivity by providing the following:

- Emphasis on clearer lines of responsibility, therefore lowering confusion.
- Allows empowerment to be set at the correct "level" and gives each level the information it needs to make effective decisions.
- Takes maximum advantage of the enhanced planning capabilities and greater responsibilities as described in Subsection C.1.2 of this document.

- Using Chandler's theory, *Strategy and Structure,* on matching structure to strategy to gain efficiencies due to the structure of the organization without losing the flexibility of a "pooled" work-force.

- Increasing visibility and ownership, therefore morale, by increasing task identification/ significance, autonomy, and feedback effectiveness.

Example of the part this BPI plays in the PIPs – The ITI-ALC team estimated that approximately 30% of the impact of this BPI is achieved early in PIP A. This is an organization issue, which places the responsibility for production of a specific aircraft set in the hands of a controller and mechanics. The administrative overhead of the backshop operation is removed. The clarity of the organization results in less lost time awaiting decisions from outside the immediate responsibility area. At PIP B, ITI-ALC provides access to information in associated databases and a slight increase in the impact is expected. At PIP C the scheduling function is automated through another BPI, relieving these resources to be applied to more direct tasks. The detailed planning capability built into the PIP D supports "on the run" changes and advice. The dynamic scheduling tool is available at PIP D and also requires the BPIs detailed in Subsections C.1.7 and C.1.12.

C.1.6 Component Parts Acquisition Policy Changes

This subsection contains a discussion of three recommendations for changes to parts acquisition policies. The Government policies/procedures that pertain to this BPI are AFMCM 57-4 and AFMCR 57-6. AFMCM 57-4 deals with setting recoverable requirements based on a two year history. AFMCR 57-6 identifies that consumable requirements are based on demand history, and that credit return computation must include procurement assets when determining stock position.

C.1.6.1 Direct Input of PDM Parts Requirements

A policy change should be implemented to allow PDM parts requirements projections be directly input to the various requirements systems. The current requirements computation systems use a set of algorithms to compute future recoverable spares requirements [AFMCM 57-4 Recoverable Item Requirement System (DO-41)], and a somewhat less sophisticated set for consumable spares requirements [AFMCR 57-6 Requirement Procedures for Economic Order Quantity (EOQ) Items (DO-62)]. Both of these systems work quite well provided the history data is accurate and the future utilization is predicted accurately. The PDM process presents a unique problem for the requirements systems in that many of the parts used in the process are only used during PDM because of the depth of maintenance involved, and because of the small quantities of these parts used. These factors along with the changing content of the PDM package make the requirements computations difficult even if the usage data has been accurately collected.

The ITI-ALC system, using the plans developed by the maintenance engineering staff that will include a list of parts required for each PDM task, will be able to provide a very accurate time phased projection of the parts required over the entire planning period (3-4 years). Since these would be based on the actual work plans, and adjusted by the improved capability of the ITI-

ALC system to track consumption, the parts required to support PDM would be very accurate and known at the time the requirements are developed.

C.1.6.2 Support Banding of Inventory to Weapons Systems

The funding level of spares should be tied to the funding level at the overall weapon system. Most spare parts are currently bought based on the funding level of the account from which they are bought, rather than on the funding level of the weapon system they support. After these spares are input to the inventory they are distributed based on the priorities established in the Uniform Materiel Management and Issue Priority System (UMMIPS) system. The combination of these two processes results in some 100% funded weapons systems being supported with spares that were 50% or 60% funded. This is further compounded by issuing parts on a first-come-first-served basis with the UMMIPS priority system.

"Banding," a policy change that would tie the funding level of spares to the funding level of the overall weapon system, would greatly improve the chance of having the right parts available at the right time. A second policy change that would control the issue of the banded spares so that they would go to the intended weapons system would ensure that the parts purchased for a weapon were available to that weapon. Both of these policies would be particularly beneficial to the PDM process, particularly if the policy change recommended in Subsection C.1.6.1 were also adopted.

C.1.6.3 Change the Time When Procured Parts Are Considered Inventory

Assets on contract should not be included as on-hand inventory. Current Air Force policy considers the quantity on contracts on-hand and includes that quantity in the on-hand balance of the item manager. This policy makes it appear that assets are readily available when in fact a large portion of them may only be in production. This policy results in a false indication of parts supportability when parts projections are used to determine if future workloads, including PDM, are parts supportable. For instance, if three months of an end-item were physically on-hand and another twelve months were on contract with a twelve month lead time, the system would indicate the workload was supportable for the next fifteen months even though there would actually be a nine month period where no parts were available. Lack of parts at the right time causes major disruptions in the PDM flow, and because the actions are often sequential and time dependent, it is very difficult to rework the schedule to be efficient and effective.

A policy change in the DO-41 system that would not include assets on contract in the on-hand quantity would provide a more accurate picture of parts supportability. This would ensure that future requirements computations would flag potential shortages where requirements have increased since the previous computation. This change would allow item managers to make the appropriate contract adjustments in sufficient time to preclude maintenance delays due to lack of parts.

Example of the part this BPI plays in the PIPs – At PIP A this BPI is not implementable; however, at the earliest implementation of ITI-ALC, information on parts requirements can be provided to the warehousing function to update them on when parts will be required. This will provide about 30% of the expected positive impact from this BPI. The real impacts occur at PIP

C and D, based on the preparation of "super" accurate BOMs and the developing knowledge base about parts consumption per work operation per tail number. This real knowledge about parts consumption and parts required is passed to the item managers with direction to assure that parts are on hand at the work location on the date required.

C.1.7 Visibility into Part Availability

The development and implementation of effective maintenance schedules requires visibility into parts availability, not only in depot maintenance, but also in the wholesale supply system and in procurement. Advanced part visibility would help to identify potential shortages before they actually effect production and would allow the item/materiel manager to take timely action to ensure the parts are available when needed. Visibility into part availability during the development of the asset plan and induction schedule would allow for more effective negotiation with the manager and operating command for maintenance actions to be added to the PDM package by ensuring that parts for add on maintenance and or TCTO's would be available during the PDM. The induction schedules for components could be controlled to improve/ensure that the desired repair/overhaul could be accomplished. Once an item has entered depot maintenance, visibility into the availability of routed parts or parts that were ordered for the specific task would allow for more accurate daily schedules and more effective utilization of personnel.

C.1.7.1 Long Term Visibility

This process would involve the development of a two to four year time-phased parts projection based on the planned induction schedule and the BOM developed as part of the reparable plan. This data would be compared to the inventory in the wholesale supply system [Depot Supply Stock Control and Distribution System (DO-35K)] as well and the quantity and delivery data for items on contract [AFMCR 70-11 Acquisition and Due-in System (JO-41)]. The data would be used to determine time periods where potential support voids appear to exist. The data would be made available to the appropriate item/material manager to ensure that all possible actions are taken to eliminate the voids before maintenance is scheduled to begin.

C.1.7.2 Short Term Visibility

During the development of the asset plan for a specific PDM or the negotiation of the induction schedule for components, the parts available in the wholesale and local retail supply system would be reviewed to ensure, to the maximum extent possible, that the desired maintenance action could be accomplished.

C.1.7.3 In-Work Visibility

While an asset is in the maintenance process, the production manager should be provided with a report of the status of all parts ordered for that specific job as well as the current location and status of all routed parts for that job. This would be accomplished by obtaining backorder status from the retail supply system and routing data from the internal maintenance systems.

The benefits to the ALCs from this process improvement would be:

- More effective utilization of maintenance personnel.

- Significant improvement in scheduling effectiveness.
- Reduction in rob-back actions.
- Reduction in component part being placed in awaiting parts AWP/G code status.
- Reduction in on-hand inventory.

Example of the part this BPI plays in the PIPs – In PIP A there are very few benefits to be derived from this BPI. At PIP B the PDM team has asset visibility of the parts on-base. This will enhance the ability of the planning function to accomplish that effort. At PIP C and D, this visibility expands to include USAF and DoD inventories. At the same time, this BPI integrates with the BPI on Process Enhancement to advise the production responsibility centers of any discrepancies between requirements and asset availability. Based on information available from the DoD inventories information, the responsibility center may be offered alternative available parts.

C.1.8 Electronic Signatures

Signatures and stamps are used by mechanics, supervisors, and inspectors to indicate task inspection and completion. Signatures and stamps are affixed to paper documents (i.e., 173 work cards, work control documents, etc.). These paper documents are then transferred to a data entry function that enters the completion data into a management information system. The original paper documents, containing the signatures or stamps are stored for an extended period of time for historical purposes. The formal Government policies/procedures that pertain to this BPI are AFMCR 66-53, AFMCR 66-18 and AFM 67-1. AFMCR 66-53 states that each ALC must establish receipt certification to ensure positive control of assets. AFMCR 66-18 indicates that all mechanics must certify their work with a stamp, signature or initials. AFM 67-1 indicates that all documentation must include date, time, and signature. These procedures should be changed within the programmed depot maintenance process to make electronic signatures binding on all members of the maintenance team. Electronic signatures may exist in many forms, such as actual digitized images of signatures, debit cards for each employee, and/or user id/passwords. A major goal is to computerize the data communication within depot maintenance. Throughout the depot maintenance process, and especially at the mechanic's level, an approval is needed before the data is released for continued processing. Therefore, the electronic signature is required to gain the full potential from an automated support system concept.

Many organizations would like to use electronic means for all transactions; however, such capabilities have been slow in development. Part of this is due to the difficulties associated with securing and verifying electronic signatures; however, this problem has been solved, at least on an intergovernmental basis, by the Federal Highway Administration (FHWA) electronic signature program, which started in 1993. This program allows state transportation departments to apply for highway project reimbursements by simply keying in their electronic signatures. The billing data is transmitted electronically to FHWA where personnel review the information on-line and indicate federal approval with their electronic signature. These payments are then transmitted to the state through the Federal Reserve System, and the Treasury is notified electronically. In the past, this process would take four days; now it takes less than one day.

In another study authored for the U.S. Postal Service, *Proposed Policy to Accept Credit and Debit Cards Make Sense Conceptually*, Arthur D. Little noted that cards are now a well-accepted method of payment for virtually all services and supplies in the world. Debit cards are increasingly used at the point of sales.

All documents that are presented, in an electronic format, to the mechanics, supervisors, and inspectors that require stamps or signatures would be annotated using electronic signature. The documents would be executed with electronic data codes, encrypted or otherwise protected which would signify approval by the sender. Without the use of electronic signatures, the benefits realized from both process improvement and computerization will be significantly reduced.

The benefits provided by this policy and procedure change includes the following:

- Eliminate the manual efforts required to enter the completion data into an information system.
- Reduce the time that it takes to update the status and schedule; therefore, providing management in more timely information.
- Full potential of the ITI-ALC system concept to be realized by the ALCs.
- Implement a paperless environment.
- Streamline the data flow.
- Eliminate or as a minimum reduce unnecessary data entry processing that is both labor intensive and error prone.
- Key improvement for electronic distribution and retrieval of information.

<u>Example of the part this BPI plays in the PIPs</u> – This BPI is not implementable at PIP A. At PIP B it captures individual mechanics logging on to the daily accomplishment of work on particular planned packages or not logged on; an improvement over current information. At PIP C the shift work operations schedule is produced electronically and presented to and opened and closed by the mechanic. In PIP D the mechanic will use the electronic signature to "sign" for the work accomplished. During this PIP the record of accomplished work operations becomes totally electronic. This BPI implementation in PIP D then allows the next BPI to produce its' maximum effects.

C.1.9 Performance Metrics Based on Actual Data

Collection of actual performance data should be enabled and a metric developed to measure effectiveness of the maintenance and maintenance support process. While concepts such as standard rates must be retained as a basis for budgeting; standard rates should identify hands-on maintenance time separate from parts acquisition time, personal time, and so forth. In addition, performance metrics must allow for realistic fluctuations in maintenance productivity and must be capable of identifying processing problems within depot maintenance and its support processes.

Currently, the cost of the maintenance work is based upon standard hours assigned to each maintenance work operation. The standards begin as estimates, then are adjusted and verified during the work-proofing phase to become the baseline for the negotiated time period. Data collection has indicated that, once established, few adjustments are made to standard hours based on feedback from their day-to-day application.
The current requirement of maintaining a high specific level of labor efficiency tempts maintenance personnel to bank hours in order to attain the rating against which they are evaluated. This approach results in inaccurate maintenance status information, camouflages problems within the maintenance process, and therefore fosters the continued application of ineffective maintenance processes.

Collection of performance data that represents realistic performance provides the basis for identifying and measuring process improvement concepts.

The benefits that would be received by the ALCs through this improvement recommendation are the following:

- More realistic maintenance status information.
- Increased potential for identifying and correcting true maintenance problems.
- Enhanced working relationship among the various levels of personnel within depot maintenance.

Example of the part this BPI plays in the PIPs – At the initial PIP A and B, this BPI will indicate minimal information about the work in process; that the mechanic is working, but little else. The object of this BPI is to produce information as a by-product of the work operations, in a non-intrusive way. In lieu of the current approach which has separate work steps set aside to accomplish work documentation and data collection, mechanics will not perform any "reporting" or "enter data" work operations. The information will be extracted from the work process. As a result, the performance metrics available to the work group will achieve its highest impact in PIP D.

C.1.10 User Technical Information Presentation System

In order for an automated tool to support the performance of programmed depot maintenance it is essential that accurate and current technical information be easily available to the mechanics, planners, and aircraft managers. In addition, the tool must simplify a means to report errors and recommendations for improvements. The Government policy/procedure that pertains to this BPI is AFMCR 66-51 which stipulates that technical orders must be used during maintenance of "critical tasks" and that AFMC Form 173 must be used for all other tasks. The user technical information presentation system would implement the functions that are described in the following areas.

C.1.10.1 Display

This part of the tool would be able to access existing electronic databases for technical information, formerly known as technical orders (TOs) data and drawings. The system would be able to display data a screen at a time, and provide a tool to assist in browsing through technical information or to aid in finding additional data if needed by the mechanic. Through the electronic link that would be established with the prime database, the system would verify for the mechanic, planner, or controller that the data is the latest updated data. Technical graphics (drawings) would be in sufficient detail that they could be printed and used for manufacturing.

C.1.10.2 Tracking

A large number of the documents (AFMC 173s and AFMC 958/959s) used in depot maintenance specify TOs for reference and use TOs as their authority. A major task for the planner is to keep track of the changes to the technical information and to keep the documents correct. Part of the Technical Information tool would record each piece of technical information referred to in a maintenance document and compare that to change notices received from the technical information management system. The system would then notify the appropriate planner that technical information referenced in a document was changed and that a revision may be necessary. A second part of this tracking module could be a system that tracks AFTO 22's and Form 202/103/two way memo's, for resolution and close-out/suspense.

C.1.10.3 Research

Most of the mechanics and planners are aware of the basic technical information that they want to use, but if they need additional information or further guidance, many have difficulty going to the next level. A research system that would walk the planner or mechanic through one of the following with a choice of ways to navigate would be very helpful: a 1) subject, 2) system, or 3) process. Examples of navigation choices would include the technical information identifier, key word, part number, stock number, and so forth.

C.1.10.4 Authoring

A significant task for the planner is to take portions of a TO and insert them into the work control documents and plans they are building/revising. Authoring would provide a system that would bring in technical information from the source and then provide the planner the capability to manipulate the data without changing the primary database and then to move that data to the system used for planning. This would allow them to cut and paste and save a lot of documentation and/or reentry of similar data.

C.1.10.5 Technical Information Discrepancy/Improvement Notification

An automated system would allow the end-user to process notification of discrepancies in the technical information as it is discovered versus the current system of having to complete a form. Currently, when the end-user of the technical information identifies an error or has a suggestion for improvement they must determine, by the application rules in TO 00-5-1, the method required for submission of the report (i.e., the urgency of the problem, the method for submission, message, AFTO Form 22, AF Form 847, AFTO Form 135, or letter) and the agency responsible for managing the information. The end-user may be the planner, controller, supervisor, or mechanic. The report is then forwarded to the individual's supervisor for a validity check, completeness, and signature. The supervisor forwards the report to the local Product Improvement office or other responsible office for review and approval. The reviewing organization shall then forward the report to the command control point(s) for review and approval. (Except for emergency reports that will be transmitted as electrical messages to the organization having management responsibility for the information.) The command control points will forward the approved reports to the organization having management responsibility of the information.

The proposed improvement is to provide the end-user an automated means for submission of a report. With the technical information residing in a database, the report would be related to information in a database, not a page in a manual. The system will take a snapshot of the current conditions and use that to identify the area of the information that is deficient. The end-user will focus on the technical aspects of the problem and have the system perform the administration functions. The system would prompt the end-user for the inputs relating to the deficiency. The system would complete the data elements such as system undergoing maintenance, operation being performed, etc. based upon the task being performed. The end-user would complete the problem report section while using the information and have the capability to switch between problem reporting and using the information. The discrepancy would be electronically transmitted to the responsible management organization for action. The technical information in the database would be labeled as having a deficiency submitted and under review. The management organization would have complete information and the capability of transmitting a response to the mechanic, be it a work around procedure or notification that the work will be held up until a resolution is developed. The controlling and planning functions would be aware that there is a problem with the information and reschedule maintenance until the information is corrected or a work around is approved.

The benefits to the ALCs through this improvement recommendation would include the following:

- Improved technical information.
- Greater interest in correcting deficiencies in and improving technical information as the process is designed to make it easier for the end-users to submit reports.
- The technical information would be flagged as having a deficiency in work and eliminate duplicate submissions.
- The controllers and planners would be made aware that a problem exists with the technical information and, if required, adjust the work plans accordingly.

- The management organization would have the ability to update the procedures with interim work-arounds until formal changes are in place that will allow work to continue without compromising reliability or safety.

- The system would mark the offending information and notify other users that a problem has been identified and is being worked.

- The system would automate the administration portion of the process and reduce the time spent performing non-production work.

Example of the part this BPI plays in the PIPs – At PIP A this BPI is not implementable. At PIP B, the technical information can be presented to mechanics at the work station in a currently available CD ROM format. At PIP C, while such issues as radio frequencies (RF) may not be resolved, the technical information will be presented at the work station to the mechanics in a portable computer format, perhaps in a miniaturized Portable Maintenance Aid (PMA) format. At PIP D, the technical information is presented to the mechanic by a personal "eye piece"/"voice activated" environment.

C.1.11 Preplanned Over and Above / Unpredictables

During the ITI-ALC team visit to the United Air Lines (UAL) heavy maintenance facility in San Francisco, CA briefings were received on several subject areas. One area was the UAL procedure for planning and incorporating into the work flow, discrepancies that cannot be fully defined prior to the aircraft's arrival for heavy maintenance. At UAL this type of discrepancy was called non-routine and included those things the Air Force identifies as unpredictables and or Over and Aboves (O&A). UAL told the ITI-ALC team that about 60% of the work done during a Heavy Maintenance Visit (HMV) fell into this category. They have instituted a process of pre-planning "Standard Non-Routine" tasks. For instance, the task to inspect the cargo door for cracks would be a standard HMV task; the number of cracks found, their location, and their size would not be known and would therefore, be non-routine. Their new procedure, being implemented at the time of our visit, was to have preplanned packages for expected locations and sizes of cracks so that at the time the inspection was performed there would be no delay in the flow of the HMV for determining the appropriate fix and putting together a plan for that fix. In those instances where a discrepancy was discovered that was similar to the current Air Force O&A, the planning package was maintained and electronically cataloged so that if the same or similar problem occurred on a different aircraft, the planning was already accomplished and easily incorporated into the flow plan for that aircraft. The aircraft work package was designed so that an inspector performing an inspection task was pointed to the preplanned "Standard Non-Routine" tasks and was able to select the correct one based on the conditions noted in the inspection. This best practice observed in the commercial airlines should be adopted by the ALCs.

The ALCs would benefit by implementing this commercial practice through: 1) reduced flow day delays due to preplanning and approval of tasks required for unpredictables and O&As, 2) more effective defect determination during the inspection phase, and 3) more effective planning for future Maintenance Requirements Review Boards (MRRB) based on accurate statistical data on unpredictables and O&As.

Example of the part this BPI plays in the PIPs – During data collection it became apparent that work effort associated with these type of activities was substantial. It was also apparent that preplanned experience was not formally fed back to the planning function for incorporation in future work. PIP A would incorporate this feedback in a manual mode. This however, would not be a substantial positive impact. At PIP B this BPI would support on-line negotiation/authorization of the tasks. However, the real impact would occur at PIP C and D. At PIP C we anticipate the mechanic selecting from a menu of choices and implementing one of the preplanned choices when faced with O&A work. At PIP D we anticipate including a learning feedback loop to build the knowledge base for application to current and future work.

C.1.12 Planning Responsibility Centers

Improving the completeness and quality of the work performed by the planner significantly increases the productivity of the mechanic. The Planning Responsibility Center concept makes a clear distinction between preparing for maintenance and performing maintenance. Any duplication of effort that exists between these areas is a detriment to productivity. With timely information available and electronic access to technical information, the planner has the capability to develop effective maintenance reparable/asset plans, enforce those plans, and adjust the plans based on information from the Production Responsibility Center (refer to Subsections C.1.2 and C.1.5). This concept will also enhance and enable the BPI pertaining to the acquisition of parts (refer to Subsection C.1.3). Furthermore, a Planning Responsibility Center is especially important given the extra responsibilities allocated to planners based on long term and short term visibility of parts availability (refer to Subsection C.1.7) and pre-planning of "standard" O&A (refer to Subsection C.1.11). The Responsibility Center concept allows mechanics to spend their time performing maintenance work rather than preparing for it. Aspects of this process improvement include:

- Clear functional separation between the planning function and the performing functions (Production Responsibility Center - Subsection C.1.5).
- Improved control of the maintenance asset plans.
- More effective use of resources.
- Elimination of mechanic training for those functions that should be performed by the planner.

The benefits to the ALCs provided by this process improvement would include fewer "flow days" and more productivity by providing the following:

- Emphasis on clearer lines of responsibility, therefore lowering confusion.
- Allowing empowerment to be set at the correct "level" and gives each level the information it needs to make effective decisions.

- Takes maximum advantage of the enhanced planning capabilities and greater responsibilities as described in Subsection C.1.2 and enables many of the BPIs identified in this document.

- Using Chandler's theory, *Strategy and Structure,* on matching structure to strategy to gain efficiencies due to the structure of the organization without losing the flexibility of a "pooled" work-force.

- Increasing visibility and ownership, therefore morale, by increasing task identification/ significance, autonomy, and feedback effectiveness.

The Government policies/procedures that pertain to this BPI are AFMCR 66-4, and AFMCR 66-55. AFMCR 66-4 establishes the engineering planning branch within a depot. AFMCR 66-55 requires a scheduler for every aircraft undergoing PDM.

Example of the part this BPI plays in the PIPs – As described in this section, there is significant duplication of effort between preparing for maintenance and performing maintenance. That duplication is a detriment to productivity. A small impact is expected from this BPI in the PIP A implementation by not having mechanics perform efforts which are also accomplished by planners. At PIP B this BPI presents information necessary to accomplish the planning function. It also starts to take advantage of the BPIs detailed in Subsections C.1.3, C.1.7, and C.1.11. At PIP C the BPI integrates the requirements for effective planning. At PIP D, the full benefit is achieved by reducing the uncertainty in the process to a minimum, by maximizing the learning that the day to day process produces.

C.1.13 Automated and Integrated Technical and Diagnostics Information

Although the automated presentation of technical information and troubleshooting procedures through electronic diagnostics is not really a change to the processes of depot maintenance, it is a significant enabler. Recent results of the field tests for IMIS indicates that the approach included in this BPI significantly enhances mechanic problem solving abilities, reduced parts consumption, significantly reduced parts ordering time, shortened work order close out efforts, and significantly reduced the error rate for data input. This is true due to the fact that automation and integration of technical and diagnostics information will make the mechanics more effective, and allow them to have more time at the work site doing maintenance, then in the present depot world.

The potential, in many cases of a weapon system's life-cycle, including depot level repair and modification functions was summarized in an Institute for Defense Analyses report published in 1991. Cost benefit guidance for Computer-Aided Acquisition and Logistics Support (CALS) applications stated that large productivity, quality, cost, and operational improvements can be realized when technical, economic, operational, and logistics data are created, stored, distributed, and used in digital form.

An automatic information system will process user-requests to obtain specific technical information for presentation to support maintenance tasks. This system will retrieve user-specified guidance materials for presentation to help in the maintenance of an aircraft. This will allow mechanics to get the directions/information they need, at whatever level of detail is required, instantaneously.

This BPI also supports the inspection and analysis of the reparable to further identify and isolate problems not previously reported or part of the standard PDM. A system will diagnose problems identified through inspections and will provide information on potential solutions consistent with the identified problems. Additionally, this system will support diagnosis of problems created as a result of reparable modifications and/or upgrades.

The benefits to the ALCs provided by this process improvement would include fewer "flow days," more productivity and fewer false replacements (RTOK) by providing the following:

- Facilitating the multi-skilled mechanic concept (refer to Subsection C.1.14) by using powerful human-to-machine interface techniques to equalize the novice and the expert.
- Those same techniques will help lower the time to perform each maintenance task by making the correct information more accessible (per IMIS demonstration results: 17% to 29% less time).
- Time consuming errors in performing maintenance will be decreased (per IMIS demonstration results: 56% to 81% fewer errors), which will also have a net results of increasing quality.
- A number of parts consumed due to erroneous troubleshooting will decrease (per IMIS demonstration results: 26% to 36% less parts consumed).

<u>Example of the part this BPI plays in the PIPs</u> – The automated technical information is an improvement, although it provides no impact in PIP A, and only a small impact at PIP B. However, in PIP C, the mechanics begin to see advantages as observed in the recent IMIS field test. The expected impact in six key areas is described in the following subsections.

C.1.13.1 Successful Task Completion

The mechanics' performance was evaluated to determine if they had satisfactorily completed all requirements (as defined above). The percentage of problems successfully completed under each test condition using IMIS or paper TOs was computed. These percentages are presented in Table C-2.

Table C-2. Percent of Problems Successfully Completed by Avionics Specialists and APG Mechanics

	TO	IMIS	Significant
Avionics Specialists	81.9	100.0	Yes**
APG Mechanics	69.4	98.6	Yes***
Total	75.7	99.3	Yes***

** $p < .01$
*** $p < .001$

The specialist and APG mechanics successfully completed nearly all the problems when using IMIS. Only one problem was failed when using IMIS compared to 26 (or 144) problems failed when using paper TOs as the source of technical data. Of particular interest is the fact that when using IMIS the APG mechanics were nearly as successful in completing the fault isolation problems as ere the avionics specialists. This is an important finding because it indicates that, with IMIS, crew chiefs could perform much wider variety of tasks, reducing the dependence on highly trained specialists.

The observed differences in performance with IMIS and paper TOs are statistically significant for both specialists and APG mechanics. Also, the difference in the observed success rate for mechanics using IMIS versus avionics specialists using paper TOs is statistically significant.

The success rate for both specialists and APG mechanics was much lower when the TO was the source of technical data. Close examination of the data reveals that most of the failures with the TO were due to a failure to complete all the required system health checks. The difference in performance can be explained by the fact that one or more built-in-tests or operational checks are required to verify that the system has been returned to operational status. System health tests and checkout requirements are presented in the follow-on maintenance requirements section of the TO. The manner in which the follow-on maintenance requirements are presented in the TOs for some systems makes it easy to overlook required checks. As a result, several mechanics failed to complete all the required checks and failed the problem. With IMIS, it is impossible to overlook the required checks. When a mechanic completes a task, IMIS automatically presents the instructions for the follow-on task. The mechanic must follow the instructions or consciously choose not to do the task.

C.1.13.2 Parts Used

The mean number of parts used by each mechanic to complete the six problems under each condition is shown in Table C-3. The specialists required an average of 8.67 parts to complete the six problems using the TO, compared to 6.42 parts when using IMIS[2]. The APG mechanics required 8.30 parts for the problems when using the TO, compared to 5.30 parts when using IMIS. Again, it should be noted that, on this measure, the APG mechanics were as proficient as the avionics specialists.

Table C-3. Mean Number of Parts used by Each Mechanic for Six Problems Under Each Condition

	TO	IMIS	Significant
Avionics Specialists	8.67	6.42	Yes***
APG Mechanics	8.30	5.30	Yes***
Total	8.48	5.84	Yes***

*** p < .0001

[2] Three of each set of six problems required replacement of a part to correct the fault. The remaining faults were caused by wiring and required no parts. Thus, rectification of the problems required three parts per subject, per condition. Any parts used in excess of three were "good" parts either replaced by the diagnostic strategy or because of an error by the mechanic. The diagnostic strategy employed in the TOs required replacemeof five good parts for the six problems. The diagnostic strategy generated by IMIS required the replacement of two good parts for the six probelms. The F-16 TOs often direct the replacement of a component to determine if it is good or bad. This normally occurs when there is not test available to determine if it is good or bad, or because the troubleshooting procedure does not take advantage of an available test.

Detailed analysis of parts usage revealed that the great majority of the part savings for IMIS were from one subsystem, the INS. This appears to be due to the differences in the complexity of the troubleshooting tasks for the system. INS troubleshooting procedures are much more complex than procedures for the FCR and HUD. Additional analyses are being performed to evaluate the observed differences.

C.1.13.3 Task Performance Times

The mean times for mechanics to perform their assigned tasks using either IMIS or paper TOs were computed. The means are presented in Table C-4.

Table C-4. Mean Problem Performance Times (in Minutes) for Each Problem

	TO	IMIS	Significant
Avionics Specialists	149.29	123.64	Yes**
APG Mechanics	175.82	124.04	Yes***
Total	161.46	123.83	Yes***

** $p < .01$
*** $p < .001$

Both the avionics specialists and APG mechanics required significantly longer to complete the fault isolation problems when using the TO. Use the IMIS reduced the problem performance times of the specialists by approximately 17% and the times of the APG mechanics by approximately 29%. The performance times of the specialists and APG mechanics were essentially the same, indicating that the APG mechanics using IMIS were able to perform the job as efficiently as the avionics specialists (and more efficiently than the avionics specialists using their current methods).

A more detailed analysis of the performance times was conducted to identify which elements of IMIS contribute the most to the observed reductions in performance times. the analysis indicated that nearly all the observed differences were due to three factors: 1) the reduction in the number of good parts replaced, 2) the reduction in the time required to order parts when IMIS is used, and 3) the reduction in the time required to complete work order close-out documentation.

C.1.13.4 Part-Ordering Time

By reducing the number of good parts unnecessarily replaced, IMIS reduces the time required to isolate and repair a system fault. Time savings were realized by eliminating unnecessary tasks, such as removing a good part, replacing it with a new part, and performing system health checks to determine that the new part did not fix the problem.

A large percentage of the observed total time difference between the IMIS and paper TO conditions was due to the difference in the way parts are ordered under the two systems. When using the paper TO, the mechanic must go to COSO, look up the part number, obtain authorization to order the part, and submit the part order to the COSO clerk who mush input the order into the SBSS. Thus, ordering parts is a time-consuming process (a conservative estimate of 15 minutes per part ordered was used for this study). In contrast, when using IMIS, mechanics are asked if they want to order the part. If they answer "yes," IMIS automatically submits the order by RF link to the Production Superintendent for approval. IMIS then submits the approved order to the SBSS. While IMIS is processing the part order, the mechanic is free to remove the defective part or perform other maintenance activities. Thus, at least 15 minutes are saved per part order.

The difference in mean part-ordering times using IMIS versus the current parts-ordering procedures are illustrated in Table C-5. As may be observed from the table, the time savings resulting from the use of IMIS are dramatic. The observed differences are statistically significant, well beyond the 0.001 level of confidence.

Table C-5. Mean Time (in Minutes) to Complete Each Part Order

	TO	IMIS	Significant
Avionics Specialists	19.42	1.16	Yes***
APG Mechanics	25.28	1.47	Yes***
Total	22.35	1.32	Yes***

*** p < .001

C.1.13.5 Close-Out Time

The third primary source of time savings is from the use of IMIS's work order close-out and RF functions to enter close-out information into CAMS. With a full implementation of the IMIS concept, IMIS will automatically record all information required to complete the work order close-out process. When the job is completed, the mechanic will instruct the system to assemble the work order close-out information; the information will be presented to the mechanic for verification and correction, if needed. After verification by the mechanic, the information will be sent by RF to CAMS to complete the work order close-out process. under the current procedures, the mechanic must make notes on actions taken, parts used, part numbers, and so forth during the fault isolation and repair process. The mechanic must then go to the maintenance office, find a CAMS terminal, and enter the information from the notes taken (or from memory).

The IMIS demonstration system did not fully implement the IMIS concept for work order close-out. The system did not automatically record all the required information. The system presented a form (similar to Air Force Technical Order [AFTO] Form 349) with some blocks filled in and other to be completed. The mechanic filled in the blanks by selecting from lists of options. When the form was completed, the information was transmitted by RF to the IMIS workstation for forwarding to CAMS. As indicated earlier, it was not possible to enter the close-out information into CAMS for the TO-based condition. To provide an estimate of the times to close out a work order with the current procedures, the mechanic completed a paper form with the required information. The time required to complete the form, plus a standard time (10 minutes) was used as an estimate of the time it would have taken to close the work order using the current procedures. The mean observed times are presented in Table C-6. The differences in observed close-out time for both the specialists and APG mechanics were statistically significant at the

0.001 level of confidence. In addition, the times for the APG mechanics using IMIS were significantly shorter than the times for the specialists using the current CAMS-based procedures ($p < .001$). In a full implementation of IMIS, the required information would automatically be collected and used to complete the data-reporting requirement. The mechanic would not have to add information, only verify that the information is correct. Thus, the time for the IMIS condition would be near zero.

Table C-6. Mean Time (in Minutes) to Close Out Each Problem

	TO	IMIS	Significant
Avionics Specialists	14.67	8.17	Yes***
APG Mechanics	17.31	8.82	Yes***
Total	15.98	8.49	Yes***

*** p < .001

C.1.13.6 Errors

It was anticipated that the use of IMIS would reduce the number of errors made by the mechanics. As shown in Table C-7, this expectation was realized. The use of IMIS resulted in a dramatic reduction in serious maintenance errors (errors which could cause the fault not to be identified or cause the unnecessary replacement of a good part). The use of IMIS resulted in a 56% reduction in major errors made by the specialists and an 82% reduction in major errors by the APG mechanics. These observed differences were statistically significant at the 0.001 level of confidence. In addition, the APG mechanics using IMIS made significantly fewer major errors than did the specialist mechanics using the paper TOs ($p < .001$).

Table C-7. Mean Number of Major Errors per Problem

	TO	IMIS	Significant
Avionics Specialists	.69	.29	No
APG Mechanics	1.06	.18	Yes***
Total	.87	.23	Yes***

*** p < .001

C.1.14 Multi-skilled Mechanics

One challenge of the ALCs is effective scheduling of the maintenance tasks associated with the negotiated requirements. Tasks are generally planned, scheduled, and sequenced according to the skill sets needed to perform the task and the access within the aircraft required to accomplish the tasks. Obstacles encountered in the schedule cause ripples across all tasks, resulting in idle time for resources and possible delays in the overall schedule.

The concept of multi-skilled mechanics provides the opportunity to more efficiently schedule resources to complete maintenance tasks, including a reduction in the overall flow days associated with aircraft maintenance. Multi-skilled mechanics will have better visibility into true aircraft status based on a much broader base of knowledge and experience in aircraft maintenance. Multi-skilled mechanics capitalize on the cross-functional knowledge to perform maintenance tasks in an efficient order. They will also be more qualified to provide feedback to the planning function on the most efficient order for accomplishing work operations due to a more comprehensive understanding of the interrelationships of tasks. Multi-skilled mechanics will have an increased need for technical information that is readily available, particularly for newer skills (refer to Subsection C.1.13 - Automated and Integrated Technical and Diagnostics Information).

NOTE: The success of this process improvement is based on: commitment by management to support the concept, effective allocation of individual resources to exercise all skills and maintain proficiency in them, a well-planned implementation that minimizes the impact to current production, and thorough training and certification.

To successfully implement the multi-skilled mechanic concept, a further analysis of the appropriate technical combinations of current skills will be required. This will lead to an individual mechanic being task-certified and/or trained in a broader scope of tasks with a corresponding increase in the documentation required to track training and certification. While the documentation of training will require tracking of the detailed courses and practical training received by an individual, the ability of managers to correlate the training to the maintenance tasks to be accomplished will be formidable without the aid of effective electronic systems. It will be essential for the Air Force to develop a method of determining the "Certification Level" of the mechanic in a skill. A three level certification plan to identify: 1) Trainees, 2) Journeymen, and 3) Master Mechanics would be sufficient to allow for the proper control of personnel being assigned to accomplish specific tasks as well as the selection of personnel to train or inspect the work of other mechanics. This should be accomplished by grouping the training within skills so that at the completion of that grouping the mechanic would be awarded the appropriate "Certification Level". A mechanic awarded a "Certification Level" in a skill would be considered to hold a "Skill Level" and would then be certified to perform a group of tasks requiring that "Skill Level". The specification of the tasks corresponding to a "Skill Level" in the certification system should be the same as the task specification in the planning system. Implementation of this concept would allow an electronic system to aid first line supervisors in training/skill management and in task assignment. It would also allow for the implementation of electronic tools to aid the planners in identifying and selecting the appropriate skill to accomplish the task being planned to perform depot maintenance.

The concept of multi-skilled personnel has been successfully implemented in the commercial arena. The benefits to the ALCs provided by this process improvement would include reduced "flow days" and increased productivity by providing the following:

- Multi-skilled workforce deployable across multiple tasks and/or "skill sets" reducing the chances for resource downtime.

- Possible reduction in total resource requirements due to elimination of the need for specialized "skill sets".

- Takes maximum advantage of the enhanced planning capabilities and greater responsibilities as described in Subsection C.1.2 of this document.

- Introduces efficiencies into the planning process by providing more effective, more credible feedback plan enhancements derived from a broader perspective of the total maintenance picture.

- Improved correlation of maintenance tasks to the appropriate skill level.

- Enhances the team concept of the Production Responsibility Centers outlined in Subsection C.1.5 of this document by fostering reliance, buy-in, and cooperation within the team.

Example of the part this BPI plays in the PIPs – One challenge of the ALCs is effective scheduling of the maintenance tasks consistent with the available resources. One way around this resource constraint is mechanics with many skills. This is possible at the PIP A level and offers a significant flexibility. However, the effort to manage the information necessary to allow the process to work over time is significant. Therefore the "low effort" application of this BPI does not occur until PIP C when the data bases for employee training and certification are integrated with the planning, scheduling and maintenance performance function. At PIP D, analysis tools are available to the planning and production responsibility centers and mechanics to assure the application of the most effective resource package to the reduction of process flow days.

C.1.15 Three Shifts of Effort

This BPI was not part of the benefit and cost analysis included in this document, but if an ALC is interested in sacrificing some reduction in operating expense to achieve greater reductions in flow days, this BPI applies. The Government policies/procedures that pertain to this BPI are AFMCR 66-4, AFMCR 66-11, AFMCR 66-80 and AFMCR 66-268.

During the data collection visits to commercial airlines, it became apparent that work very similar to organic aircraft PDM was being accomplished in substantially fewer flow days. That difference was not just a function of a more detailed understanding of the aircraft condition prior to the arrival of the aircraft in the maintenance complex. The difference was not just a function of having virtually all parts on hand when the aircraft arrived for maintenance. That difference was not just organizing the parts needed for maintenance into readily available packages, quickly available to the mechanics. The difference was not just the ability to quickly and simply have support organizations expedite problem parts, at the final moments of work. It was all these things. But a substantial portion of the difference was the amount of labor applied to an aircraft in the repair process. As discussed earlier, mechanic teams worked commercial airliners through an HMV around the clock for twenty days. This type of effort is possible in the ITI-ALC domain. However, this BPI presents two problems.

First, the ALC must balance the objectives of reducing the current level of organic aircraft PDM operating expense with reducing flow days. Second, though the ALC has demonstrated the ability to surge to reduce process flow days in an emergency, the ability to continue that effort as a normal course of business inside of the currently defined process and information flows is not possible. This project has shown that under normal operating conditions, 30 % of the effort is associated with managing the uncertainty of a day to day normal operation. In a surge situation, the level of uncertainty increases, the time reference compresses, and the level of stress induced in the system rises exponentially in a very short period of time. In addition, very quickly, parts become a problem.

<u>Example of the part this BPI plays in the PIPs</u> – While this BPI can be implemented at any level of PIP, because of the difficulties described above, this BPI does not offer help in reducing flow days significantly until one reaches PIP C or D. At that point, the resources currently managing uncertainty begin to be available for application to direct maintenance effort. At the same time "super accurate" BOMs begin to be available and fed to the suppliers of parts. Available parts are provided to the mechanics for their use at a significantly increased rate.

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Appendix D

TurboBPR2 Analysis Tool

D.1 INTRODUCTION

This section explains how TurboBPR2 handles several key concepts relating to the Business Case. The following information was incorporated directly from the TurboBPR2 tool; therefore, the format is not consistent with the entire document.

FINANCIAL INDICATORS

Discounting

A dollar today is worth more than a dollar tomorrow.

When evaluating the cost of an alternative relative to the baseline plan, the analyst is comparing two streams of costs that unfold over time. Choosing the alternative that simply produces more dollar savings ignores the time value of money.

To take into account the time value of money, future dollars must be converted into their equivalent present value. This is called discounting. The rate at which the conversion is calculated is called the discount rate.

Accounting for the time value of money is crucial to conducting an economic analysis. If a financial indicator does not recognize the time value of money, it is not useful for decision making. Four financial indicators that do take the time value of money into account are:

- Net Present Value
- Discounted Payback
- Internal Rate of Return
- Return on Investment

Example: Discounting Costs

Suppose that Alternative A generates savings this year of $100 while Alternative B produces more savings, $105; but these savings are not received until next year.

To figure out which alternative is the better choice, we need to calculate the present value of the savings for Alternative B. To do that we need a discount rate.

Let's suppose that the discount rate is 10% (0.1). The present value of the savings from Alternative B equals:

$$PV = \$105 \times \frac{1}{(1+0.1)} = \$95$$

The savings from Alternative B are equivalent to receiving $95 in savings this year, less than the $100 generated by Alternative A.

$110 = 100\ (1.10)$

	Present Value	Future Value
Alternative A	\$100	\$110
Alternative B	\$95	\$105

$95 = 105 / 1.10$

In fact, the \$100 in savings from Alternative A is worth more than the \$105 savings received next year as long as the discount rate is greater than 5%.

Net Present Value

Discounting is the method you use to calculate the present value of a future payment. The present value (PV) of a future payment equals the discount factor for year *t* multiplied by the cash received in year *t*, that is:

$$PV = F_t \times C_t$$

If all cash flows are assumed to occur at the end-of-year, the discount factor in year *t* equals:

$$F_t = \frac{1}{(1+r)^t}$$

where *r* is the discount rate.

The net present value (NPV) of an alternative is:

$$\sum_{t=1}^{n} \frac{\text{investment}(t) + \text{impacts}(t)}{(1+r)^t}$$

where *n* is the number of years in the investment life cycle

r is the discount rate

impacts(t) = the alternative cost impact in year t

investment(t) = the alternative investment cost in year t.

If you use NPV as the basis for your decision making, you can accept any alternative if its NPV is higher than that of the baseline. According to the net present value rule, the best alternative is the one with the highest NPV.

Advantage of Net Present Value Rule

If you have two projects, A and B, the net present value of the combined investment is

$$NPV(A+B) = NPV(A) + NPV(B)$$

Suppose Project B has a negative NPV. If you tack it onto Project A, the joint project will have a lower NPV than A on its own. Therefore, when you use net present value to make an investment decision, you are unlikely to be mislead into accepting a poor project just because it's packaged with a good one.

Many of the other financial indicators do not have this property.

Discounted Payback

The discounted payback of an alternative is found by counting the number of years it takes before the total discounted cost impacts equal the total discounted investment. That is, find *m* such that:

$$\sum_{t=1}^{m} \frac{\text{impacts(t)}}{(1+r)^t} = \sum_{t=1}^{m} \frac{\text{investment(t)}}{(1+r)^t} \qquad 1 \leq m \leq n$$

where *n* is the number of years in the investment life cycle

r is the discount rate

impacts(t) = the alternative cost impact in year t

investment(t) = the alternative investment cost in year t.

If you use discounted payback as the basis for your decision making, you can accept any alternative if its payback date occurs before a specified cutoff date. Thus, in order to use the payback rule, the financial manager has to decide on the appropriate cutoff date.

According to the payback rule, the best alternative is the one with the earliest payback.

Problems with Discounted Payback

The best choice for a cutoff would be the discounted payback date of the baseline.

One problem with using the discounted payback as a decision making tool is that there are no good general rules for determining a project's cutoff date.

- If you use the same cutoff date regardless of the life of a project life, you will tend to accept too many short-term projects and too few long-term ones.
- If, on average the cutoff periods are too *long*, you will accept some projects that *increase* costs.
- If, on average the cutoff periods are too *short*, you will reject some projects that *decrease* costs.

Another problem with discounted payback is that it gives no weight to cash flows occurring after the payback date.

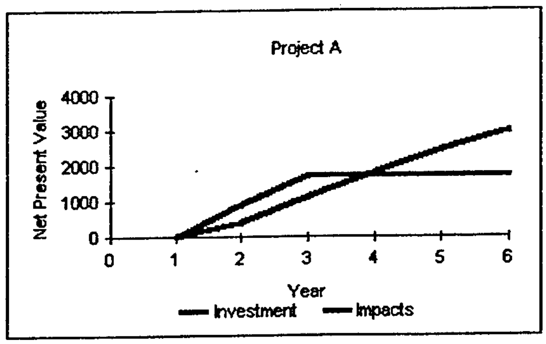
Example: Computing the Discounted Payback

Consider Projects A and B:

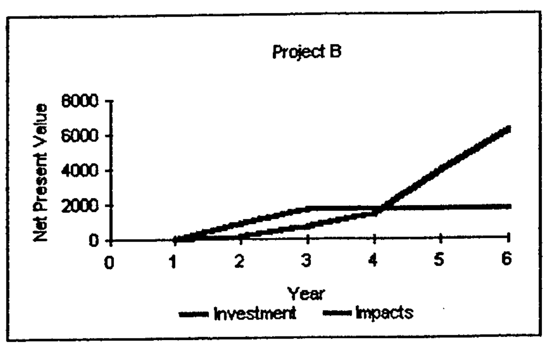
Year:	1	2	3	4	5	6
Project A Investment	1,000	1,000	0	0	0	0
Project A Impact	0	-500	-1,000	-1,000	-1,000	-1,000
Project B Investment	1,000	1,000	0	0	0	0
Project B Impact	0	-250	-750	-1,000	-4,000	-4,000

The negative signs in front of the impacts indicate that they *decrease* costs.

Assume the discount rate is 10%. The net present value for the investment costs and impacts are shown in the graphs below:



The payback is the date when the investment curve and the impacts curve cross. For Project A, the payback is slightly less than 4 years.



The payback for Project B is slightly more than 4 years.

Based on payback date alone, Project A would be the better investment. Note however that over the life of the projects, Project B has the greater impact.

Internal Rate of Return

The internal rate of return (IRR) is a profitability measure which depends solely upon the amount and timing of the cash flows. The internal rate of return for an alternative is the rate that makes the net present value equal zero. That is, find *IRR* such that:

$$\sum_{t=1}^{n} \frac{\text{investment(t)} + \text{impacts(t)}}{(1+\text{IRR})^{t}} = 0$$

where n is the number of years in the investment life cycle

impacts(t) = the cost impact in year t

investment(t) = the investment cost in year t.

If net present value *decreases* as the discount rate *increases* then it is very easy to use IRR for your decision making. This is because:

1. when the discount rate r is less than the *IRR*, the project has a *positive* net present value (decreases costs) when discounted at r; and
2. when the discount rate r is greater than the *IRR*, the project has a *negative* net present value (increases costs) when discounted at r.

If this is the case, you can accept any alternative if its internal rate of return is *greater* than the discount rate. Furthermore, the "best" alternative is the one with the highest IRR.

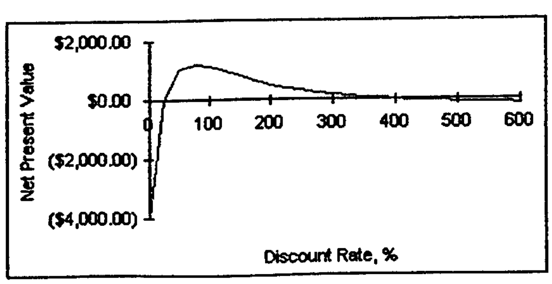
Problems with Internal Rate of Return

There are occasions when it is inappropriate to use the IRR rule as stated above to evaluate an alternative.

For example, some alternatives have no internal rate of return. For any discount rate, the NPV is always positive (profit) or negative (loss).

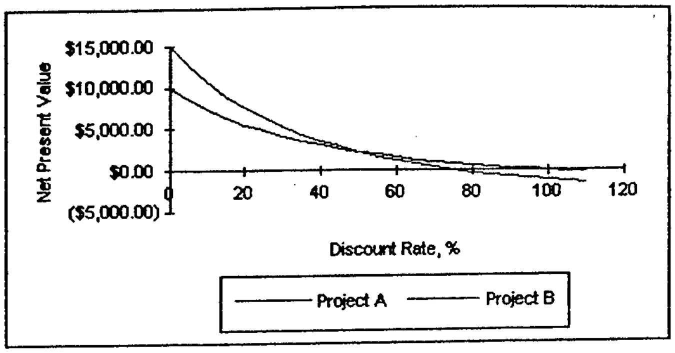
In some rare instances, the NPV of an alternative may be an *increasing* function of the discount rate. If NPV *increases* as the discount rate increases, you should accept the alternative only if its internal rate of return is *less* than the discount rate.

Some alternatives can have more than one internal rate of return. For instance, in the graph below, the NPV equals zero when the discount rate is 25% and 400%.



Internal Rate of Return Versus Net Present Value

The best solution based on IRR is not always the best solution based on NPV. Consider Projects A and B:



Project A has an IRR of 100%. Project B has an IRR of 75%.

Assume the discount rate is 10%. Since the IRR is greater than the discount rate, both projects are acceptable. If you had to choose between the two projects using IRR, Project A would be the winner. However, the graph indicates that as long as the discount rate is greater than 50%, Project B will have a greater net present value than Project A.

Note: The IRR is not the discount rate. The *discount rate* is a standard of profitability that is used to calculate how much a project is worth. The *discount rate* is established in capital markets.

Return on Investment

The return on investment for an alternative is:

$$\frac{\text{NPV(investment)} + \text{NPV(impacts)}}{\text{NPV(investment)}}$$

where *NPV(investment)* = the net present value of the investment

NPV(impacts) = the net present value of the impacts

The ROI threshold accepts any alternative if its return on investment is greater than 0. When the ROI is greater than 0, the alternative has a positive NPV.

According to the ROI rule, the best alternative is the one with the highest ROI.

Return on Investment Versus Net Present Value

Like the IRR, the best solution based on ROI can be different from the best solution based on NPV. Consider Projects A and B:

(The discount rate is 10%. Negative signs indicate a *cost decrease.*)

Project	FY1	FY2	NPV	ROI
A	100	-200	-74	82%
B	10,000	-15,000	-3306	36%

Based upon ROI, both are good projects (ROIs > 0). However, Project A has an ROI of 82%, while Project B has an ROI of only 36%. If you had to choose between the two projects using ROI, Project A would be the winner. If you based your decision on NPV, Project B would be the winner.

RISK-ADJUSTED DISCOUNTED CASH FLOWS

Background

The risk-adjusted discounted cash flow (RADCF) is a total cost measure. It is created by first discounting future cash flows to account for the time value of money, and then adjusting those discounted cash flows to reflect potential risk (possible deviations from expected costs or cost impacts).

There are two general quantitative methods that can be used to assess risk. One method is simulation, which was used in earlier versions of the Functional Economic Analysis Model (FEAM). However, simulation is not well suited to do sensitivity analysis, which some users wanted to perform.

The other option is analytical methods. Analytical methods, while often computationally complex, have the advantage of making sensitivity analysis very easy.

TurboBPR Version 2.0 makes use of analytical methods to carry out the risk calculations. The calculations are the same as those used by the FEAM Version 3.0VB.

The basic steps are as follows:

1. Calculating Alternative Investment Costs and Impacts
2. Estimating with the Triangular Distribution
3. Discounting Alternative Costs
4. Adjusting for Risk

Calculations

Calculating Alternative Investment Costs and Impacts

TurboBPR computes alternative costs and impacts from the initiative costs and impacts that the user enters.

1. High, Low, and Expected Investment Costs. The expected investment cost of an alternative is the sum of the investment costs of all initiatives included in the alternative. For a given alternative, the expected investment cost in year *t* is:

$$EC(t) = \sum_{k \in A} C(t,k)$$

where $C(t,k)$ is the expected investment cost for initiative *k* in year *t*. The term $k \in A$ means include only the initiatives that are in the given alternative.

The user also inputs high and low percentages for each initiative. The user should choose the low percentage to reflect the value beyond which costs could not realistically fall. Similarly, the high percentage reflects the value above which costs could not realistically rise.

TurboBPR uses the high and low percentages to bound the total investment cost for each alternative. The high investment cost for a given alternative in year *t* is:

$$HC(t) = \sum_{k \in A} (1+\eta_k) \times C(t,k)$$

where η_k is the high cost percentage for initiative *k*. The total low investment cost is:

$$LC(t) = \sum_{k \in A} (1+\lambda_k) \times C(t,k)$$

where λ_k is the low cost percentage for initiative *k*.

2. High, Low, and Expected Cost Impacts. TurboBPR computes the cost impacts for each alternative in a similar manner. For a given alternative, the total expected cost impact in year *t* is:

$$EB(t) = \sum_{k \in A} B(t,k)$$

where B(t,k) is the impact of initiative *k* in year *t*. The high impact in year *t* is:

$$HB(t) = \sum_{k \in A} (1+\delta_k) \times B(t,k)$$

where δ_k is the high impact percentage for initiative *k*. The low impact in year *t* is:

$$LB(t) = \sum_{k \in A} (1+\varepsilon_k) \times B(t,k)$$

where ε_k is the low impact percentage for initiative k.

3. High, Low, and Expected Total Cost. The total cost of an alternative is the sum of its investment costs and its impacts. Therefore, the expected cost for an alternative is:

$$E_{TC}(t) = EC(t) + EB(t)$$

To compute total high cost, first consider the cost impacts. Since negative impacts represent cost savings, the more negative the impact, the lower total operations costs will be. Conversely, the more positive the impact, the higher total operations costs will be.

Total cost will be at its highest when the investment cost is at its highest *and* the cost impact is at its lowest. The total estimated high cost in year *t* for a given alternative is:

$$H_{TC}(t) = HC(t) + LB(t)$$

which is the sum of its *high* investment cost and its *low* cost impact. Similarly, the total estimated low cost in year t for a given alternative is:

$$L_{TC}(t) = LC(t) + HB(t)$$

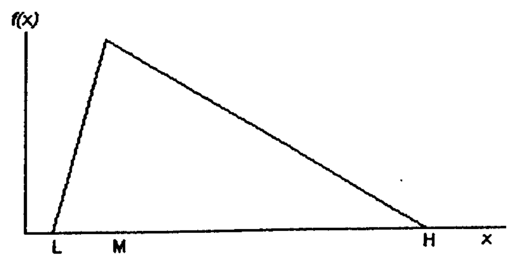
which is the sum of its *low* investment cost and its *high* cost impact.

The Triangular Distribution

Since cost is really a continuous variable, its representation by only the high, expected, and low outcomes is an approximation. However, we can use these specific outcomes to estimate a continuous cost distribution.

TurboBPR uses a Triangular distribution to estimate the mean and the variance of the alternative costs. The Triangular distribution was used for two reasons. First, the only required parameters are the mode and the endpoints (high and low values). Once these three parameters are specified, the mean and variance are predetermined.

Second, users can express most likely (i.e., mode) and endpoint estimates more easily the mean, variance, and bounds required by more complicated distributions.



Given the mode, high, and low values, the mean of the Triangular distribution is:

$$\mu = \frac{\text{Low} + \text{Mode} + \text{High}}{3}$$

The variance of the Triangular distribution is:

$$\sigma^2 = \frac{(\text{High} - \text{Low})^2 + (\text{Mode} - \text{High})(\text{Mode} - \text{Low})}{18}$$

TurboBPR estimates the mean and variance of the cost for a given alternative in year *t* as:

$$\mu_{TC}(t) = \frac{L_{TC}(t, A) + E_{TC}(t, A) + H_{TC}(t, A)}{3}$$

and

$$\sigma^2_{TC}(t, A) = \frac{(H_{TC}(t) - L_{TC}(t))^2 + (E_{TC}(t) - H_{TC}(t)) \times (E_{TC}(t) - L_{TC}(t))}{18}$$

where Mode = $E_{TC}(t)$, Low = $L_{TC}(t)$, and High = $H_{TC}(t)$.

Discounting Alternative Costs

TurboBPR employs the "end-of-year" discounting convention to discount all costs to their present values. This means that even costs in the first year of analysis will be discounted.

The net discounted expected cost for a given alternative over the period of analysis is

$$E = \sum_{t=1}^{n} \frac{E_{TC}(t)}{(1+r)^t}$$

where *n* is the number of years in the analysis and *r* is the discount rate. The net discounted high and low costs for an alternative are likewise computed as:

$$H = \sum_{t=1}^{n} \frac{H_{TC}(t)}{(1+r)^t}$$

and

$$L = \sum_{t=1}^{n} \frac{L_{TC}(t)}{(1+r)^t}$$

respectively.

The mean cash flow is:

$$\mu = \sum_{t=1}^{n} \frac{\mu_{TC}(t)}{(1+r)^t}$$

and the variance is:

$$\sigma^2 = \sum_{t=1}^{n} \frac{\sigma^2_{TC}(t)}{(1+r)^{2t}}$$

Adjusting for Risk

TurboBPR assumes that the risk-adjusted discounted costs have a Beta distribution. The Beta distribution was chosen for its flexibility, not because of any a priori knowledge that it is the actual cost distribution. TurboBPR estimates the mean and variance of the Beta distribution using the previously calculated mean and variance discounted cash flow values.

The Beta distribution has two shape parameters, α and β. Using the mean, Variance, High, and Low discounted values, TurboBPR computes α and β as follows:

$$\alpha = \frac{(\mu - L)^2 \times (H - \mu)}{\sigma^2 \times (H - L)} - \frac{\mu - L}{H - L}$$

and

$$\beta = \frac{\alpha \times (H - \mu)}{\mu - L}$$

TurboBPR reports most likely risk adjusted cost as:

$$M_R = L + (H - L) \times \frac{1 - \alpha}{2 - \alpha -}$$

which is the mode of the Beta distribution.

TurboBPR uses the 2.5 and 97.5 percentiles from the RADCF distribution to estimate the low and high costs, respectively. The 97.5 percentile is the value π_H that lies above 97.5% of the costs predicted by the risk-adjusted cost distribution. The high risk-adjusted discounted cost estimate is:

$$H_R = L + (H - L) \times \pi_H$$

where

$$\frac{\Gamma(\alpha+\beta)}{\Gamma(\alpha)\Gamma(\beta)} \int_0^{\pi_H} x^{\alpha-1}(1-x)^{\beta-1} = 0.975$$

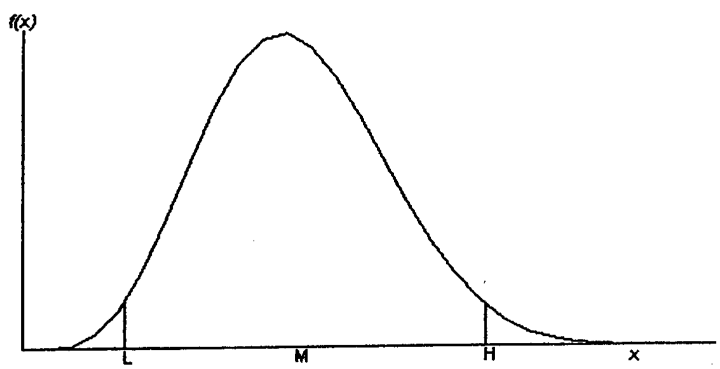
The 2.5 percentile is the value π_L that is greater than only 2.5%, or lower than 97.5%, of the costs predicted by the risk-adjusted cost distribution. The low risk-adjusted discounted cost estimate is:

$$L_R = L + (H - L) \times \pi_L$$

where

$$\frac{\Gamma(\alpha+\beta)}{\Gamma(\alpha)\Gamma(\beta)} \int_0^{\pi_L} x^{\alpha-1}(1-x)^{\beta-1} = 0.025$$

The high, expected and low risk-adjusted discounted cost values are depicted in the graph below.



Using Risk-Adjusted Discounted Cash Flows

The RADCFs are used in the analysis of alternatives to help answer the following questions:

What are the savings in function costs?

Use the expected RADCFs to rank the alternatives by their potential savings. This is the best overall measure of savings because it is the most likely value within the distribution of possible savings results generated by the risk analysis.

What is the risk associated with the savings estimates?

This is shown by the high and low RADCF values. Alternative A is clearly superior to Alternative B in producing savings if A's low RADCF savings are greater than B's high estimate.

Of course, clear rankings like this will not always result, but the range of RADCF values by alternative can still be used to evaluate the relative risk of the alternatives being considered.

Is an alternative affordable?

Comparing the total costs for an alternative with the costs in the current FYDP can determine whether the alternative will fit within current funding constraints. If an otherwise good alternative departs from the budget targets, the action plan can be restructured to affect the timing of investment costs and cost savings.

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Appendix E

ITI-ALC "AS-IS" Functional Model Node List

and Data Collection Results

E.1 ITI-ALC "AS-IS" FUNCTIONAL MODEL NODE LIST

This listing includes each activity described in the "AS-IS" functional model to its lowest-level of decomposition. Each is described in detail in the Final Architecture Report. This list includes the activities to which labor resources needed to be attached to portray an activity based cost model.

- A-2 PERFORM MAINTENANCE
- A-1 PERFORM ORGANIC DEPOT-LEVEL MAINTENANCE
  - A-0 PERFORM DEPOT MAINTENANCE
    - A0 PERFORM DEPOT MAINTENANCE
      - A1 PLAN PRODUCTION
        - A11 SPECIFY & ACCESS GUIDANCE MATERIALS
        - A12 INTEGRATE WORK REQUIREMENTS
          - A121 SEPARATE RQMTS INTO OPERATIONS
          - A122 ACCESS APPLICABLE PLANS
          - A123 DEFINE TASK BREAKDOWN
          - A124 ASSIGN OPERATIONAL RQMTS
            - A1241 ASSIGN SKILL REQUIREMENTS
            - A1242 ESTABLISH LABOR STANDARDS
            - A1243 IDENTIFY SPECIAL TOOLS & EQUIPMENT
            - A1244 COMPILE LABOR REQUIREMENTS
          - A125 MERGE THE TASKS
        - A13 IDENTIFY MATERIAL REQUIREMENTS
          - A131 IDENTIFY REPLACEMENT PARTS
          - A132 IDENTIFY REQUIRED PARTS
          - A133 SPECIFY QUANTITY REQUIRED
          - A134 COMPILE MATERIAL REQUIREMENTS
        - A14 COMPILE COST DATA
        - A15 STORE & DISTRIBUTE PLAN
      - A2 CONTROL PRODUCTION
        - A21 ASSIGN MAINTENANCE DATES
        - A22 INDUCT ITEM INTO THE DEPOT
          - A221 INITIATE ASSET INDUCTION
          - A222 CLEAR TRANSACTION
          - A223 INCREMENT ON-HAND WORK COUNT
        - A23 PREPOSITION PARTS
        - A24 COORDINATE ACTIVITIES
        - A25 ASSIGN RESOURCES
          - A251 DEFINE PRESENT NEED
          - A252 IDENTIFY CANDIDATES
          - A253 SELECT CANDIDATE
          - A254 PRIORITIZE ASSIGNMENTS
        - A26 SELL COMPONENTS
          - A261 INITIATE TURN-IN TO SUPPLY
          - A262 DECREMENT ON-HAND ACCOUNT
          - A263 ESTABLISH CREDIT

- A3 ACQUIRE/ ISSUE PARTS/ SUPPLIES
  - A31 DETERMINE ABILITY TO SUPPORT OPERATIONS
  - A32 REQUISITION ITEMS
  - A33 MANAGE INVENTORY
    - A331 DETERMINE ITEM LOCATION
    - A332 STORE ITEM
    - A333 RETRIEVE ITEM
    - A334 TRACK INVENTORY
  - A34 ISSUE ITEMS
- A4 REPAIR / MANUFACTURE COMPONENTS
  - A41 SELECT WORKLOAD
  - A42 OBTAIN GUIDANCE
  - A43 ORDER PARTS
  - A44 EXECUTE TASK
  - A45 PROVIDE INDUSTRIAL SUPPORT
  - A46 DOCUMENT WORK
- A5 MAINTAIN / REPAIR A/C
  - A51 SELECT TASK
  - A52 OBTAIN GUIDANCE
    - A521 DETERMINE REPOSITORY FOR INFORMATION
    - A522 GO TO THE DESIGNATED REPOSITORY
    - A523 GAIN ACCESS TO INFORMATION
    - A524 TRANSPORT MATERIAL TO SITE
  - A53 ORDER PARTS
    - A531 RESEARCH PART DATA
    - A532 ENTER DATA
    - A533 SUBMIT REQUEST
  - A54 PERFORM TASK
    - A541 INDUCT AIRCRAFT
      - A5411 SAFE & SHUTDOWN A/C
      - A5412 CONDUCT INVENTORY INSPECTION
      - A5413 PARTICIPATE IN DEBRIEF
      - A5414 TRANSFER CUSTODY
    - A542 INSPECT AIRCRAFT
    - A543 DIAGNOSE FAILURE
    - A544 EXECUTE REPAIR TASK
      - A5441 REFERENCE GUIDANCE MATERIAL
      - A5442 OBTAIN PART
      - A5443 VERIFY PART CONFIGURATION
      - A5444 DISASSEMBLE, OVERHAUL & ASSEMBLE ITEM
      - A5445 TURN IN COMPONENTS
      - A5446 ROUTE COMPONENTS
    - A545 PREPARE FOR OPERATION
    - A546 SIGN-OFF TASK COMPLETION

A55 ASSURE QUALITY
A551 INSPECT END ITEM
A552 PLAN FUNCTIONAL CHECK FLIGHT
A553 EXECUTE FUNCTIONAL CHECK FLIGHT
A554 CONDUCT DEBRIEF
A56 DOCUMENT WORK
A-1.1 PLAN FACILITY WORKLOAD
A-1.2 CONTROL FINANCES
A-1.3 REENGINEER
A-2.11 PERFORM ORGANIZATIONAL LEVEL MAINTENANCE
A-2.12 PERFORM CONTRACT DEPOT LEVEL MAINTENANCE
A-2.13 PERFORM INTERMEDIATE LEVEL MAINTENANCE

E.2 APPROACH USED FOR THE ALLOCATION OF LABOR RESOURCES

This and the following sections explain how SM-ALC/LA labor was initially allocated to the ITI-ALC "AS-IS" FM as shown in Figure 2-4, and how the approach was used for the WR-ALC effort added by ECP-2.

During the data collection effort, it became apparent that gathering enough quantitative information in a timely manner to allow allocation of all resources to the ITI-ALC "AS-IS" FM would not be cost effective. As a result, the ITI-ALC team developed an alternative approach. This approach considered three components: 1) formal data collection accomplished by the USAF Occupational Measurement Squadron (OMS) at Brooks Air Force Base, 2) manpower, position descriptions and organizational assignment documents provided by the ALCs, and 3) expert judgment used by the subject matter experts on the ITI-ALC team. The three components are described in the following paragraphs.

E.3 USAF DATA COLLECTION RESULTS

In 1990, at the request of HQ AFLC, the US Air Force Occupational Measurement Squadron, Brooks AFB, TX, studied the tasks performed by AFLC personnel assigned to the Civilian Aircraft Mechanic Occupational Series 8852. The result is directly applicable to this project. In April 1990, the OMS authored the Occupational Survey Report AFLC Civilian Aircraft Mechanic Occupational Series 8852, AFPT 90-8852-827. The total number of individuals in the series 8852 at that time was 2784. The number of individuals in the sample was 1699. The number responding to the survey was 1569. Ninety-three percent of the respondents were wage grade (WG). Two percent were work leader (WL) and 4% were work supervisor (WS). The report stated that WG individuals spend most of their time performing maintenance tasks. The work leaders perform a combination of maintenance tasks, similar to the WG and managerial tasks similar to the WS. The work supervisor deals mostly with determining personnel, supply and equipment needs, as well as work priorities. The report describes the methodology followed to produce the report. Table E-1 describes the pertinent information from that report.

Table E-1. USAF OMS Report Results

Percent of Time Spent on Duties by Job Cluster						
	General Aircraft Mechanic	Process Out Flight Control Mechanic, most from SM-ALC	Airframe Maintenance Mechanic, 60 from SM-ALC	Fuel System Mechanic	General Inspector	Supervisor
N=	187	41	155	155	40	66
Total Sample 1699						
Percent of Sample	11.01	2.41	9.12	9.12	2.35	3.88
Percent of time which each work cluster said was spent on these tasks						
Organizing and Planning	1	2	2	2	1	22
Directing and Implementing	*	1	1	1	*	18
Inspecting and Evaluating	1	2	3	2	3	17
Performing Administrative Functions	*	1	1	*	*	4
Performing Supply Functions	1	3	4	3	1	5
Maintaining Forms and Records	2	4	4	3	2	8
* is < 1%						
Total Percent	5	13	15	11	7	74

E.4 MANPOWER DOCUMENTS PROVIDED BY SM-ALC AND WR-ALC

During the data collection effort, the ITI-ALC team obtained current manpower listings position identifier information, organizational charts to the lowest-level, and other descriptive information from four directorates at SM-ALC; SM-ALC/LA, LH, LI, and TI and three divisions at WR-ALC (LBP, LFP, and LJP), representing approximately 7000 personnel. The ITI-ALC team then correlated the information on the number of individuals assigned to these organizations by specific occupational series and level of responsibility. For further details, see the matrices that follow Section E.5.

E.5 EXPERT JUDGMENT

The ITI-ALC team included a number of subject matter experts with significant experience in the organic aircraft depot maintenance activities of the AFMC. Those individuals took the information gathered in the previous steps, and combined it with information collected during the interviews. The experts concluded that WG/WL/WS individuals within the ITI-ALC domain for occupational series 8852, 3806, 2892, 8801, 4102, 7009, 6652, 8268, and 2604 (see matrix following this section) spent the percentage of their time in non-maintenance tasks as shown in Table E-2.

Table E-2. Percentage Allocation to Non-Maintenance Tasks

	WG	WL	WS
Organizing and Planning	2	11	22
Directing and Implementing	1	9	18
Inspecting and Evaluating	3	8	17
Performing Administrative Functions	1	2	4
Performing Supply Functions	4	3	5
Maintaining Forms and Records	4	4	8

The ITI-ALC team combined this information with its expert judgment to produce the allocation of personnel to the activities in the ITI-ALC "AS-IS" FM depicted in Figure 2-4 and for use in the remainder of the business case.

The following sections of this appendix include:

- Matrix Depicting Organizational Assignments of Occupational Series in SM-ALC/LA.
- ITI-ALC "AS-IS" Functional Model Activity A1 Matrix showing allocation of SM-ALC/LA labor to the lowest level node.
- ITI-ALC "AS-IS" Functional Model Activity A2 Matrix showing allocation of SM-ALC/LA labor to the lowest level node.
- ITI-ALC "AS-IS" Functional Model Activity A3 Matrix showing allocation of SM-ALC/LA labor to the lowest level node.
- ITI-ALC "AS-IS" Functional Model Activity A4. This activity did not emphasize component repair; therefore, no labor resources from SM-ALC/LA were allocated.
- ITI-ALC "AS-IS" Functional Model Activity A5 Matrix showing allocation of SM-ALC/LA labor to the lowest level node.
- ITI-ALC "AS-IS" Functional Model Matrix showing activities that consumed the greatest number of labor resources at SM-ALC/LA.
- Matrix Depicting Organizational Assignments of Occupational Series in WR-ALC/LBP, LFP, and LJP.

MATRIX DEPICTING ORGANIZATIONAL ASSIGNMENTS OF OCCUPATIONAL SERIES IN SM-ALC/LA

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1					# of individuals assigned to this organization	8852 Aircraft Mechanical	3806 Aircraft Sheet Metal	2892 Aircraft Elect	8801 Aircraft Fuel Systems	4102 Painter Training Lead	GS2005 Supply Technician	GS895 Industrial Eng Tech	7009 Equipment Cleaner	GS1152 Production Controller	6652 Aircraft Ord Sys Repair Suprv	GS303 Office Support Asst
2				Total for each Personnel series	0	336	236	210	82	68	55	51	51	44	32	31
3					Cum Total Personnel	336	572	782	864	932	987	1038	1089	1133	1165	1196
39						8852 Aircraft Mechanical	3806 Aircraft Sheet Metal	2892 Aircraft Elect	8801 Aircraft Fuel Systems	4102 Painter Training Lead	GS2005 Supply Technician	GS895 Industrial Eng Tech	7009 Equipment Cleaner	GS1152 Production Controller	6652 Aircraft Ord Sys Repair Suprv	GS303 Office Support Asst
40	Approximately 1520 DMIF slots were represented on the 1 Oct 94 org charts we obtained from SMALC/LAR Manpower Office	Note: The Manpower Office also provided a summary did Feb95 which indicated 1495 assigned.			# of individuals assigned to this series	336	236	210	82	68	55	51	51	44	32	31
41				80	# WS	36	9	6	8	6			3		3	
42					% of Series	10.71%	3.81%	2.86%	9.76%	8.82%			5.88%		9.38%	
43				95	#WL	37	14	10	9	6			6		5	
44					% of Series	11.01%	5.93%	4.76%	10.98%	8.82%			11.76%		15.63%	
45																
46	LA Total				1512											
47	LA Staff				8											
48	LAP Total				1450											
49	LAP Staff				3											
50		LAPF			2	1										
51			LAPFAX Admin		8											7
52			LAPFB A-10 F-15 MOD Section		1	1										
53				LAPFBA F-15 MOD Repair Elmt 1	23	14	4	3								
54				LAPFBS A-10 MOD Repair Elmt 1	18	6	2	3	2							
55				LAPFBC F-15 MOD Repair Elmt 2	24	13	5	3								
56				LAPFBE A-10 Flight Prep Elmt	16	12	1	2								

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1					# of individuals assigned to this organization	8852 Aircraft Mechanical	3806 Aircraft Sheet Metal	2892 Aircraft Elect	8801 Aircraft Fuel Systems	4102 Painter Training Lead	GS2005 Supply Technician	GS895 Industrial Eng Tech	7009 Equipment Cleaner	GS1152 Production Controller	6652 Aircraft Ord Sys Repair Suprv	GS303 Office Support Asst
2				Total for each Personnel series	0	336	236	210	82	68	55	51	51	44	32	31
3					Cum Total Personnel	336	572	782	864	932	987	1038	1089	1133	1165	1196
57				LAPFBW F-15 Wings&Vari ramp	18		18									
58				LAPFBD F-15 TDY Element Budget only	3	2	1									
59				LAPFBF A-10 TDY Element Budget only	3	1		2								
60			LAPFP F-111 Mod Section		3	3										
61				LAPFPG Electr Crew Elmt 3	27			27								
62				LAPFPB Electr Crew Elmt 1	26			26								
63				LAPFPF Electr Crew Elmt 2	25			25								
64				LAPFPD Pyro Elmt	17		5								12	
65				LAPFPP Fuel Crew Elmt 2	17		3		14							
66				LAPFPH Fuel Crew Elmt 1	18		3		15							
67				LAPFPJ MOD Repair Elmt 1	17	15									1	
68				LAPFPU MOD Repair Elmt 2	18	16									1	
69				LAPFPL MOD Repair Elmt 3	17	17										
70				LAPFPC Sheetmetal Crew Elmt 1	16		16									
71				LAPFPR Sheetmetal Crew Elmt 2	16		16									

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1					# of individuals assigned to this organization	8852 Aircraft Mechanical	3806 Aircraft Sheet Metal	2892 Aircraft Elect	8801 Aircraft Fuel Systems	4102 Painter Training Lead	GS2005 Supply Technician	GS895 Industrial Eng Tech	7009 Equipment Cleaner	GS1152 Production Controller	6652 Aircraft Ord Sys Repair Suprv	GS303 Office Support Asst
2				Total for each Personnel series	0	336	236	210	82	68	55	51	51	44	32	31
3					Cum Total Personnel	336	572	782	864	932	987	1038	1089	1133	1165	1196
72				LAPFPM Sheetmetal Crew Elmt 3	17		17									
73				LAPFPA Final Seil Cold Proof Elmt	38	24	2	5								
74				LAPFPS F-111 Flight Prep Elmt	25	18	1	4								
75				LAPFPT F-111 Wings Elmt	35	18	15	2								
76				LAPFPI F-111 Fast Track Honeycomb Elmt	28	8	11	4								
77				LAPFPN TDY Element Budget only	6	3	1	2								
78		LAPP Production Support Flight			2											
79			LAPPA Fighter Planning Sect		19							19				
80			LAPPF Fighter Schedule Sect		14									14		
81			LAPPG A/C Services Planning Sect		12							12				
82			LAPPH Aircraft Services Scheduling Sect		13									12		1
83			LAPPS Tanker Scheduling Sect		12									12		
84			LAPPT Tanker Planning Sect		14							14				
85			LAPP 1 PDMSS Support		2							2				
86			LAPP 2 Engineering Support		5											

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1					# of individuals assigned to this organization	8852 Aircraft Mechanical	3806 Aircraft Sheet Metal	2892 Aircraft Elect	8801 Aircraft Fuel Systems	4102 Painter Training Lead	GS2005 Supply Technician	GS895 Industrial Eng Tech	7009 Equipment Cleaner	GS1152 Production Controller	6652 Aircraft Ord Sys Repair Suprv	GS303 Office Support Asst
2				Total for each Personnel series	0	336	236	210	82	68	55	51	51	44	32	31
3					Cum Total Personnel	336	572	782	864	932	987	1038	1089	1133	1165	1196
87			LAPP 3 Safety & Environmental		5							1				
88		LAPS Tanker Prod Flight			2	1										
89			LAPSA Admin Support		8											7
90			LAPSE Tanker MOD Sect 3		1	1										
91				LAPSEM Tanker Elect Elmt 2	19			19								
92				LAPSEC Tanker Elect Elmt 1	40			39								
93				LAPSEE Tanker SHeet Metal Elmt 1	33		33									
94				LAPSEK Tanker Sheet Metal	18		18									
95				LAPSEJ Tanker Back Shop Elmt	21		20									
96				LAPSEL Tanker Landing Gear & Panel Elmt	21		19									
97			LAPSK Tanker MOD Sect 2		0											
98				LAPSKP Tanker MOD Elmt 2	25	12	8	1								
99				LAPSKR Tanker MOD Elmt 7	15	10		4								
100				LAPSKA Tanker MOD Elmt 8	15	10		4								
101				LAPSKH Tanker MOD Support	13	10		3								
102			LAPSB Tanker MOD Sect 1		1	1										

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1					# of individuals assigned to this organization	8852 Aircraft Mechanical	3806 Aircraft Sheet Metal	2892 Aircraft Elect	8801 Aircraft Fuel Systems	4102 Painter Training Lead	GS2005 Supply Technician	GS895 Industrial Eng Tech	7009 Equipment Cleaner	GS1152 Production Controller	6652 Aircraft Ord Sys Repair Suprv	GS303 Office Support Asst
2				Total for each Personnel series	0	336	236	210	82	68	55	51	51	44	32	31
3					Cum Total Personnel	336	572	782	864	932	987	1038	1089	1133	1165	1196
103				LAPSBA Tank MOD Elmt 1	27	13	5	5								
104				LAPSBD Tanker MOD Elmt 4	26	13	4	5								
105				LAPSBN Tanker MOD Elmt 5	17	12		4								
106				LAPSBB Tanker MOD Elmt 6	16	11		4								
107			LAPSJ Tanker MOD Sect 4		1	1										
108				LAPSJG Tanker Fuel Elmt	43	18			25							
109				LAPSJF E&I MOD Elmt	20	12	5	1								
110				LAPSJJ Tanker Flight Prep Elmt	32	22	1	6								
111		LAPH Aircraft Services Flight			2				1							
112			LAPHA A/C Support Section 1		1					1						
113				LAPHAC Aircraft Cleaning Elmt	53								51			
114				LAPHAP Paint/Bead Blast Elmt	70					66						
115			LAPHS		1											
116				LAPHSA Avionics Final Sell Elmt	22											
117				LAPHSB Avionics Flight Prep Elmt	20											
118			LAPHC		1				1							

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1					# of individuals assigned to this organization	8852 Aircraft Mechanical	3806 Aircraft Sheet Metal	2892 Aircraft Elect	8801 Aircraft Fuel Systems	4102 Painter Training Lead	GS2005 Supply Technician	GS895 Industrial Eng Tech	7009 Equipment Cleaner	GS1152 Production Controller	6652 Aircraft Ord Sys Repair Suprv	GS303 Office Support Asst
2				Total for each Personnel series	0	336	236	210	82	68	55	51	51	44	32	31
3					Cum Total Personnel	336	572	782	864	932	987	1038	1089	1133	1165	1196
138		LARE Engineering Services			17							2				
139			LAREA A/C Support Equip		2											
140		LARF Financial & Mgt Support Flight			6											
141			LARFA Mgt Support Sect		3											
142		LARQ Quality Flight			1											
143			LARQA A/C Quality Support		15											
144			LARQB Aircraft Production Support		8											
145			Total # Individuals by Series		1555	336	236	210	82	68	55	51	51	44	32	31
146			SMALC/FM DMBA estimating factor per individual per year($000)		42	42	42	42	42	42	42	42	42	42	42	42
147			Estimate per series per year($000)		$65,310	$14,112	$9,912	$8,820	$3,444	$2,856	$2,310	$2,142	$2,142	$1,848	$1,344	$1,302

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1					# of individuals assigned to this organization	8852 Aircraft Mechanical	3806 Aircraft Sheet Metal	2892 Aircraft Elect	8801 Aircraft Fuel Systems	4102 Painter Training Lead	GS2005 Supply Technician	GS895 Industrial Eng Tech	7009 Equipment Cleaner	GS1152 Production Controller	6652 Aircraft Ord Sys Repair Suprv	GS303 Office Support Asst
2				Total for each Personnel series	0	336	236	210	82	68	55	51	51	44	32	31
3					Cum Total Personnel	336	572	782	864	932	987	1038	1089	1133	1165	1196
119				LAPHCF Fuel Elmt	28			2	24							
120				LAPHCM Mobile Equip Elmt	18											
121				LAPHCT Tubing Weight & Balance Elmt	7											
122				LAPHCE Engr Flight Test Elmt	14	11		3								
123				LAPHCS Seat Shop Elmt	11										6	
124				LAPHCO Ordnance/oxygen Elmt	15										10	
125				LAPHCD Eng Repair Test Elmt	33											
126				LAPHCV Facility Repair Elmt	13											
127			LAPHX		5											4
128		LAPR Resources Mgt Flight			2											
129			LAPRF Fighter Material		18						14					
130			LAPRM Indirect Material & Pharmacy		18						14					
131			LAPRR Budget & Records		21						1					10
132			LAPRT Training		24	6	2	2		1					2	1
133			LAPRH A/C Services Material Sect		16						13					
134			LAPRP A/C Control TDY Sect		23							1		6		1
135			LAPRS TankerMaterial		17						13					
136	LAR Total				54											
137	LAR Program Control Staff				2											

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	Q	R	S	T	U	V	W	X	Y	Z	AA
1					# of individuals assigned to this organization	8268 Aircraft Pneudraulic Systems	GS1101 Industrial Production Mgr	2604 Elect Mechanic Suprv	6904 Tools & Parts Attendant	GS301 Suprv Workload Mgt Spec	2610 Elect Integrated Sys Mech	8602 Aircraft Engine Mech	GS2001 Maintenance Supply Support Spec	Military	3502 Laborer	GS896 Industrial Eng
2				Total for each Personnel series	0	29	21	21	19	19	19	18	15	14	11	9
3					Cum Total Personnel	1225	1246	1267	1286	1305	1324	1342	1357	1371	1382	1391
39						8268 Aircraft Pneudraulic Systems	GS1101 Industrial Production Mgr	2604 Elect Mechanic Suprv	6904 Tools & Parts Attendant	GS301 Suprv Workload Mgt Spec	2610 Elect Integrated Sys Mech	8602 Aircraft Engine Mech	GS2001 Maintenance Supply Support Spec	Military	3502 Laborer	GS896 Industrial Eng
40	Approximately 1520 DMIF slots were represented on the 1 Oct 94 org charts we obtained from SMALC/LAR Manpower Office	Note: The Manpower Office also provided a summary dtd Feb95 which indicated 1495 assigned.			# of individuals assigned to this series	29	21	21	19	19	19	19	15	16	11	9
41				80	# WS			4			1					
42					% of Series			19.05%			5.26%					
43				95	#WL	2						3				
44					% of Series	6.90%						15.79%				
45																
46	LA Total				1512											
47	LA Staff				8									2		
48	LAP Total				1450											
49	LAP Staff				3									1		
50		LAPF			2		1									
51			LAPFAX Admin		8											
52			LAPFB A-10 F-15 MOD Section		1											
53				LAPFBA F-15 MOD Repair Elmt 1	23				2							
54				LAPFBS A-10 MOD Repair Elmt 1	18	1			1					2	1	
55				LAPFBC F-15 MOD Repair Elmt 2	24	1									2	
56				LAPFBE A-10 Flight Prep Elmt	16										1	

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	Q	R	S	T	U	V	W	X	Y	Z	AA
1					# of individuals assigned to this organization	8268 Aircraft Pneudraulic Systems	GS1101 Industrial Production Mgr	2604 Elect Mechanic Suprv	6904 Tools & Parts Attendant	GS301 Suprv Workload Mgt Spec	2610 Elect Integrated Sys Mech	8602 Aircraft Engine Mech	GS2001 Maintenance Supply Support Spec	Military	3502 Laborer	GS896 Industrial Eng
2				Total for each Personnel series	0	29	21	21	19	19	19	18	15	14	11	9
3					Cum Total Personnel	1225	1246	1267	1286	1305	1324	1342	1357	1371	1382	1391
57				LAPFBW F-15 Wings&Vari ramp	18											
58				LAPFBD F-15 TDY Element Budget only	3											
59				LAPFBF A-10 TDY Element Budget only	3											
60			LAPFP F-111 Mod Section		3											
61				LAPFPG Electr Crew Elmt 3	27											
62				LAPFPB Electr Crew Elmt 1	26											
63				LAPFPF Electr Crew Elmt 2	25											
64				LAPFPD Pyro Elmt	17											
65				LAPFPP Fuel Crew Elmt 2	17											
66				LAPFPH Fuel Crew Elmt 1	18											
67				LAPFPJ MOD Repair Elmt 1	17	1										
68				LAPFPU MOD Repair Elmt 2	18	1										
69				LAPFPL MOD Repair Elmt 3	17											
70				LAPFPC Sheetmetal Crew Elmt 1	16											
71				LAPFPR Sheetmetal Crew Elmt 2	16											

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	Q	R	S	T	U	V	W	X	Y	Z	AA
1					# of individuals assigned to this organization	8268 Aircraft Pneudraulic Systems	GS1101 Industrial Production Mgr	2604 Elect Mechanic Suprv	6904 Tools & Parts Attendant	GS301 Suprv Workload Mgt Spec	2610 Elect Integrated Sys Mech	8602 Aircraft Engine Mech	GS2001 Maintenance Supply Support Spec	Military	3502 Laborer	GS896 Industrial Eng
2				Total for each Personnel series	0	29	21	21	19	19	19	18	15	14	11	9
3					Cum Total Personnel	1225	1246	1267	1286	1305	1324	1342	1357	1371	1382	1391
72				LAPFPM Sheetmetal Crew Elmt 3	17											
73				LAPFPA Final Sell Cold Proof Elmt	38	5					1				1	
74				LAPFPS F-111 Flight Prep Elmt	25				1						1	
75				LAPFPT F-111 Wings Elmt	35											
76				LAPFPI F-111 Fast Track Honeycomb Elmt	28				5							
77				LAPFPN TDY Element Budget only	6											
78		LAPP Production Support Flight			2		1									
79			LAPPA Fighter Planning Sect		19											
80			LAPPF Fighter Schedule Sect		14											
81			LAPPG A/C Services Planning Sect		12											
82			LAPPH Aircraft Services Scheduling Sect		13											
83			LAPPS Tanker Scheduling Sect		12											
84			LAPPT Tanker Planning Sect		14											
85			LAPP 1 PDMSS Support		2											
86			LAPP 2 Engineering Support		5											

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	Q	R	S	T	U	V	W	X	Y	Z	AA
1					# of individuals assigned to this organization	8268 Aircraft Pneudraulic Systems	GS1101 Industrial Production Mgr	2604 Elect Mechanic Suprv	6904 Tools & Parts Attendant	GS301 Suprv Workload Mgt Spec	2610 Elect Integrated Sys Mech	8602 Aircraft Engine Mech	GS2001 Maintenance Supply Support Spec	Military	3502 Laborer	GS896 Industrial Eng
2				Total for each Personnel series	0	29	21	21	19	19	19	18	15	14	11	9
3					Cum Total Personnel	1225	1246	1267	1286	1305	1324	1342	1357	1371	1382	1391
87			LAPP 3 Safety & Environmental		5									1		
88		LAPS Tanker Prod Flight			2		1									
89			LAPSA Admin Support		8											
90			LAPSE Tanker MOD Sect 3		1											
91				LAPSEM Tanker Elect Elmt 2	19											
92				LAPSEC Tanker Elect Elmt 1	40										1	
93				LAPSEE Tanker SHeet Metal Elmt 1	33											
94				LAPSEK Tanker Sheet Metal	18											
95				LAPSEJ Tanker Back Shop Elmt	21				1							
96				LAPSEL Tanker Landing Gear & Panel Elmt	21											
97			LAPSK Tanker MOD Sect 2		0											
98				LAPSKP Tanker MOD Elmt 2	25	2			1						1	
99				LAPSKR Tanker MOD Elmt 7	15	1										
100				LAPSKA Tanker MOD Elmt 8	15	1										
101				LAPSKH Tanker MOD Support	13											
102			LAPSB Tanker MOD Sect 1		1											

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	Q	R	S	T	U	V	W	X	Y	Z	AA
1					# of individuals assigned to this organization	8268 Aircraft Pneudraulic Systems	GS1101 Industrial Production Mgr	2604 Elect Mechanic Suprv	6904 Tools & Parts Attendant	GS301 Suprv Workload Mgt Spec	2610 Elect Integrated Sys Mech	8602 Aircraft Engine Mech	GS2001 Maintenance Supply Support Spec	Military	3502 Laborer	GS896 Industrial Eng
2				Total for each Personnel series	0	29	21	21	19	19	19	18	15	14	11	9
3					Cum Total Personnel	1225	1246	1267	1286	1305	1324	1342	1357	1371	1382	1391
103				LAPSBA Tank MOD Elmt 1	27	2			1						1	
104				LAPSBD Tanker MOD Elmt 4	26	2			1						1	
105				LAPSBN Tanker MOD Elmt 5	17	1										
106				LAPSBB Tanker MOD Elmt 6	16	1										
107			LAPSJ Tanker MOD Sect 4		1											
108				LAPSJG Tanker Fuel Elmt	43											
109				LAPSJF E&I MOD Elmt	20	1			1							
110				LAPSJJ Tanker Flight Prep Elmt	32	2			1							
111		LAPH Aircraft Services Flight			2		1									
112			LAPHA A/C Support Section 1		1											
113				LAPHAC Aircraft Cleaning Elmt	53				1							
114				LAPHAP Paint/Bead Blast Elmt	70										1	
115			LAPHS		1			1								
116				LAPHSA Avionics Final Sell Elmt	22			11			9					
117				LAPHSB Avionics Flight Prep Elmt	20			9			9			1		
118			LAPHC		1											

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	Q	R	S	T	U	V	W	X	Y	Z	AA
1					# of individuals assigned to this organization	8268 Aircraft Pneudraulic Systems	GS1101 Industrial Production Mgr	2604 Elect Mechanic Suprv	6904 Tools & Parts Attendant	GS301 Suprv Workload Mgt Spec	2610 Elect Integrated Sys Mech	8602 Aircraft Engine Mech	GS2001 Maintenance Supply Support Spec	Military	3502 Laborer	GS896 Industrial Eng
2				Total for each Personnel series	0	29	21	21	19	19	19	18	15	14	11	9
3					Cum Total Personnel	1225	1246	1267	1286	1305	1324	1342	1357	1371	1382	1391
119				LAPHCF Fuel Elmt	28				1							
120				LAPHCM Mobile Equip Elmt	18											
121				LAPHCT Tubing Weight & Balance Elmt	7											
122				LAPHCE Engr Flight Test Elmt	14											
123				LAPHCS Seat Shop Elmt	11											
124				LAPHCO Ordnance/oxygen Elmt	15	5										
125				LAPHCD Eng Repair Test Elmt	33							18		8		
126				LAPHCV Facility Repair Elmt	13											
127			LAPHX		5											
128		LAPR Resources Mgt Flight			2		1									
129			LAPRF Fighter Material		18								4			
130			LAPRM Indirect Material & Pharmacy		18								1			
131			LAPRR Budget & Records		21		5			1						
132			LAPRT Training		24	2						1				
133			LAPRH A/C Services Material Sect		16								3			
134			LAPRP A/C Control TDY Sect		23		10						2			
135			LAPRS TankerMaterial		17								4			
136	LAR Total				54											
137	LAR Program Control Staff				2									1		

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	Q	R	S	T	U	V	W	X	Y	Z	AA
1					# of individuals assigned to this organization	8268 Aircraft Pneudraulic Systems	GS1101 Industrial Production Mgr	2604 Elect Mechanic Suprv	6904 Tools & Parts Attendant	GS301 Suprv Workload Mgt Spec	2610 Elect Integrated Sys Mech	8602 Aircraft Engine Mech	GS2001 Maintenance Supply Support Spec	Military	3502 Laborer	GS896 Industrial Eng
2				Total for each Personnel series	0	29	21	21	19	19	19	18	15	14	11	9
3					Cum Total Personnel	1225	1246	1267	1286	1305	1324	1342	1357	1371	1382	1391
138		LARE Engineering Services			17				2							9
139			LAREA A/C Support Equip		2								1			
140		LARF Financial & Mgt Support Flight			6		1			2						
141			LARFA Mgt Support Sect		3											
142		LARQ Quality Flight			1					1						
143			LARQA A/C Quality Support		15					15						
144			LARQB Aircraft Production Support		8											
145			Total # Individuals by Series		1555	29	21	21	19	19	19	19	15	14	11	9
146			SMALC/FM DMBA estimating factor per individual per year($000)		42	42	42	42	42	42	42	42	42	42	42	42
147			Estimate per series per year($000)		$65,310	$1,218	$882	$882	$798	$798	$798	$798	$630	$588	$462	$378

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM
1					# of individuals assigned to this organization	5705 Tractor Operator	GS1910 Suprv QA Spec	8840 Aircraft Mechanical Parts Repairer	5350 Prod Mach Mechanic	GS318 Secretary	6910 Materials Expediter	3105 Fabric Worker Lead	2606 Electr Industrial Controls Mech	GS861 Aero Engineer	5725 Crane Operator	5701 Mobile Equip Operator Suprv	3872 Metal Tube Maker
2				Total for each Personnel series	0	8	8	7	7	6	6	6	6	5	5	4	4
3					Cum Total Personnel	1399	1407	1414	1421	1427	1433	1439	1445	1450	1455	1459	1463
39						5705 Tractor Operator	GS1910 Suprv QA Spec	8840 Aircraft Mechanical Parts Repairer	5350 Prod Mach Mechanic	GS318 Secretary	6910 Materials Expediter	3105 Fabric Worker Lead	2606 Electr Industrial Controls Mech	GS861 Aero Engineer	5725 Crane Operator	5701 Mobile Equip Operator Suprv	3872 Metal Tube Maker
40	Approximately 1520 DMIF slots were represented on the 1 Oct 94 org charts we obtained from SMALC/LAR Manpower Office	Note: The Manpower Office also provided a summary dtd Feb95 which indicated 1495 assigned.			# of individuals assigned to this series	8	8	7	7	7	6	6	6	5	5	4	4
41				80	# WS								1			2	1
42					% of Series								16.67%			50.00%	25.00%
43				95	#WL	3											
44					% of Series	37.50%											
45																	
46	LA Total				1512												
47	LA Staff				8												
48	LAP Total				1450												
49	LAP Staff				3					1							
50		LAPF			2												
51			LAPFAX Admin		8					1							
52			LAPFB A-10 F-15 MOD Section		1												
53				LAPFBA F-15 MOD Repair Elmt 1	23												
54				LAPFBS A-10 MOD Repair Elmt 1	18												
55				LAPFBC F-15 MOD Repair Elmt 2	24												
56				LAPFBE A-10 Flight Prep Elmt	16												

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM
1					# of individuals assigned to this organization	5705 Tractor Operator	GS1910 Suprv QA Spec	8840 Aircraft Mechanical Parts Repairer	5350 Prod Mach Mechanic	GS318 Secretary	6910 Materials Expediter	3105 Fabric Worker Lead	2606 Electr Industrial Controls Mech	GS861 Aero Engineer	5725 Crane Operator	5701 Mobile Equip Operator Suprv	3872 Metal Tube Maker
2				Total for each Personnel series	0	8	8	7	7	6	6	6	6	5	5	4	4
3					Cum Total Personnel	1399	1407	1414	1421	1427	1433	1439	1445	1450	1455	1459	1463
57				LAPFBW F-15 Wings&Vari ramp	18												
58				LAPFBD F-15 TDY Element Budget only	3												
59				LAPFBF A-10 TDY Element Budget only	3												
60			LAPFP F-111 Mod Section		3												
61				LAPFPG Electr Crew Elmt 3	27												
62				LAPFPB Electr Crew Elmt 1	26												
63				LAPFPF Electr Crew Elmt 2	25												
64				LAPFPD Pyro Elmt	17												
65				LAPFPP Fuel Crew Elmt 2	17												
66				LAPFPH Fuel Crew Elmt 1	18												
67				LAPFPJ MOD Repair Elmt 1	17												
68				LAPFPU MOD Repair Elmt 2	18												
69				LAPFPL MOD Repair Elmt 3	17												
70				LAPFPC Sheetmetal Crew Elmt 1	16												
71				LAPFPR Sheetmetal Crew Elmt 2	16												

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM
1					# of individuals assigned to this organization	5705 Tractor Operator	GS1910 Suprv QA Spec	8840 Aircraft Mechanical Parts Repairer	5350 Prod Mach Mechanic	GS318 Secretary	6910 Materials Expediter	3105 Fabric Worker Lead	2606 Electr Industrial Controls Mech	GS861 Aero Engineer	5725 Crane Operator	5701 Mobile Equip Operator Suprv	3872 Metal Tube Maker
2				Total for each Personnel series	0	8	8	7	7	6	6	6	6	5	5	4	4
3					Cum Total Personnel	1399	1407	1414	1421	1427	1433	1439	1445	1450	1455	1459	1463
72				LAPFPM Sheetmetal Crew Elmt 3	17												
73				LAPFPA Final Sell Cold Proof Elmt	38												
74				LAPFPS F-111 Flight Prep Elmt	25												
75				LAPFPT F-111 Wings Elmt	35												
76				LAPFPI F-111 Fast Track Honeycomb Elmt	28												
77				LAPFPN TDY Element Budget only	6												
78		LAPP Production Support Flight			2					1							
79			LAPPA Fighter Planning Sect		19												
80			LAPPF Fighter Schedule Sect		14												
81			LAPPG A/C Services Planning Sect		12												
82			LAPPH Aircraft Services Scheduling Sect		13												
83			LAPPS Tanker Scheduling Sect		12												
84			LAPPT Tanker Planning Sect		14												
85			LAPP 1 PDMSS Support		2												
86			LAPP 2 Engineering Support		5									5			

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM
1					# of individuals assigned to this organization	5705 Tractor Operator	GS1910 Suprv QA Spec	8840 Aircraft Mechanical Parts Repairer	5350 Prod Mach Mechanic	GS318 Secretary	6910 Materials Expediter	3105 Fabric Worker Lead	2606 Electr Industrial Controls Mech	GS861 Aero Engineer	5725 Crane Operator	5701 Mobile Equip Operator Suprv	3872 Metal Tube Maker
2				Total for each Personnel series	0	8	8	7	7	6	6	6	6	5	5	4	4
3					Cum Total Personnel	1399	1407	1414	1421	1427	1433	1439	1445	1450	1455	1459	1463
87			LAPP 3 Safety & Environmental		5												
88		LAPS Tanker Prod Flight			2												
89			LAPSA Admin Support		8					1							
90			LAPSE Tanker MOD Sect 3		1												
91				LAPSEM Tanker Elect Elmt 2	19												
92				LAPSEC Tanker Elect Elmt 1	40												
93				LAPSEE Tanker SHeet Metal Elmt 1	33												
94				LAPSEK Tanker Sheet Metal	18												
95				LAPSEJ Tanker Back Shop Elmt	21												
96				LAPSEL Tanker Landing Gear & Panel Elmt	21			2									
97			LAPSK Tanker MOD Sect 2		0												
98				LAPSKP Tanker MOD Elmt 2	25												
99				LAPSKR Tanker MOD Elmt 7	15												
100				LAPSKA Tanker MOD Elmt 8	15												
101				LAPSKH Tanker MOD Support	13												
102			LAPSB Tanker MOD Sect 1		1												

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM
1					# of individuals assigned to this organization	5705 Tractor Operator	GS1910 Suprv QA Spec	8840 Aircraft Mechanical Parts Repairer	5350 Prod Mach Mechanic	GS318 Secretary	6910 Materials Expediter	3105 Fabric Worker Lead	2606 Electr Industrial Controls Mech	GS861 Aero Engineer	5725 Crane Operator	5701 Mobile Equip Operator Suprv	3872 Metal Tube Maker
2				Total for each Personnel series	0	8	8	7	7	6	6	6	6	5	5	4	4
3					Cum Total Personnel	1399	1407	1414	1421	1427	1433	1439	1445	1450	1455	1459	1463
103				LAPSBA Tank MOD Elmt 1	27												
104				LAPSBD Tanker MOD Elmt 4	26												
105				LAPSBN Tanker MOD Elmt 5	17												
106				LAPSBB Tanker MOD Elmt 6	16												
107			LAPSJ Tanker MOD Sect 4		1												
108				LAPSJG Tanker Fuel Elmt	43												
109				LAPSJF E&I MOD Elmt	20												
110				LAPSJJ Tanker Flight Prep Elmt	32												
111		LAPH Aircraft Services Flight			2												
112			LAPHA A/C Support Section 1		1												
113				LAPHAC Aircraft Cleaning Elmt	53												
114				LAPHAP Paint/Bead Blast Elmt	70												
115			LAPHS		1												
116				LAPHSA Avionics Final Sell Elmt	22						2						
117				LAPHSB Avionics Flight Prep Elmt	20						1						
118			LAPHC		1												

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM
1					# of individuals assigned to this organization	5705 Tractor Operator	GS1910 Suprv QA Spec	8840 Aircraft Mechanical Parts Repairer	5350 Prod Mach Mechanic	GS318 Secretary	6910 Materials Expediter	3105 Fabric Worker Lead	2606 Electr Industrial Controls Mech	GS861 Aero Engineer	5725 Crane Operator	5701 Mobile Equip Operator Suprv	3872 Metal Tube Maker
2				Total for each Personnel series	0	8	8	7	7	6	6	6	6	5	5	4	4
3					Cum Total Personnel	1399	1407	1414	1421	1427	1433	1439	1445	1450	1455	1459	1463
119				LAPHCF Fuel Elmt	28												
120				LAPHCM Mobile Equip Elmt	18	8									4	4	
121				LAPHCT Tubing Weight & Balance Elmt	7												4
122				LAPHCE Engr Flight Test Elmt	14												
123				LAPHCS Seat Shop Elmt	11							5					
124				LAPHCO Ordnance/oxygen Elmt	15												
125				LAPHCD Eng Repair Test Elmt	33			2									
126				LAPHCV Facility Repair Elmt	13				7				6				
127			LAPHX		5					1							
128		LAPR Resources Mgt Flight			2					1							
129			LAPRF Fighter Material		18												
130			LAPRM Indirect Material & Pharmacy		18						3						
131			LAPRR Budget & Records		21												
132			LAPRT Training		24			3				1			1		
133			LAPRH A/C Services Material Sect		16												
134			LAPRP A/C Control TDY Sect		23												
135			LAPRS TankerMaterial		17												
136	LAR Total				54												
137	LAR Program Control Staff				2												

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM
1					# of individuals assigned to this organization	5705 Tractor Operator	GS1910 Suprv QA Spec	8840 Aircraft Mechanical Parts Repairer	5350 Prod Mach Mechanic	GS318 Secretary	6910 Materials Expediter	3105 Fabric Worker Lead	2606 Electr Industrial Controls Mech	GS861 Aero Engineer	5725 Crane Operator	5701 Mobile Equip Operator Suprv	3872 Metal Tube Maker
2				Total for each Personnel series	0	8	8	7	7	6	6	6	6	5	5	4	4
3					Cum Total Personnel	1399	1407	1414	1421	1427	1433	1439	1445	1450	1455	1459	1463
138		LARE Engineering Services			17												
139			LAREA A/C Support Equip		2												
140		LARF Financial & Mgt Support Flight			6												
141			LARFA Mgt Support Sect		3					1							
142		LARQ Quality Flight			1												
143			LARQA A/C Quality Support		15												
144			LARQB Aircraft Production Support		8		8										
145			Total # Individuals by Series		1555	8	8	7	7	7	6	6	6	5	5	4	4
146			SMALC/FM DMBA estimating factor per individual per year($000)		42	42	42	42	42	42	42	42	42	42	42	42	42
147			Estimate per series per year($000)		$65,310	$336	$336	$294	$294	$294	$252	$252	$252	$210	$210	$168	$168

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY
1					# of individuals assigned to this organization	3501 Plant Maintenance Wrkr	WG-XXXX	GS326 Office Automation	5485 Aircraft Weight & Bal Tech	GS819 Environ Engr	GS344 Mgt Asst	5704 Fork Lift Operator	GS334 Comp Spec	GS343 Mgt Analyst	GS1702 Training Tech	GS1020 Illustrator	GS2102 Transportation Asst(typing)
2				Total for each Personnel series	0	4	4	3	3	3	3	2	2	2	1	1	1
3					Cum Total Personnel	1467	1471	1474	1477	1480	1483	1485	1487	1489	1490	1491	1492
39						3501 Plant Maintenance Wrkr	WG-XXXX	GS326 Office Automation	5485 Aircraft Weight & Bal Tech	GS819 Environ Engr	GS344 Mgt Asst	5704 Fork Lift Operator	GS334 Comp Spec	GS343 Mgt Analyst	GS1702 Training Tech	GS1020 Illustrator	GS2102 Transportation Asst(typing)
40	Approximately 1520 DMIF slots were represented on the 1 Oct 94 org charts we obtained from SMALC/LAR Manpower Office	Note: The Manpower Office also provided a summary dtd Feb95 which indicated 1495 assigned.			# of individuals assigned to this series	4	10	3	3	3	3	2	2	2	1	1	1
41				80	# WS												
42					% of Series												
43				95	#WL												
44					% of Series												
45																	
46	LA Total				1512												
47	LA Staff				8		6										
48	LAP Total				1450												
49	LAP Staff				3												
50		LAPF			2												
51			LAPFAX Admin		8												
52			LAPFB A-10 F-15 MOD Section		1												
53				LAPFBA F-15 MOD Repair Elmt 1	23												
54				LAPFBS A-10 MOD Repair Elmt 1	18												
55				LAPFBC F-15 MOD Repair Elmt 2	24												
56				LAPFBE A-10 Flight Prep Elmt	16												

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY
1					# of individuals assigned to this organization	3501 Plant Maintenance Wrkr	WG-XXXX	GS326 Office Automation	5485 Aircraft Weight & Bal Tech	GS819 Environ Engr	GS344 Mgt Asst	5704 Fork Lift Operator	GS334 Comp Spec	GS343 Mgt Analyst	GS1702 Training Tech	GS1020 Illustrator	GS2102 Transportation Asst(typing)
2				Total for each Personnel series	0	4	4	3	3	3	3	2	2	2	1	1	1
3					Cum Total Personnel	1467	1471	1474	1477	1480	1483	1485	1487	1489	1490	1491	1492
57				LAPFBW F-15 Wings&Vari ramp	18												
58				LAPFBD F-15 TDY Element Budget only	3												
59				LAPFBF A-10 TDY Element Budget only	3												
60			LAPFP F-111 Mod Section		3												
61				LAPFPG Electr Crew Elmt 3	27												
62				LAPFPB Electr Crew Elmt 1	26												
63				LAPFPF Electr Crew Elmt 2	25												
64				LAPFPD Pyro Elmt	17												
65				LAPFPP Fuel Crew Elmt 2	17												
66				LAPFPH Fuel Crew Elmt 1	18												
67				LAPFPJ MOD Repair Elmt 1	17												
68				LAPFPU MOD Repair Elmt 2	18												
69				LAPFPL MOD Repair Elmt 3	17												
70				LAPFPC Sheetmetal Crew Elmt 1	16												
71				LAPFPR Sheetmetal Crew Elmt 2	16												

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY
1					# of individuals assigned to this organization	3501 Plant Maintenance Wrkr	WG-XXXX	GS326 Office Automation	5485 Aircraft Weight & Bal Tech	GS819 Environ Engr	GS344 Mgt Asst	5704 Fork Lift Operator	GS334 Comp Spec	GS343 Mgt Analyst	GS1702 Training Tech	GS1020 Illustrator	GS2102 Transportation Asst(typing)
2				Total for each Personnel series	0	4	4	3	3	3	3	2	2	2	1	1	1
3					Cum Total Personnel	1467	1471	1474	1477	1480	1483	1485	1487	1489	1490	1491	1492
72				LAPFPM Sheetmetal Crew Elmt 3	17												
73				LAPFPA Final Seil Cold Proof Elmt	38												
74				LAPFPS F-111 Flight Prep Elmt	25												
75				LAPFPT F-111 Wings Elmt	35												
76				LAPFPI F-111 Fast Track Honeycomb Elmt	28												
77				LAPFPN TDY Element Budget only	6												
78		LAPP Production Support Flight			2												
79			LAPPA Fighter Planning Sect		19												
80			LAPPF Fighter Schedule Sect		14												
81			LAPPG A/C Services Planning Sect		12												
82			LAPPH Aircraft Services Scheduling Sect		13												
83			LAPPS Tanker Scheduling Sect		12												
84			LAPPT Tanker Planning Sect		14												
85			LAPP 1 PDMSS Support		2												
86			LAPP 2 Engineering Support		5												

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY
1					# of individuals assigned to this organization	3501 Plant Maintenance Wrkr	WG-XXXX	GS326 Office Automation	5485 Aircraft Weight & Bal Tech	GS819 Environ Engr	GS344 Mgt Asst	5704 Fork Lift Operator	GS334 Comp Spec	GS343 Mgt Analyst	GS1702 Training Tech	GS1020 Illustrator	GS2102 Transportation Asst(typing)
2				Total for each Personnel series	0	4	4	3	3	3	3	2	2	2	1	1	1
3					Cum Total Personnel	1467	1471	1474	1477	1480	1483	1485	1487	1489	1490	1491	1492
87			LAPP 3 Safety & Environmental		5					1							
88		LAPS Tanker Prod Flight			2												
89			LAPSA Admin Support		8												
90			LAPSE Tanker MOD Sect 3		1												
91				LAPSEM Tanker Elect Elmt 2	19												
92				LAPSEC Tanker Elect Elmt 1	40												
93				LAPSEE Tanker SHeet Metal Elmt 1	33												
94				LAPSEK Tanker Sheet Metal	18												
95				LAPSEJ Tanker Back Shop Elmt	21												
96				LAPSEL Tanker Landing Gear & Panel Elmt	21												
97			LAPSK Tanker MOD Sect 2		0												
98				LAPSKP Tanker MOD Elmt 2	25												
99				LAPSKR Tanker MOD Elmt 7	15												
100				LAPSKA Tanker MOD Elmt 8	15												
101				LAPSKH Tanker MOD Support	13												
102			LAPSB Tanker MOD Sect 1		1												

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY
1					# of individuals assigned to this organization	3501 Plant Maintenance Wrkr	WG-XXXX	GS326 Office Automation	5485 Aircraft Weight & Bal Tech	GS819 Environ Engr	GS344 Mgt Asst	5704 Fork Lift Operator	GS334 Comp Spec	GS343 Mgt Analyst	GS1702 Training Tech	GS1020 Illustrator	GS2102 Transportation Asst(typing)
2				Total for each Personnel series	0	4	4	3	3	3	3	2	2	2	1	1	1
3					Cum Total Personnel	1467	1471	1474	1477	1480	1483	1485	1487	1489	1490	1491	1492
103				LAPSBA Tank MOD Elmt 1	27												
104				LAPSBD Tanker MOD Elmt 4	26												
105				LAPSBN Tanker MOD Elmt 5	17												
106				LAPSBB Tanker MOD Elmt 6	16												
107			LAPSJ Tanker MOD Sect 4		1												
108				LAPSJG Tanker Fuel Elmt	43												
109				LAPSJF E&I MOD Elmt	20												
110				LAPSJJ Tanker Flight Prep Elmt	32												
111		LAPH Aircraft Services Flight			2												
112			LAPHA A/C Support Section 1		1												
113				LAPHAC Aircraft Cleaning Elmt	53	1											
114				LAPHAP Paint/Bead Blast Elmt	70	3											
115			LAPHS		1												
116				LAPHSA Avionics Final Sell Elmt	22												
117				LAPHSB Avionics Flight Prep Elmt	20												
118			LAPHC		1												

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY
1					# of individuals assigned to this organization	3501 Plant Maintenance Wrkr	WG-XXXX	GS326 Office Automation	5485 Aircraft Weight & Bal Tech	GS819 Environ Engr	GS344 Mgt Asst	5704 Fork Lift Operator	GS334 Comp Spec	GS343 Mgt Analyst	GS1702 Training Tech	GS1020 Illustrator	GS2102 Transportation Asst(typing)
2				Total for each Personnel series	0	4	4	3	3	3	3	2	2	2	1	1	1
3					Cum Total Personnel	1467	1471	1474	1477	1480	1483	1485	1487	1489	1490	1491	1492
119				LAPHCF Fuel Elmt	28												
120				LAPHCM Mobile Equip Elmt	18							2					
121				LAPHCT Tubing Weight & Balance Elmt	7				3								
122				LAPHCE Engr Flight Test Elmt	14												
123				LAPHCS Seat Shop Elmt	11												
124				LAPHCO Ordnance/oxygen Elmt	15												
125				LAPHCD Eng Repair Test Elmt	33		4										
126				LAPHCV Facility Repair Elmt	13												
127			LAPHX		5												
128		LAPR Resources Mgt Flight			2												
129			LAPRF Fighter Material		18												
130			LAPRM Indirect Material & Pharmacy		18												
131			LAPRR Budget & Records		21			2									
132			LAPRT Training		24			1							1		
133			LAPRH A/C Services Material Sect		16												
134			LAPRP A/C Control TDY Sect		23											1	1
135			LAPRS TankerMaterial		17												
136	LAR Total				54												
137	LAR Program Control Staff				2												

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY
1					# of individuals assigned to this organization	3501 Plant Maintenance Wrkr	WG-XXXX	GS326 Office Automation	5485 Aircraft Weight & Bal Tech	GS819 Environ Engr	GS344 Mgt Asst	5704 Fork Lift Operator	GS334 Comp Spec	GS343 Mgt Analyst	GS1702 Training Tech	GS1020 Illustrator	GS2102 Transportation Asst(typing)
2				Total for each Personnel series	0	4	4	3	3	3	3	2	2	2	1	1	1
3					Cum Total Personnel	1467	1471	1474	1477	1480	1483	1485	1487	1489	1490	1491	1492
138		LARE Engineering Services			17					2			2				
139			LAREA A/C Support Equip		2												
140		LARF Financial & Mgt Support Flight			6						1			2			
141			LARFA Mgt Support Sect		3						2						
142		LARQ Quality Flight			1												
143			LARQA A/C Quality Support		15												
144			LARQB Aircraft Production Support		8												
145			Total # Individuals by Series		1555	4	4	3	3	3	3	2	2	2	1	1	1
146			SMALC/FM DMBA estimating factor per individual per year($000)		42	42	42	42	42	42	42	42	42	42	42	42	42
147			Estimate per series per year($000)		$65,310	$168	$168	$126	$126	$126	$126	$84	$84	$84	$42	$42	$42

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	AZ	BA	BB	BC	BD	BE	BF	BG	BH
1					# of individuals assigned to this organization	5703 Motor Vehicle Optr	GS510 Acctg Anst	GS526 Acctg Clrk	3566 Laborer	5413 Fuel Sys Distr Worker	GS1601 Suprv Equip Mgt Tech	GS0018 Safety & Occupt Hlth Spec	GS0028 Envirnmtl Prot Spec	GS346 Log Mgt Spec
2				Total for each Personnel series	0	1	1	1	1	1	1	1	1	1
3					Cum Total Personnel	1493	1494	1495	1496	1497	1498	1499	1500	1501
39						5703 Motor Vehicle Optr	GS510 Acctg Anst	GS526 Acctg Clrk	3566 Laborer	5413 Fuel Sys Distr Worker	GS1601 Suprv Equip Mgt Tech	GS0018 Safety & Occupt Hlth Spec	GS0028 Envirnmtl Prot Spec	GS346 Log Mgt Spec
40	Approximately 1520 DMIF slots were represented on the 1 Oct 94 org charts we obtained from SMALC/LAR Manpower Office	Note: The Manpower Office also provided a summary dtd Feb95 which indicated 1495 assigned.			# of individuals assigned to this series	1	1	1	1	1	2	1	1	1
41				80	# WS									
42					% of Series									
43				95	#WL									
44					% of Series									
45														
46	LA Total				1512									
47	LA Staff				8									
48	LAP Total				1450									
49	LAP Staff				3						1			
50		LAPF			2									
51			LAPFAX Admin		8									
52			LAPFB A-10 F-15 MOD Section		1									
53				LAPFBA F-15 MOD Repair Elmt 1	23									
54				LAPFBS A-10 MOD Repair Elmt 1	18									
55				LAPFBC F-15 MOD Repair Elmt 2	24									
56				LAPFBE A-10 Flight Prep Elmt	16									

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	AZ	BA	BB	BC	BD	BE	BF	BG	BH
1					# of individuals assigned to this organization	5703 Motor Vehicle Optr	GS510 Acctg Anst	GS526 Acctg Clrk	3566 Laborer	5413 Fuel Sys Distr Worker	GS1601 Suprv Equip Mgt Tech	GS0018 Safety & Occupt Hlth Spec	GS0028 Envirnmtl Prot Spec	GS346 Log Mgt Spec
2				Total for each Personnel series	0	1	1	1	1	1	1	1	1	1
3					Cum Total Personnel	1493	1494	1495	1496	1497	1498	1499	1500	1501
57				LAPFBW F-15 Wings&Vari ramp	18									
58				LAPFBD F-15 TDY Element Budget only	3									
59				LAPFBF A-10 TDY Element Budget only	3									
60			LAPFP F-111 Mod Section		3									
61				LAPFPG Electr Crew Elmt 3	27									
62				LAPFPB Electr Crew Elmt 1	26									
63				LAPFPF Electr Crew Elmt 2	25									
64				LAPFPD Pyro Elmt	17									
65				LAPFPP Fuel Crew Elmt 2	17									
66				LAPFPH Fuel Crew Elmt 1	18									
67				LAPFPJ MOD Repair Elmt 1	17									
68				LAPFPU MOD Repair Elmt 2	18									
69				LAPFPL MOD Repair Elmt 3	17									
70				LAPFPC Sheetmetal Crew Elmt 1	16									
71				LAPFPR Sheetmetal Crew Elmt 2	16									

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	AZ	BA	BB	BC	BD	BE	BF	BG	BH
1					# of individuals assigned to this organization	5703 Motor Vehicle Optr	GS510 Acctg Anst	GS526 Acctg Clrk	3566 Laborer	5413 Fuel Sys Distr Worker	GS1601 Suprv Equip Mgt Tech	GS0018 Safety & Occupt Hlth Spec	GS0028 Envirnmtl Prot Spec	GS346 Log Mgt Spec
2				Total for each Personnel series	0	1	1	1	1	1	1	1	1	1
3					Cum Total Personnel	1493	1494	1495	1496	1497	1498	1499	1500	1501
72				LAPFPM Sheetmetal Crew Elmt 3	17									
73				LAPFPA Final Sell Cold Proof Elmt	38									
74				LAPFPS F-111 Flight Prep Elmt	25									
75				LAPFPT F-111 Wings Elmt	35									
76				LAPFPI F-111 Fast Track Honeycomb Elmt	28									
77				LAPFPN TDY Element Budget only	6									
78		LAPP Production Support Flight			2									
79			LAPPA Fighter Planning Sect		19									
80			LAPPF Fighter Schedule Sect		14									
81			LAPPG A/C Services Planning Sect		12									
82			LAPPH Aircraft Services Scheduling Sect		13									
83			LAPPS Tanker Scheduling Sect		12									
84			LAPPT Tanker Planning Sect		14									
85			LAPP 1 PDMSS Support		2									
86			LAPP 2 Engineering Support		5									

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	AZ	BA	BB	BC	BD	BE	BF	BG	BH
1					# of individuals assigned to this organization	5703 Motor Vehicle Optr	GS510 Acctg Anst	GS526 Acctg Clrk	3566 Laborer	5413 Fuel Sys Distr Worker	GS1601 Suprv Equip Mgt Tech	GS0018 Safety & Occupt Hlth Spec	GS0028 Envimmtl Prot Spec	GS346 Log Mgt Spec
2				Total for each Personnel series	0	1	1	1	1	1	1	1	1	1
3					Cum Total Personnel	1493	1494	1495	1496	1497	1498	1499	1500	1501
87			LAPP 3 Safety & Environmental		5							1	1	
88		LAPS Tanker Prod Flight			2									
89			LAPSA Admin Support		8									
90			LAPSE Tanker MOD Sect 3		1									
91				LAPSEM Tanker Elect Elmt 2	19									
92				LAPSEC Tanker Elect Elmt 1	40									
93				LAPSEE Tanker SHeet Metal Elmt 1	33									
94				LAPSEK Tanker Sheet Metal	18									
95				LAPSEJ Tanker Back Shop Elmt	21									
96				LAPSEL Tanker Landing Gear & Panel Elmt	21									
97			LAPSK Tanker MOD Sect 2		0									
98				LAPSKP Tanker MOD Elmt 2	25									
99				LAPSKR Tanker MOD Elmt 7	15									
100				LAPSKA Tanker MOD Elmt 8	15									
101				LAPSKH Tanker MOD Support	13									
102			LAPSB Tanker MOD Sect 1		1									

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	AZ	BA	BB	BC	BD	BE	BF	BG	BH
1					# of individuals assigned to this organization	5703 Motor Vehicle Optr	GS510 Acctg Anst	GS526 Acctg Clrk	3566 Laborer	5413 Fuel Sys Distr Worker	GS1601 Suprv Equip Mgt Tech	GS0018 Safety & Occupt Hlth Spec	GS0028 Envimmtl Prot Spec	GS346 Log Mgt Spec
2				Total for each Personnel series	0	1	1	1	1	1	1	1	1	1
3					Cum Total Personnel	1493	1494	1495	1496	1497	1498	1499	1500	1501
103				LAPSBA Tank MOD Elmt 1	27									
104				LAPSBD Tanker MOD Elmt 4	26									
105				LAPSBN Tanker MOD Elmt 5	17									
106				LAPSBB Tanker MOD Elmt 6	16									
107			LAPSJ Tanker MOD Sect 4		1									
108				LAPSJG Tanker Fuel Elmt	43									
109				LAPSJF E&I MOD Elmt	20									
110				LAPSJJ Tanker Flight Prep Elmt	32									
111		LAPH Aircraft Services Flight			2									
112			LAPHA A/C Support Section 1		1									
113				LAPHAC Aircraft Cleaning Elmt	53									
114				LAPHAP Paint/Bead Blast Elmt	70									
115			LAPHS		1									
116				LAPHSA Avionics Final Sell Elmt	22									
117				LAPHSB Avionics Flight Prep Elmt	20									
118			LAPHC		1									

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	AZ	BA	BB	BC	BD	BE	BF	BG	BH
1					# of individuals assigned to this organization	5703 Motor Vehicle Optr	GS510 Acctg Anst	GS526 Acctg Clrk	3566 Laborer	5413 Fuel Sys Distr Worker	GS1601 Suprv Equip Mgt Tech	GS0018 Safety & Occupt Hlth Spec	GS0028 Envlmmtl Prot Spec	GS346 Log Mgt Spec
2				Total for each Personnel series	0	1	1	1	1	1	1	1	1	1
3					Cum Total Personnel	1493	1494	1495	1496	1497	1498	1499	1500	1501
119				LAPHCF Fuel Elmt	28					1				
120				LAPHCM Mobile Equip Elmt	18									
121				LAPHCT Tubing Weight & Balance Elmt	7									
122				LAPHCE Engr Flight Test Elmt	14									
123				LAPHCS Seat Shop Elmt	11									
124				LAPHCO Ordnance/oxygen Elmt	15									
125				LAPHCD Eng Repair Test Elmt	33				1					
126				LAPHCV Facility Repair Elmt	13									
127			LAPHX		5									
128		LAPR Resources Mgt Flight			2									
129			LAPRF Fighter Material		18									
130			LAPRM Indirect Material & Pharmacy		18									
131			LAPRR Budget & Records		21		1	1						
132			LAPRT Training		24									
133			LAPRH A/C Services Material Sect		16									
134			LAPRP A/C Control TDY Sect		23	1								
135			LAPRS TankerMaterial		17									
136	LAR Total				54									
137	LAR Program Control Staff				2									1

Matrix Depicting Organizational Assignments of Occupational Series at SMALC/LA (Continued)

	A	B	C	D	E	AZ	BA	BB	BC	BD	BE	BF	BG	BH
1					# of individuals assigned to this organization	5703 Motor Vehicle Optr	GS510 Acctg Anst	GS526 Acctg Clrk	3566 Laborer	5413 Fuel Sys Distr Worker	GS1601 Suprv Equip Mgt Tech	GS0018 Safety & Occupt Hlth Spec	GS0028 Envirnmtl Prot Spec	GS346 Log Mgt Spec
2				Total for each Personnel series	0	1	1	1	1	1	1	1	1	1
3					Cum Total Personnel	1493	1494	1495	1496	1497	1498	1499	1500	1501
138		LARE Engineering Services			17									
139			LAREA A/C Support Equip		2						1			
140		LARF Financial & Mgt Support Flight			6									
141			LARFA Mgt Support Sect		3									
142		LARQ Quality Flight			1									
143			LARQA A/C Quality Support		15									
144			LARQB Aircraft Production Support		8									
145			Total # Individuals by Series		1555	1	1	1	1	1	2	1	1	1
146			SMALC/FM DMBA estimating factor per individual per year($000)		42	42	42	42	42	42	42	42	42	42
147			Estimate per series per year($000)		$65,310	$42	$42	$42	$42	$42	$84	$42	$42	$42

ITI-ALC "AS-IS" FUNCTIONAL MODEL ACTIVITY A1 MATRIX SHOWING ALLOCATION OF SM-ALC/LA LABOR TO THE LOWEST LEVEL NODE

Cell: D2
NOTE: Includes these series--8852 Aircraft Mechanical, 3806 Aircraft Sheet Metal, 2892 Aircraft Electrical, 8801 Aircraft Fuel Systems, 4102 Painter, 7009 Equipment Cleaner, 6652 Aircraft Ordnance System, 8268 Aircraft Pneudralic Systems, 2604 Electrical Mechanic, 2610 Electronic Integrated Systems Mechanic, 8602 Aircraft Engine Mechanic, 8840 Aircraft Mechanical Parts Repair, 3105 Fabric Worker, and 3872 Metal Tube Maker.

Cell: E4
NOTE: Based on the information contained in the OMS Report.

Cell: D5
NOTE: Count of the actual number of WS and WL in the technicians skill on the SM-ALC organizational assignment charts provided by the Manpower office.

Cell: D6
NOTE: Count of the actual number of WS and WL in the technicians skill on the SM-ALC organizational assignment charts provided by the Manpower office.

ITI-ALC "AS-IS" Functional Model Activity A1 Matrix

	A	B	C	D	E	F	G	H	I	J	K	L
1				A/C Technicians		GS895 Industrial Eng. Tech (Planners)		GS303 Office Support Asst.		GS896 Industrial Eng.		Number of personnel equivalents consumed in this activity
2			Total Assigned	1119		51.00		31.00		9.00		
3												
4	Node Number	Activity Name			Percentage of this level of A/C Technician time consumed in A1							
5			WS	80	none							
6			WL	80	none							
7			WG	959	none							
8					Total A/C Technician personnel equivalents consumed in A2							
9					none							
10												
11	A1-3	REENGINEER										
12	A1-2	CONTROL FINANCES						0.3	9.3			9.30
13	A0											
14	A1											
15	A11	SPECIFY & ACCESS GUIDANCE MATERIALS				0.07	3.57	0.00	0	0.00	0	3.57
16	A12											0.00
17	A121	SEPARATE RQMTS INTO OPERATIONS				0.10	4.10	0.00	0	0.00	0	4.10
18	A122	ACCESS APPLICABLE PLANS				0.03	1.53	0.00	0	0.00	0	1.53
19	A123	DEFINE TASK BREAKDOWN				0.10	4.10	0.00	0	0.00	0	4.10
20	A1241	ASSIGN SKILL REQUIREMENTS				0.03	1.53	0.00	0	0.00	0	1.53
21	A1242	ESTABLISH LABOR STANDARDS				0.15	6.65	0.00	0	0.84	7.56	14.21

ITI-ALC "AS-IS" Functional Model Activity A1 Matrix (Continued)

	A	B	C	D	E	F	G	H	I	J	K	L
22	A1243	IDENTIFY SPECIAL TOOLS & EQUIPMENT				0.05	2.55	0.00	0	0.00	0	2.55
23	A1244	COMPILE LABOR REQUIREMENTS				0.03	1.53	0.00	0	0.00	0	1.53
24	A125	MERGE THE TASKS				0.05	2.55	0.00	0	0.00	0	2.55
25	A13											0.00
26	A131	IDENTIFY REPLACEMENT PARTS				0.07	3.57	0.00	0	0.15	1.35	4.92
27	A132	IDENTIFY REQUIRED PARTS				0.07	3.57	0.00	0	0.00	0	3.57
28	A133	SPECIFY QUANTITY REQUIRED				0.07	3.57	0.00	0	0.00	0	3.57
29	A134	COMPILE MATERIAL REQUIREMENTS				0.03	1.53	0.00	0	0.00	0	1.53
30	A14	COMPILE COST DATA				0.03	1.53	0.40	12.4	0.00	0	13.93
31	A15	STORE & DISTRIBUTE PLAN				0.06	3.06	0.00	0	0.00	0	3.06
32							44.94		21.7		8.91	
33	* Factor is an estimate of the % of time this series consumes performing this activity						Total Personnel Equivalents Accounted For				75.55	75.55

ITI-ALC "AS-IS" FUNCTIONAL MODEL ACTIVITY A2
MATRIX SHOWING
ALLOCATION OF SM-ALC/LA LABOR TO
THE LOWEST LEVEL NODE

Cell: L1
NOTE: Includes 7 ea. 5350 Prod Mach Mechanics; 6 ea 2606 Electrical Industrial Controls Mech.; 4 ea 3501 Plant Maintenance Workers; 3 ea GS344 Mgt. Asst.; 2 ea 5704 Fork Lift Operators; 1 ea GS346 Log Mgt. Spec.

Cell: D2
NOTE: Includes these series--8852 Aircraft Mechanical, 3806 Aircraft Sheet Metal, 2892 Aircraft Electrical, 8801 Aircraft Fuel Systems, 4102 Painter, 7009 Equipment Cleaner, 6652 Aircraft Ordnance System, 8268 Aircraft Pneudralic Systems, 2604 Electrical Integrated Systems Mechanic, 8602 Aircraft Engine Mechanic, 8840 Aircraft Mechanical Parts Repair, 3105 Fabric Worker, and 3872 Metal Tube Maker.

Cell: E3
Based on the information contained in the OMS Report.

Cell: D4
NOTE: Count of the actual number of WS and WL in the technicians skill on the SM-ALC organizational assignment charts provided by the Manpower office.

Cell: D5
NOTE: Count of the actual number of WS and WL in the technicians skill on the SM-ALC organizational assignment charts provided by the Manpower office.

ITI-ALC "AS-IS" Functional Model Activity A2 Matrix

	A	B	C	D	E	F	G	H	I	J	K	L	M
1				A/C Technicians		GS1152 Production Controller (Schedulers)		GS1101 Industrial Production Mgr.		Military		Other	Number of personnel equivalents consumed in this activity
2			Total Assigned	1119.00		44.00		21.00		14.00		23.00	
3	Node Number	Activity Name			Percentage of this level of A/C Technician time consumed in A2								
4			WS	80	0.52								
5			WL	80	0.26								
6			WG	959	0.04								
7					Total A/C Technician personnel equivalents consumed in A2								
8					100.76								
9	A2	CONTROL PRODUCTION				0.00		0.00		0.00			
10	A21	ASSIGN MAINTENANCE DATES			10.08	0.00		0.00		0.00			10.08
11	A221	INITIATE ASSET INDUCTION				0.00		0.00		0.00			0.00
12	A222	CLEAR TRANSACTION				0.00		0.00		0.00			0.00
13	A223	INCREMENT ON-HAND WORK COUNT				0.00		0.00		0.00			0.00
14	A23	PREPOSITION PARTS				0.10	4.40	0.00		0.00			4.40
15	A24	COORDINATE ACTIVITIES			60.46	0.50	22.00	0.39	8.19	0.50	7.00	4.00	101.65
16	A25	ASSIGN RESOURCES				0.00	0.00	0.00		0.00			0.00
17	A251	DEFINE PRESENT NEED				0.00	0.00	0.00		0.00			0.00
18	A252	IDENTIFY CANDIDATES			5.04	0.00	0.00	0.00		0.00			5.04

ITI-ALC "AS-IS" Functional Model Activity A2 Matrix (Continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M
19	A253	SELECT CANDIDATE			5.04	0.00	0.00	0.00		0.00			5.04
20	A254	PRIORITIZE ASSIGNMENTS			20.15	0.00	0.00	0.00		0.00			20.15
21	A261	INITIATE TURN-IN TO SUPPLY				0.02	0.88	0.00		0.00			0.88
22	A262	DECREMENT ON-HAND ACCOUNT				0.00		0.00		0.00			0.00
23	A263	ESTABLISH CREDIT				0.00		0.00		0.00			0.00
24					100.76		27.28		8.19		7.00	4.00	
25	* Factor is an estimate of the % of time this series consumes performing this activity							Total Personnel Equivalents Accounted For				147.23	147.23

ITI-ALC "AS-IS" FUNCTIONAL MODEL ACTIVITY A3 MATRIX SHOWING ALLOCATION OF SM-ALC/LA LABOR TO THE LOWEST LEVEL NODE

Cell: D2
NOTE: Includes these series--8852 Aircraft Mechanical, 3806 Aircraft Sheet Metal, 2892 Aircraft Electrical, 8801 Aircraft Fuel Systems, 4102 Painter, 7009 Equipment Cleaner, 6652 Aircraft Ordnance System, 8268 Aircraft Pneudralic Systems, 2604 Electrical Mechanic, 2610 Electronic Integrated Systems Mechanic, 8602 Aircraft Engine Mechanic, 8840 Aircraft Mechanical Parts Repair, 3105 Fabric Worker, and 3872 Metal Tube Maker.

Cell: E3
Based on the information contained in the OMS Report.

Cell: D4
NOTE: Count of the actual number of WS and WL in the technicians skill on the SM-ALC organizational assignment charts provided by the Manpower office.

Cell: D5
NOTE: Count of the actual number of WS and WL in the technicians skill on the SM-ALC organizational assignment charts provided by the Manpower office.

ITI-ALC "AS-IS" Functional Model Activity A3 Matrix

	A	B	C	D	E	F
1				A/C Technicians		Number of personnel equivalents consumed in this activity
2			Total Assigned	1119.00		
3	Node Number	Activity Name			Percentage of this level of A/C Technician time consumed in A3	
4			WS	80	0.05	
5			WL	80	0.03	
6			WG	959	none	
7					Total A/C Technician personnel equivalents consumed in A3	
8					6.40	
9	A3					
10	A31	DETERMINE ABILITY TO SUPPORT OPERATIONS			6.40	6.40
11						
12						
13	A32	REQUISITION ITEMS				
14	A33					
15	A331	DETERMINE ITEM LOCATION				
16	A332	STORE ITEM				
17						
18	A333	RETRIEVE ITEM				
19						
20						
21	A334	TRACK INVENTORY				
22	A34	ISSUE ITEMS				
23						
24		Total Personnel Equivalents Accounted For			6.40	6.40

ITI-ALC "AS-IS" FUNCTIONAL MODEL ACTIVITY A4

Since the "AS-IS" Functional Model did not emphasize component repair, no labor resources from SM-ALC/LA were allocated to the ITI-ALC "AS-IS" Activity A4.

ITI-ALC "AS-IS" FUNCTIONAL MODEL ACTIVITY A5
MATRIX SHOWING
ALLOCATION OF SM-ALC/LA LABOR TO
THE LOWEST LEVEL NODE

Cell: R1
NOTE: Includes 6 ea 6910 Materials Expediters.

Cell: W1
NOTE: Includes 67 people; 4 ea WG-XXX; 3 ea 326 Office Automation; 3 ea 5485 Weight & Balance; 3 ea 819 Envirn Engr.; 2 ea 5704 Fork Lift Operator; 2 ea 343 Mgt. Analysts; 1 ea 1702 Training Tech; 1 ea 1020 Illustrator; 1 ea 2102 Transportation Asst.; 1 ea 5703 Motor Vehicle Operator; 1 ea 510 Accounting Asst.; 1 ea 5413 Fuel System Distr. Worker; 1 ea 1601 Supervisor Equip Mgt. Tech; 1 ea 0018 Safety & Occup Health Spec; 1 ea 0028 Envirn Prot Spec; 11 ea 3502 Laborers; 8 ea 5705 Tractor Ops; 6 ea 318 Secretary; 5 ea 318 Secretary; 5 ea 5725 Crane Ops; 4 ea 5701 Mobile Equip Ops; 1 ea 3566 Laborer.

Cell: X1
NOTE: Includes 7 ea 5350 Prod Mach Mechanics; 6 ea 2606 Electrical Industrial Controls Mech.; 4 ea 3501 Plant Maintenance Workers; 3 ea GS344 Mgt. Asst.; 2 ea 5704 Fork Lift Operators; 1 ea GS346 Log Mgt. Spec.

Cell: D2
NOTE: Includes these series--8852 Aircraft Mechanical, 3806 Aircraft Sheet Metal, 2892 Aircraft Electrical, 8801 Aircraft Fuel Systems, 4102 Painter, 7009 Equipment Cleaner, 6652 Aircraft Ordnance System, 8268 Aircraft Pneudralic Systems, 2604 Electrical Mechanic, 2610 Electronic Integrated Systems Mechanic, 8602 Aircraft Engine Mechanic, 8840 Aircraft Mechanical Parts Repair, 3105 Fabric Worker, and 3872 Metal Tube Maker.

Cell: E3
Based on the information contained in the OMS Report.

Cell: D4
NOTE: Count of the actual number of WS and WL in the technicians skill on the SM-ALC organizational assignment charts provided by the Manpower office.

Cell: D5
NOTE: Count of the actual number of WS and WL in the technicians skill on the SM-ALC organizational assignment charts provided by the Manpower office.

ITI-ALC "AS-IS" Functional Model Activity A5 Matrix (Continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M
1				A/C Technicians		GS2005 Supply Technician		GS895 Industrial Eng Tech (Planners)		GS1152 Production Controller (Schedulers)		GS303 Office Support Asst	
2			Total Assigned	1119.00		55.00		51.00		44.00		31.00	
3	Node Number	Activity Name			Percentage of this level of A/C Technician time consumed in A5								
4			WS	80	0.43								
5			WL	80	0.71								
6			WG	959	0.96								
7					Total A/C Technician personnel equivalents consumed in A5								
8					1011.84								
9	A5	MAINTAIN AND REPAIR A/C											
10	A51	SELECT TASK			10.12								
11	A52	OBTAIN GUIDANCE											
12	A521	DETERMINE REPOSITORY FOR INFORMATION			5.06								
13	A522	GO TO THE DESIGNATED REPOSITORY			5.06								
14	A523	GAIN ACCESS TO INFORMATION			5.06								
15													
16	A524	TRANSPORT MATERIAL TO SITE			5.06								
17	A53	ORDER PARTS											
18	A531	RESEARCH PART DATA			10.12	0.20	11.00				2.00		
19	A532	ENTER DATA			10.12	0.20	11.00				1.00		
20	A533	SUBMIT REQUEST			10.12	0.20	11.00				1.00		
21	A54	PERFORM TASK											
22	A541												

TTI-ALC "AS-IS" Functional Model Activity A5 Matrix (Continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M
1				A/C Technicians		GS2005 Supply Technician		GS895 Industrial Eng Tech (Planners)		GS1152 Production Controller (Schedulers)		GS303 Office Support Asst	
2			Total Assigned	1119.00		55.00		51.00		44.00		31.00	
23	A5411	SAFE & SHUTDOWN A/C			25.30								
24	A5412	CONDUCT INVENTORY INSPECTION			25.30								
25													
27	A5413	PARTICIPATE IN DEBRIEF			10.12				1.00				
28	A5414	TRANSFER CUSTODY			5.06								
29													
30	A542	INSPECT AIRCRAFT			25.30								
31													
32													
33	A543	DIAGNOSE FAILURE			15.18								
34													
35	A544	EXECUTE TASK											
36	A5441	REFERENCE GUIDANCE MATERIAL			10.12	0.03	1.65		1.00		1.00		2.00
37													
38	A5442	OBTAIN PART			10.12	0.20	11.00		1.00		1.00		
39													
40	A5443	VERIFY PART CONFIGURATION			11.23								
41													
42	A5444	DISASSEMBLE, OVERHAUL & ASSEMBLE ITEM			576.75								
43													
44													
45													
46	A5445	TURN IN COMPONENTS			10.12	0.10	5.50						
47	A5446	ROUTE COMPONENTS			20.24								
48	A545	PREPARE FOR OPERATION			91.07								
49	A546	SIGN-OFF TASK COMPLETION											
50	A55												
51	A551	INSPECT END ITEM			30.36						1.00		2.00
52													

ITI-ALC "AS-IS" Functional Model Activity A5 Matrix (Continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M
1				A/C Technicians		GS2005 Supply Technician		GS895 Industrial Eng Tech (Planners)		GS1152 Production Controller (Schedulers)		GS303 Office Support Asst	
2			Total Assigned	1119.00		55.00		51.00		44.00		31.00	
53	A552	PLAN FUNCTIONAL CHECK FLIGHT			10.12						1.00		
54	A553	EXECUTE FUNCTIONAL CHECK FLIGHT			20.24								
55													
56	A554	CONDUCT DEBRIEF			10.12								1.00
57													
58	A56	DOCUMENT WORK			36.83						2.00		4.00
59					1004.24		51.15	0.00	3.00	0.00	10.00	0.00	9.00
60													

TI-ALC AS-IS Functional Model Activity A5 Matrix (Continued)

	A	B	N	O	P	Q	R	S	T	U	V	W
1			GS1101 Industrial Production Mgr	6904 Tools & Parts Attendant		GS301 Suprv Workload Mgt Spec	GS2001 Maintenance Supply Support Spec		Military	GS1910 Suprv QA Spec	5350 Prod Mach Mechanic	Miscellaneous
2			21.00	19.00		19.00	21.00		14.00	8.00	7.00	67.00
3	Node Number	Activity Name										
4												
5												
6												
7												
8												
9	A5	MAINTAIN AND REPAIR A/C										
10	A51	SELECT TASK										
11	A52	OBTAIN GUIDANCE										
12	A521	DETERMINE REPOSITORY FOR INFORMATION										
13	A522	GO TO THE DESIGNATED REPOSITORY										
14	A523	GAIN ACCESS TO INFORMATION										
15												
16	A524	TRANSPORT MATERIAL TO SITE										
17	A53	ORDER PARTS										
18	A531	RESEARCH PART DATA					0.20	4.20				
19	A532	ENTER DATA					0.20	4.20				
20	A533	SUBMIT REQUEST					0.20	4.20				
21	A54	PERFORM TASK										
22	A541											

ITI-ALC "AS-IS" Functional Model Activity A5 Matrix (Continued)

	A	B	N	O	P	Q	R	S	T	U	V	W
1			GS1101 Industrial Production Mgr	6904 Tools & Parts Attendant		GS301 Suprv Workload Mgt Spec	GS2001 Maintenance Supply Support Spec		Military	GS1910 Suprv QA Spec	5350 Prod Mach Mechanic	Miscellaneous
2			21.00	19.00		19.00	21.00		14.00	8.00	7.00	67.00
23	A5411	SAFE & SHUTDOWN A/C										
24	A5412	CONDUCT INVENTORY INSPECTION										
25												
27	A5413	PARTICIPATE IN DEBRIEF	1.00									
28	A5414	TRANSFER CUSTODY										
29												
30	A542	INSPECT AIRCRAFT										
31												
32												
33	A543	DIAGNOSE FAILURE										
34												
35	A544	EXECUTE TASK										
36	A5441	REFERENCE GUIDANCE MATERIAL										
37												
38	A5442	OBTAIN PART		1.00	19.00		0.40	8.40				
39												
40	A5443	VERIFY PART CONFIGURATION										
41												
42	A5444	DISASSEMBLE, OVERHAUL & ASSEMBLE ITEM									7.00	
43												
44												
45												
46	A5445	TURN IN COMPONENTS										
47	A5446	ROUTE COMPONENTS										
48	A545	PREPARE FOR OPERATION							7.00			67.00
49	A546	SIGN-OFF TASK COMPLETION				14.00						
50	A55											
51	A551	INSPECT END ITEM				5.00				8.00		
52												

ITI-ALC "AS-IS" Functional Model Activity A5 Matrix (Continued)

	A	B	N	O	P	Q	R	S	T	U	V	W
1			GS1101 Industrial Production Mgr	6904 Tools & Parts Attendant		GS301 Suprv Workload Mgt Spec	GS2001 Maintenance Supply Support Spec		Military	GS1910 Suprv QA Spec	5350 Prod Mach Mechanic	Miscellaneous
2			21.00	19.00		19.00	21.00		14.00	8.00	7.00	67.00
53	A552	PLAN FUNCTIONAL CHECK FLIGHT										
54	A553	EXECUTE FUNCTIONAL CHECK FLIGHT										
55												
56	A554	CONDUCT DEBRIEF										
57												
58	A56	DOCUMENT WORK	1.00									
59			2.00		19.00	19.00		21.00	7.00	8.00	7.00	67.00
60												

ITI-ALC "AS-IS" Functional Model Activity A5 Matrix (Continued)

	A	B	X	Y
1			Other	Number of personnel equivalents consumed in this activity
2			23.00	
3	Node Number	Activity Name		
4				
5				
6				
7				
8				
9	A5	MAINTAIN AND REPAIR A/C		0.00
10	A51	SELECT TASK		10.12
11	A52	OBTAIN GUIDANCE		0.00
12	A521	DETERMINE REPOSITORY FOR INFORMATION		5.06
13	A522	GO TO THE DESIGNATED REPOSITORY		5.06
14	A523	GAIN ACCESS TO INFORMATION		5.06
15				0.00
16	A524	TRANSPORT MATERIAL TO SITE		5.06
17	A53	ORDER PARTS		0.00
18	A531	RESEARCH PART DATA		27.32
19	A532	ENTER DATA		26.32
20	A533	SUBMIT REQUEST		26.32
21	A54	PERFORM TASK		0.00
22	A541			0.00

	A	B	X	Y
1			Other	Number of personnel equivalents consumed in this activity
2			23.00	
23	A5411	SAFE & SHUTDOWN A/C		25.30
24	A5412	CONDUCT INVENTORY INSPECTION		25.30
25				0.00
27	A5413	PARTICIPATE IN DEBRIEF		12.12
28	A5414	TRANSFER CUSTODY		5.06
29				0.00
30	A542	INSPECT AIRCRAFT		25.30
31				0.00
32				0.00
33	A543	DIAGNOSE FAILURE		15.18
34				0.00
35	A544	EXECUTE TASK		0.00
36	A5441	REFERENCE GUIDANCE MATERIAL		15.77
37				0.00
38	A5442	OBTAIN PART		50.52
39				0.00
40	A5443	VERIFY PART CONFIGURATION		11.23
41				0.00
42	A5444	DISASSEMBLE, OVERHAUL & ASSEMBLE ITEM		583.75
43				0.00
44				0.00
45				0.00
46	A5445	TURN IN COMPONENTS		15.62
47	A5446	ROUTE COMPONENTS		20.24
48	A545	PREPARE FOR OPERATION	19.00	184.07
49	A546	SIGN-OFF TASK COMPLETION		14.00
50	A55			0.00
51	A551	INSPECT END ITEM		46.36
52				0.00

ITI-ALC "AS-IS" Functional Model Activity A5 Matrix (Continued)

	A	B	X	Y
1			Other	Number of personnel equivalents consumed in this activity
2			23.00	
53	A552	PLAN FUNCTIONAL CHECK FLIGHT		11.12
54	A553	EXECUTE FUNCTIONAL CHECK FLIGHT		20.24
55				0.00
56	A554	CONDUCT DEBRIEF		11.12
57				0.00
58	A56	DOCUMENT WORK		43.83
59			19.00	1246.39
60				

**ITI-ALC "AS-IS" FUNCTIONAL MODEL MATRIX
SHOWING ACTIVITIES THAT CONSUMED
THE GREATEST NUMBER
OF LABOR RESOURCES AT SM-ALC/LA**

ITI-ALC "AS-IS" Functional Model Matrix
Showing Activities that Consumed the Greatest Number of Labor Resources at SM-ALC/LA

Node Number	Activity Name	Personnel Equivalents(PE)	Cost of the Personnel Equivalents at $42000 per P.E.
A5444	DISASSEMBLE, OVERHAUL & ASSEMBLE ITEM	583.75	$24,517,500
A545	PREPARE FOR OPERATION	184.07	$7,730,755
A24	COORDINATE ACTIVITIES	101.65	$4,269,132
A5442	OBTAIN PART	50.52	$2,121,773
A551	INSPECT END ITEM	46.36	$1,946,918
A56	DOCUMENT WORK	43.83	$1,840,675
A531	RESEARCH PART DATA	27.32	$1,147,373
A532	ENTER DATA	26.32	$1,105,373
A533	SUBMIT REQUEST	26.32	$1,105,373
A5411	SAFE & SHUTDOWN A/C	25.30	$1,062,432
A5412	CONDUCT INVENTORY INSPECTION	25.30	$1,062,432
A542	INSPECT AIRCRAFT	25.30	$1,062,432
A5446	ROUTE COMPONENTS	20.24	$849,946
A553	EXECUTE FUNCTIONAL CHECK FLIGHT	20.24	$849,946
A254	PRIORITIZE ASSIGNMENTS	20.15	$846,384
A5441	REFERENCE GUIDANCE MATERIAL	15.77	$662,273
A5445	TURN IN COMPONENTS	15.62	$655,973
A543	DIAGNOSE FAILURE	15.18	$637,459
A1242	ESTABLISH LABOR STANDARDS	14.21	$596,820
A546	SIGN-OFF TASK COMPLETION	14.00	$588,000
A14	COMPILE COST DATA	13.93	$585,060
A5413	PARTICIPATE IN DEBRIEF	12.12	$508,973
A5443	VERIFY PART CONFIGURATION	11.23	$471,576
A552	PLAN FUNCTIONAL CHECK FLIGHT	11.12	$466,973
A554	CONDUCT DEBRIEF	11.12	$466,973
A51	SELECT TASK	10.12	$424,973
A21	ASSIGN MAINTENANCE DATES	10.08	$423,192
A1-2	CONTROL FINANCES	9.30	$390,600
A31	DETERMINE ABILITY TO SUPPORT OPERATIONS	6.40	$268,800
A521	DETERMINE REPOSITORY FOR INFORMATION	5.06	$212,486
A522	GO TO THE DESIGNATED REPOSITORY	5.06	$212,486
A523	GAIN ACCESS TO INFORMATION	5.06	$212,486
A524	TRANSPORT MATERIAL TO SITE	5.06	$212,486
A5414	TRANSFER CUSTODY	5.06	$212,486
A252	IDENTIFY CANDIDATES	5.04	$211,596
A253	SELECT CANDIDATE	5.04	$211,596
A131	IDENTIFY REPLACEMENT PARTS	4.92	$206,640

ITI-ALC "AS-IS" Functional Model Matrix
Showing Activities that Consumed the Greatest Number of Labor Resources at SM-ALC/LA (Continued)

Node Number	Activity Name	Personnel Equivalents(PE)	Cost of the Personnel Equivalents at $42000 per P.E.
A23	PREPOSITION PARTS	4.40	$184,800
A121	SEPARATE RQMTS INTO OPERATIONS	4.10	$172,200
A123	DEFINE TASK BREAKDOWN	4.10	$172,200
A11	SPECIFY & ACCESS GUIDANCE MATERIALS	3.57	$149,940
A132	IDENTIFY REQUIRED PARTS	3.57	$149,940
A133	SPECIFY QUANTITY REQUIRED	3.57	$149,940
A15	STORE & DISTRIBUTE PLAN	3.06	$128,520
A1243	IDENTIFY SPECIAL TOOLS & EQUIPMENT	2.55	$107,100
A125	MERGE THE TASKS	2.55	$107,100
A122	ACCESS APPLICABLE PLANS	1.53	$64,260
A1241	ASSIGN SKILL REQUIREMENTS	1.53	$64,260
A1244	COMPILE LABOR REQUIREMENTS	1.53	$64,260
A134	COMPILE MATERIAL REQUIREMENTS	1.53	$64,260
A261	INITIATE TURN-IN TO SUPPLY	0.88	$36,960

MATRIX DEPICTING ORGANIZATIONAL ASSIGNMENTS OF OCCUPATIONAL SERIES IN WR-ALC/LBP, LFP, AND LJP

Matrix Depicting Organizational Assignments of Occupational Series at WR-ALC/LBP, LFP, and LJP

	A	B	D	E	F	G	H	I	J	K	L	M
1			8852 Aircraft Mechanical	3806 Aircraft Sheet Metal	2892 Aircraft Elect	8801 Aircraft Fuel Systems	4102 Painter Training Lead	GS2005 Supply Technician	GS895 Industrial Eng Tech	7009 Equipment Cleaner	GS1152 Production Controller	GS303 Office Support Asst
2	LBPF C-130 Production Branch		42	45	34	9			3		7	
3	LBPM C-130 Production Branch		30	70	29	9	39		6	6	2	
4	LBPL C-130 Logistics Branch							3			8	1
5												
6	LFPA F-15 Production Branch A		23	31	24	9					4	
7	LFPB F-15 Production Branch B		23	30	29	14					6	
8	LFPC F-15 Production Branch C		26	28	33	7						
9	LFPL F-15 Logistics Services Branch											
10		LFPLC Production Control Team							4			
11		LFPLE Engineering Team							1		1	
12		LFPLO Operations Team						5			4	
13		LFPLP Planning Team							13		5	
14		LFPLW Workload Team							2		1	
15	LFPS F-15 Production Support Branch											
16		LFPSF Functional Test Team	10	1	7	2					1	
17		LFPSI F-15 Production Support	13	3	1	2	29	4			5	
18		LFPSM Miscellaneous Production Team	17	1	1	1					1	
19												
20	LJPA Production Branch A		126	116	22	7						

Matrix Depicting Organizational Assignments of Occupational Series at WR-ALC/LBP, LFP, and LJP (Continued)

	A	B	D	E	F	G	H	I	J	K	L	M
1			8852 Aircraft Mechanical	3806 Aircraft Sheet Metal	2892 Aircraft Elect	8801 Aircraft Fuel Systems	4102 Painter Training Lead	GS2005 Supply Technician	GS895 Industrial Eng Tech	7009 Equipment Cleaner	GS1152 Production Controller	GS303 Office Support Asst
21	LJPC Production Branch C		118	105	28	8						
22	LJPD Production Branch											
23		LJPDA Speedline Team	2	152		16						
24		LJPDB Functional Test Team	17	1	3	2						
25		LJPDC Pre/Post Dock Team	73		19	3						
26		LJPDD Engine Shop Team				1						
27	LJPL Production Control Branch											
28		LJPLA Planning/Scheduling Team A							1		9	1
29		LJPLB Planning/Scheduling Team B							2		8	
30		LJPLC Planning/Scheduling Team C							2		8	
31		LJPLD Planning/Scheduling Team D							2		12	
32		LJPLE Engineering Team							1			
33		LJPLF Production Control Team							6		10	3
34		LJPLM Ops Research Mgt Team									1	
35		LJPLQ Quality Assurance Team						4				
36	LJPP Production Support Branch					1						
37		LJPPA NDI Team										
38		LJPPB Control Sup Cen Team	5	16		5		1	2		3	
39		LJPPC Backshop Team	2			1						

Matrix Depicting Organizational Assignments of Occupational Series at WR-ALC/LBP, LFP, and LJP (Continued)

	A	B	D	E	F	G	H	I	J	K	L	M
1			8852 Aircraft Mechanical	3806 Aircraft Sheet Metal	2892 Aircraft Elect	8801 Aircraft Fuel Systems	4102 Painter Training Lead	GS2005 Supply Technician	GS895 Industrial Eng Tech	7009 Equipment Cleaner	GS1152 Production Controller	GS303 Office Support Asst
40	LJPS Paint/Corosn Branch											
41		LJPS Paint/Corosn Branch					15			37		
42		LJPS Paint/Corosn Branch					35					
43	Total Personnel Per Series		527	599	230	97	118	17	45	43	96	5

Matrix Depicting Organizational Assignments of Occupational Series at WR-ALC/LBP, LFP, and LJP (Continued)

	A	B	N	O	P	Q	R	S	T	U	V	W	X
1			8268 Aircraft Pneudraulic Systems	GS1101 Industrial Production Mgr	2604 Elect Mechanic Suprv	6904 Tools & Parts Attendant	2610 Elect Integrated Sys Mech	8602 Aircraft Engine Mech	GS896 Industrial Eng	GS1910 Suprv QA Spec	GS318 Secretary	6910 Materials Expediter	GS326 Office Automation
2	LBPF C-130 Production Branch		6	2	5						2		
3	LBPM C-130 Production Branch		5	2	6			2			3		
4	LBPL C-130 Logistics Branch			8						4			
5													
6	LFPA F-15 Production Branch A				4		1				2		
7	LFPB F-15 Production Branch B		5		3		1				1		
8	LFPC F-15 Production Branch C		5		3		1				1		
9	LFPL F-15 Logistics Services Branch												
10		LFPLC Production Control Team		2									
11		LFPLE Engineering Team							3				1
12		LFPLO Operations Team											
13		LFPLP Planning Team									1		
14		LFPLW Workload Team		9							1		
15	LFPS F-15 Production Support Branch										1		
16		LFPSF Functional Test Team			2						1		
17		LFPSI F-15 Production Support			2	1	4					1	
18		LFPSM Miscellaneous Production Team						7			1		
19											1		
20	LJPA Production Branch A		18								1		1

Matrix Depicting Organizational Assignments of Occupational Series at WR-ALC/LBP, LFP, and LJP (Continued)

	A	B	N	O	P	Q	R	S	T	U	V	W	X
1			8268 Aircraft Pneudraulic Systems	GS1101 Industrial Production Mgr	2604 Elect Mechanic Suprv	6904 Tools & Parts Attendant	2610 Elect Integrated Sys Mech	8602 Aircraft Engine Mech	GS896 Industrial Eng	GS1910 Suprv QA Spec	GS318 Secretary	6910 Materials Expediter	GS326 Office Automation
21	LJPC Production Branch C		20								1		1
22	LJPD Production Branch										1		1
23		LJPDA Speedline Team											
24		LJPDB Functional Test Team	4				2						
25		LJPDC Pre/Post Dock Team	10										
26		LJPDD Engine Shop Team						20					
27	LJPL Production Control Branch			1							1		
28		LJPLA Planning/Scheduling Team A		1									
29		LJPLB Planning/Scheduling Team B											
30		LJPLC Planning/Scheduling Team C											
31		LJPLD Planning/Scheduling Team D											
32		LJPLE Engineering Team							3				1
33		LJPLF Production Control Team		1							1		
34		LJPLM Ops Research Mgt Team		2									1
35		LJPLQ Quality Assurance Team								9			
36	LJPP Production Support Branch										1		1
37		LJPPA NDI Team											
38		LJPPB Control Sup Cen Team			4							9	
39		LJPPC Backshop Team	2										

Matrix Depicting Organizational Assignments of Occupational Series at WR-ALC/LBP, LFP, and LJP (Continued)

	A	B	N	O	P	Q	R	S	T	U	V	W	X
1			8268 Aircraft Pneudraulic Systems	GS1101 Industrial Production Mgr	2604 Elect Mechanic Suprv	6904 Tools & Parts Attendant	2610 Elect Integrated Sys Mech	8602 Aircraft Engine Mech	GS896 Industrial Eng	GS1910 Suprv QA Spec	GS318 Secretary	6910 Materials Expediter	GS326 Office Automation
40	LJPS Paint/Corosn Branch												
41		LJPS Paint/Corosn Branch											
42		LJPS Paint/Corosn Branch				1							
43	Total Personnel Per Series		75	28	29	2	9	29	6	13	21	10	7

Matrix Depicting Organizational Assignments of Occupational Series at WR-ALC/LBP, LFP, and LJP (Continued)

	A	B	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1			5485 Aircraft Weight & Bal Tech	GS819 Environ Engr	GS344 Mgt Asst	5704 Fork Lift Operator	GS343 Mgt Analyst	3566 Laborer	GS1601 Suprv Equip Mgt Tech	Misc	3705	Total Personnel per Shop
2	LBPF C-130 Production Branch											155
3	LBPM C-130 Production Branch		1							1	6	217
4	LBPL C-130 Logistics Branch						1			1		26
5												
6	LFPA F-15 Production Branch A								2			100
7	LFPB F-15 Production Branch B											112
8	LFPC F-15 Production Branch C							1				105
9	LFPL F-15 Logistics Services Branch						1			1		2
10		LFPLC Production Control Team					1					7
11		LFPLE Engineering Team								3		9
12		LFPLO Operations Team					3			2		14
13		LFPLP Planning Team								1		20
14		LFPLW Workload Team										13
15	LFPS F-15 Production Support Branch								1			2
16		LFPSF Functional Test Team										24
17		LFPSI F-15 Production Support										65
18		LFPSM Miscellaneous Production Team	2								9	40
19									1			2
20	LJPA Production Branch A								2			293

Matrix Depicting Organizational Assignments of Occupational Series at WR-ALC/LBP, LFP, and LJP (Continued)

	A	B	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1			5485 Aircraft Weight & Bal Tech	GS819 Environ Engr	GS344 Mgt Asst	5704 Fork Lift Operator	GS343 Mgt Analyst	3566 Laborer	GS1601 Suprv Equip Mgt Tech	Misc	3705	Total Personnel per Shop
21	LJPC Production Branch C								2			283
22	LJPD Production Branch								2			4
23		LJPDA Speedline Team										172
24		LJPDB Functional Test Team										32
25		LJPDC Pre/Post Dock Team										105
26		LJPDD Engine Shop Team										21
27	LJPL Production Control Branch											2
28		LJPLA Planning/Scheduling Team A										10
29		LJPLB Planning/Scheduling Team B										12
30		LJPLC Planning/Scheduling Team C										10
31		LJPLD Planning/Scheduling Team D										15
32		LJPLE Engineering Team		1						6		12
33		LJPLF Production Control Team			4							25
34		LJPLM Ops Research Mgt Team					3			1		8
35		LJPLQ Quality Assurance Team										13
36	LJPP Production Support Branch								2			5
37		LJPPA NDI Team	3							1	40	44
38		LJPPB Control Sup Cen Team				1				3		49
39		LJPPC Backshop Team								3		8

Matrix Depicting Organizational Assignments of Occupational Series at WR-ALC/LBP, LFP, and LJP (Continued)

	A	B	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1			5485 Aircraft Weight & Bal Tech	GS819 Environ Engr	GS344 Mgt Asst	5704 Fork Lift Operator	GS343 Mgt Analyst	3566 Laborer	GS1601 Suprv Equip Mgt Tech	Misc	3705	Total Personnel per Shop
40	LJPS Paint/Corosn Branch											
41		LJPS Paint/Corosn Branch										52
42		LJPS Paint/Corosn Branch										36
43	Total Personnel Per Series		6	1	4	1	9	1	12	23	55	2118

Appendix F

Air Force Vision and AFMC and DoD Objectives

F.1 AIR FORCE VISION

The Air Force's vision is of a rapid deployment of ad hoc forces; a significantly smaller force structure with significantly reduced logistics support structures; an increased reliance on fewer levels of maintenance; a premium on data completeness, accuracy, and visibility for success in the operation and support process; automated aids to diagnose faults; and information systems minimizing the need for data entry (Institute for Defense Analysis, 1993).

F.2 AFMC OBJECTIVES

The ITI-ALC team determined that AFMC objectives supported the Air Force vision and the five AFMC goals. The nine AFMC objectives are:

1. Plan and meet all commitments through interaction with our customers and suppliers.
2. Meet all AFMC deployment and wartime support requirements.
3. Ensure our people have the knowledge, skills, abilities, work climate, and leadership to accomplish the mission.
4. Continuously improve the quality and relevance of technology development and its timely application.
5. Aggressively share our dual use technology and technical capabilities with the US public and private sectors.
6. Improve the quality and reduce the cost of our products and services through continuous improvement and re-engineering of our processes and through aggressive interservicing.
7. Aggressively plan and execute environmental pollution prevention, compliance, and restoration programs.
8. Continuously improve facilities, infrastructure, services, working and living environments for all our people.
9. Champion solutions that facilitate joint requirements and services.

These objectives indicate a need to identify enablers that will allow AFMC to support the vision of the Air Force and 1) be the customers' supplier of choice by meeting cost, schedule, and performance baselines, and 2) enhance competitiveness by improving throughput, and decreasing inventory and operating expense for all its functions. These objectives are important in their own right, but are also consistent with logistics and depot maintenance objectives described in the following subsections.

F.3 DOD LOGISTICS OBJECTIVES

Not only was it important for ITI-ALC to support the AFMC objectives, but also to link with higher level objectives passed down through the groupings of functional disciplines at the DoD level. The ITI-ALC team accomplished this linkage by integrating with the business strategy of the DoD logistics business area. The ITI-ALC team captured the major objectives of the Materiel Resources Functional Area (Office of the Assistant Secretary of Defense, 1993) discussed in detail in the Logistics Business Strategic Plan (LBSP). The LBSP provides direction to the lower-level echelons of all DoD organizations reporting to the Principal Staff Assistant (PSA) for logistics. The objectives from the LBSP are:

1. Provide effective, integrated, logistics processes to support peacetime operations and approved wartime scenarios.
2. Implement weapon system-oriented materiel support capability.
3. Reduce materiel inventories and manage effectively with reduced materiel purchase, repair and transportation resources.
4. Achieve maximum practical visibility, protection and most effective use of materiel assets.
5. Achieve maximum work force productivity.
6. Make the most effective use of modern business practices and technology in the logistics system.
7. Facilitate reutilization or disposal of inactive inventories.
8. Incorporate environmental requirements throughout the logistics processes.
9. Employ commercial practices and competition, where appropriate.
10. Provide decision-makers at all levels with sufficient, usable management information.
11. Reduce the response times for initial and follow-on logistics support.
12. Establish and maintain a good working relationship with Congress, General Accounting Office (GAO), Office of Management and Budget (OMB), DoD Inspector General, and industry.

F.4 DOD DEPOT MAINTENANCE GENERAL OBJECTIVES

To complete the linkage through the levels of the maintenance hierarchy, the ITI-ALC team researched AFMC and other DoD planning documents to identify goals for depot maintenance. Within the logistics area the Joint Policy Coordinating Group (JPCG)—Depot Maintenance Executive Group[1] developed these FY95 objectives for depot maintenance.

1. Maintain service management of depot maintenance.

2. Provide "best value" for every DoD dollar spent on depot maintenance. Achieve this through:
    - Reduced cycle time in maintenance.
    - Improved flexibility in the industrial and management process, physical resources, and workforce to adjust to uncertain and changing workloads.
    - Increased quality and effectiveness in maintenance performance.
    - Increased efficiency.

3. Maintain capability to support both peacetime and contingency requirements.

4. Identify and satisfy 100% of customer requirements.

5. Increase ability to operate in a business-like fashion without rules constraining this capability.

6. Increase our ability to compete "two ways" and on a level playing field.
    - Compete within DoD depot maintenance community.
    - Compete for the workload that goes to contract.
    - Compete for the workload that goes to industry.

7. Have environmentally compliant depots (i.e., won't generate hazardous waste).

F.5 CORPORATE INFORMATION MANAGEMENT (CIM) OBJECTIVES

The ITI-ALC system also supports the CIM objectives. It leverages the ongoing focus in depot maintenance systems on improved maintenance management. Specifically, the ITI-ALC team has taken into account DoD actions on information systems to migrate toward standard depot maintenance systems in order to:

- Reduce cycle time so that items return to the field as rapidly as possible and pipeline inventory requirements may be reduced.

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[1] During discussions with representatives of AFMC/LGP in May 1995, the ITI-ALC team confirmed these objectives remain in effect.

- Capitalize on cycle time reductions and achieving economies of scale through better utilization of capacity.

- Increase cost efficiency in the utilization of manpower, material, and support activities

- Provide Executive Information Systems which allow users to balance the management of cost, performance, and customer responsiveness with reduced cycle time.

- Improve interaction with the entire distribution and supply systems in recognition that cycle time is influenced by more than just depot maintenance process time.

- Review depot maintenance performance including asset visibility as it directly supports readiness and integrated weapon system management.

- Reduce material defects.

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Appendix G

Simulation Results

G.1 OVERVIEW

The team used dynamic simulation to conduct "what-if" analyses to determine the effects changes are likely to have on the "AS-IS" world. Simulation explored the effects of slices of BPIs, specifically in the activities associated with acquiring parts and the uses of technical data and planning enhancements. Simulation also explored the effects of the PIPs on the maintenance process. The use of this technique provided a test of the engineering assessment and helped define a range of benefit possibilities.

The dynamic analysis used performance data collected from the ALCs, the Information Integration for Concurrent Engineering (IICE) project, the IMIS demonstration results related to new technology, and maximum acceptable response times defined in the SSS. The data consisted of three types: 1) duration time to complete a process, 2) frequency of occurrence of a process or product, and 3) delay or response time for specific exceptions (e.g., the time between generation of a part order and the actual delivery of the part, the time between the submittal of an over and above requirement and the receipt of the approval or disapproval of the over and above.)

This appendix includes the performance data collected at each of the ALCs, along with a description of its characteristics.

G.2 ASSUMPTIONS

In addition to the detailed "Table of Assumptions" (see Table G-1) which apply to the simulation of PIPs, the assumptions below apply to specific BPI and PIP simulations.

NOTE: The term "task" is equivalent to the term "operations" in depot maintenance.

The following assumptions were made for the Planning and Scheduling BPI simulations.

- 65% of all tasks use parts.
- Every 100 tasks was considered to be a major job for planning purposes.
- The basic work package starts with 8000 tasks.

The following assumptions were made for the PIP Maintenance simulations.

- 65% of all tasks use parts.
- 11 mechanics are available to perform all the work.
- The same mechanic who selects the task works it all the way through to sign-off, unless there is a long delay for guidance, parts or a routed item.
- Activities performed during induction and preparation for flight test are also considered maintenance tasks, and are included in the simulations as such. Specific probabilities are

assigned to the first 500 tasks of the system, assumed to be induction, and the last 500 tasks of the system, assumed to be preparation for flight test.

- The basic work package starts with 8000 tasks.
- All the necessary tools are available for the mechanic to perform the task selected.
- The aircraft manager was not modeled, but delays were incorporated for activities requiring his decision.
- No task is delayed for parts more than one time.
- No task is delayed for guidance more than one time.
- Multiple mechanics are needed for 10% of the tasks.

Table G-1. Assumptions used in Maintenance PIP Simulations (A5 Maintain/Repair Aircraft only)

	Includes Induction	*Includes Preparation for Flight Test*	*"AS-IS"*	*PIP A*	*PIP B*	*PIP C*	*PIP D*
Parts Available at Work Site	Yes	Yes	35%	45%	60%	75%	85%
Part Delays Less than 3 hrs.	Yes	Yes	30%	25%	25%	20%	20%
Part Delays 3 to 24 hrs.	Yes	Yes	45%	45%	45%	50%	50%
Part Delays Greater than 24 hrs.	Yes	Yes	25%	30%	30%	30%	30%
Use of Guidance	Yes	Yes	50%	50%	50%	65%	80%
When Obtaining Guidance, Need for Additional Guidance	Yes	Yes	50%	50%	25%	10%	2%
Guidance Delays Less Than 3 hrs.	Yes	Yes	67%	67%	75%	75%	80%
Guidance Delays 3 to 24 hrs.	Yes	Yes	30%	30%	22%	22%	20% For all Delays Greater than 3 hrs.
Guidance Delays Greater Than 24 hrs	Yes	Yes	3%	3%	3%	3%	20% For all Delays Greater than 3 hrs.
When Obtaining Guidance, Need for an EAR	Yes	Yes	10%	10%	8%	6%	3%
O&As identified during Induction Debriefing and Record Review	Yes	No	5%	5%	5%	5%	5%
O&As identified during Maintenance	Yes	No	10%	10%	10%	9%	8%
O&As identified during Diagnostics	Yes	Yes	25%	25%	10%	5%	1%
O&As Approved	Yes	Yes	75%	75%	75%	80%	99%
Preplanned O&As	Yes	Yes	N/A	10%	30%	50%	70%
Required Diagnostics during Induction & Preparation for Flight Test	Yes	Yes	10%	10%	10%	10%	10%
Required Diagnostics during Maintenance	No	No	1%	1%	1%	1%	1%
Required Diagnostics during Flight Test	No	No	30%	30%	30%	30%	30%
Maintenance Tasks that generate an EAR	No	No	10%	10%	8%	5%	3%
Maintenance Tasks that Require Additional Guidance	Yes	Yes	10%	10%	10%	7%	5%
Guidance Delays Less Than 3 hrs.	Yes	Yes	67%	67%	75%	75%	80%

Table G-1. Assumptions used in Maintenance PIP Simulations (A5 Maintain/Repair Aircraft only) Continued

	Includes Induction	***Includes Preparation for Flight Test***	***"AS-IS"***	***PIP A***	***PIP B***	***PIP C***	***PIP D***
Guidance Delays 3 to 24 hrs.	Yes	Yes	30%	30%	22%	22%	20% For all Delays Greater than 3 hrs.
Guidance Delays Greater Than 24 hrs.	Yes	Yes	3%	3%	3%	3%	20% For all Delays Greater than 3 hrs.
Maintenance Tasks that Require Additional Parts	Yes	Yes	10%	10%	8%	7.50%	5%
Part Delays Less than 3 hrs.	No	No	30%	25%	25%	20%	20%
Part Delays 3 to 24 hrs.	No	No	45%	45%	45%	50%	50%
Part Delays Greater than 24 hrs.	No	No	25%	30%	30%	30%	30%
Parts Verified as Properly Configured	Yes	Yes	97%	97%	97%	97%	97%
Maintenance Tasks that Route Parts	No	No	10%	10%	10%	6%	4.50%

The results of the BPI simulations are summarized in Section 3. A summary of the PIP simulation results and the improvements identified by each PIP is presented in Table G-2. The results are consistent with those included in the engineering assessments. The left column identifies some important parameters analyzed.

NOTE: Labor hours and flow days are in bold because they are the two most important parameters for measuring reduction in operating costs out of the simulations.

The remainder of the table is divided by PIPs. The current environment is depicted under "AS-IS." The full-scale ITI-ALC implementation is depicted under "PIP-D," including the results and the percent change from the "AS-IS" results. The columns depicting "PIP-A," "PIP-B," and "PIP-C" include the results of each simulation and a percentage of the total improvement for the full-scale ITI-ALC implementation (the "AS-IS" to "PIP-D" improvement). For example, "AS-IS" flow days are 219 and "PIP-D" flow days are 151. This depicts an improvement of 68 flow days or 31% of "AS-IS" flow days. "PIP-A" resulted in 212 flow days. This depicts an improvement of 7 flow days or 10% of the total "PIP-D" 68 flow day improvement. All improvements depicted for "PIP-A," "PIP-B," and "PIP-C" are computed in this same manner.

These results depict a slight increase in approved over and aboves. This was the expected result. The preplanning of over and aboves eliminates the delays currently being experienced to develop an engineering "fix" and to determine cost. This allows the over and above to be efficiently scheduled with minimal impact on the overall PDM.

Table G-2. PIP Maintenance Simulation Results
(A5 only for "AS-IS" Network and A4 only for "TO-BE" Network)

	"AS-IS"	PIP-A		PIP-B		PIP-C		PIP-D	
Metrics	**Results**	**Results**	**Percent of "AS-IS" vs PIP-D Improvement**	**Results**	**Percent of "AS-IS" vs PIP-D Improvement**	**Results**	**Percent of "AS-IS" vs PIP-D Improvement**	**Results**	**Percent Reduction from "AS-IS"**
Initial Tasks	8000	8000		8000		8000		8000	
Flow Days	**219**	**212**	**10%**	**196**	**34%**	**169**	**74%**	**151**	**31%**
Labor-hours	**13096**	**12638**	**12%**	**11929**	**30%**	**10256**	**73%**	**9195**	**30%**
Rob-backs	503	515	-4%	393	39%	335	59%	220	56%
Over & Aboves Approved	673	663	-10%	741	71%	734	64%	769	-14%
Routed Tasks	560	533	11%	456	43%	421	57%	316	44%
Number of Part Delays	2077	1923	16%	1804	28%	1311	78%	1089	48%
Mechanic Delays to Obtain Parts	1103	808	36%	604	60%	415	83%	274	75%
Labor Hours Obtaining Parts	3845	3367	31%	2838	65%	2512	86%	2300	40%
Number of Guidance Delays	870	879	-1%	583	39%	318	74%	125	86%
Mechanic Delays to Obtain Guidance	1766	1783	-1%	1751	1%	966	63%	503	72%
Number of EARs	856	817	10%	774	22%	719	36%	478	44%
Labor Hours Obtaining Guidance	3874	3895	-0%	1234	71%	351	95%	146	96%

Both part delays and guidance delays include those tasks where the mechanic began work on another task while waiting for parts or additional guidance to complete the original. They do not include tasks where the mechanic obtained the part/guidance himself. Those tasks are depicted in the area "Mechanic Delays to Obtain Parts/Guidance."

G.3 NETWORKS

$IDEF_3$ process models were constructed depicting the networks used for the simulations. These are based on the $IDEF_3$ PMs included in the Architecture Report. They depict the lowest level nodes with some modifications to implement simulation. These PMs represent only the mechanics performing the work on the aircraft. They start with the aircraft arriving at depot maintenance and complete with returning custody of the aircraft back to the using organization. The "AS-IS" flow is based on the A5 decompositions of the "AS-IS" PM. The "AS-IS" flow was used for both the "AS-IS" and PIP-A simulations. The "TO-BE" flow is based on the A4 decompositions of the "TO-BE" PM. The "TO-BE" flow was used for the PIP-B, PIP-C, and PIP-D simulations. The assumptions represented in Table G-2 were used to construct the simulations. The Architecture Report includes information regarding reading $IDEF_3$ process models.

Uncertainty in the simulation results.

The confidence limit for a 99% confidence level is ±10% of the mean for all of the data derived from the PIP simulations. In fact, 76% of the "AS-IS" data and 86% of the "TO-BE" data maintained a confidence limit less than ±1%. These numbers were computed using the Witness software based on the "t" test.

$$\textbf{Confidence Limit} = \bar{x} \pm \frac{(t \times s)}{\sqrt{N}};$$

where; $\bar{x}$ = **mean of the observations**
t = **Student's statistics for N-1 degrees of freedom**
s = **standard error**
N = **total number of observations**

G.4 SINSITIVITY ANALYSIS

Monte Carlo experiments were conducted by using the same data in its entirety to repeatedly produce new hypothetical samples by rearranging the original observations stochastically and generating results which could be analyzed. A multitude of runs were conducted to generate results, with each run taking other samples out of the distribution. The randomness was varied to the maximum extent possible within the Witness simulation software. Varying the input data was performed to make certain that validity exists in the final results. These final results were used to compute the benefits defined in Section 3.3.

The ITI-ALC team recognized early on that the results of simulation may be sensitive to certain values. As a results, sensitivity analyses were conducted on those simulations which 1) rely on low number of data points, 2) exhibit a wide variation in data points, 3) depend on areas of judgment by the subject matter experts, and 4) rely on activities in the "acquire parts" or "obtain guidance" portions of the networks which are the major areas of constraints for users.

Figures G-1 and G-2 depict the sensitivity analysis results for the "AS-IS" network. A regression analysis was conducted to illustrate the trend in the data. The regression types used in the analysis and depicted in these figures include linear, polynomial, and exponential. The x-axis identifies the percentage change in the parameter tested. The y-axis depicts the percentage change in flow days as a result of the parameter change. As shown in Figure G-1, many areas did not identify a major impact on the simulation. For this reason, additional data was not required to be collected for these areas. For example, the sample data collected for the amount of time passing as material was transported to the work site was comprised of a low number of data points. An analysis was conducted to determine how sensitive the simulation was to changes to this period of time. As shown in the first data series [Low Data (Tran Mat'l)] in Figure G-1, as the time to perform the activity changed by 50%, the flow days for the entire simulation changed by only 2.5%. Users identified variability in another example; the third data series [Data Spread

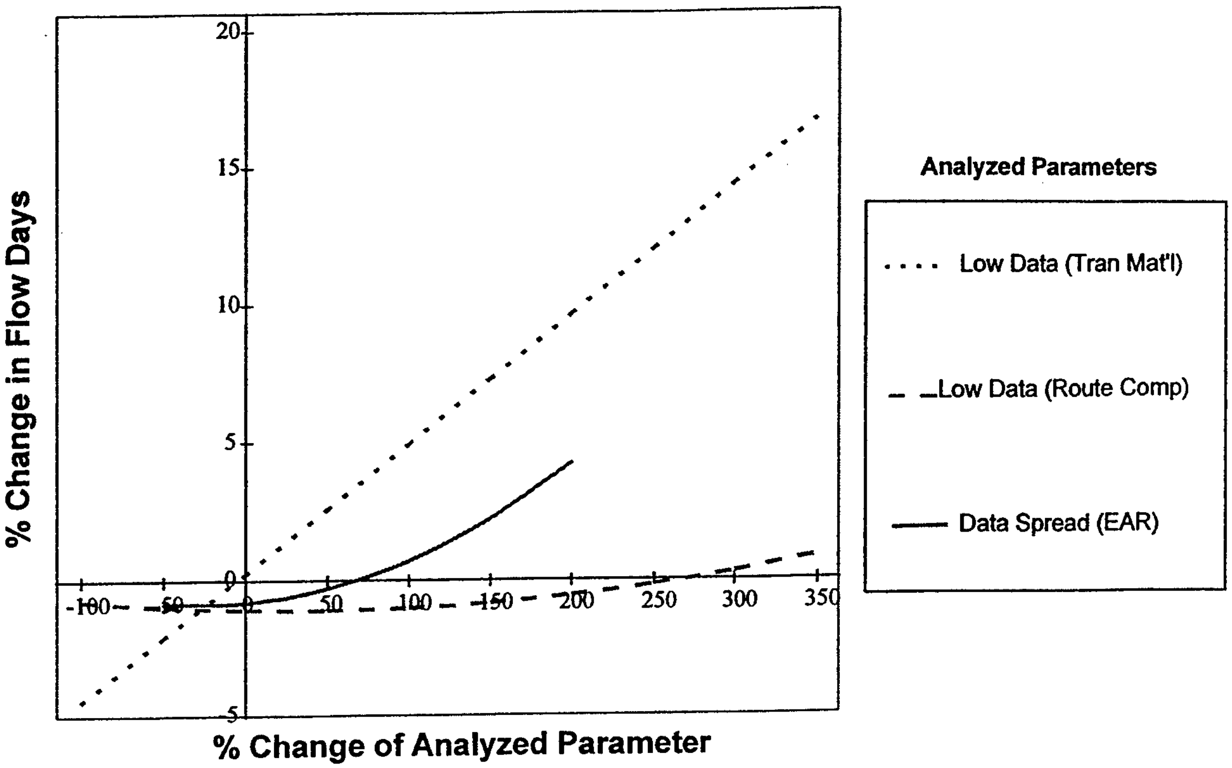

Figure G-1. "AS-IS" Sensitivity Analysis (Non-Sensitive Parameters)

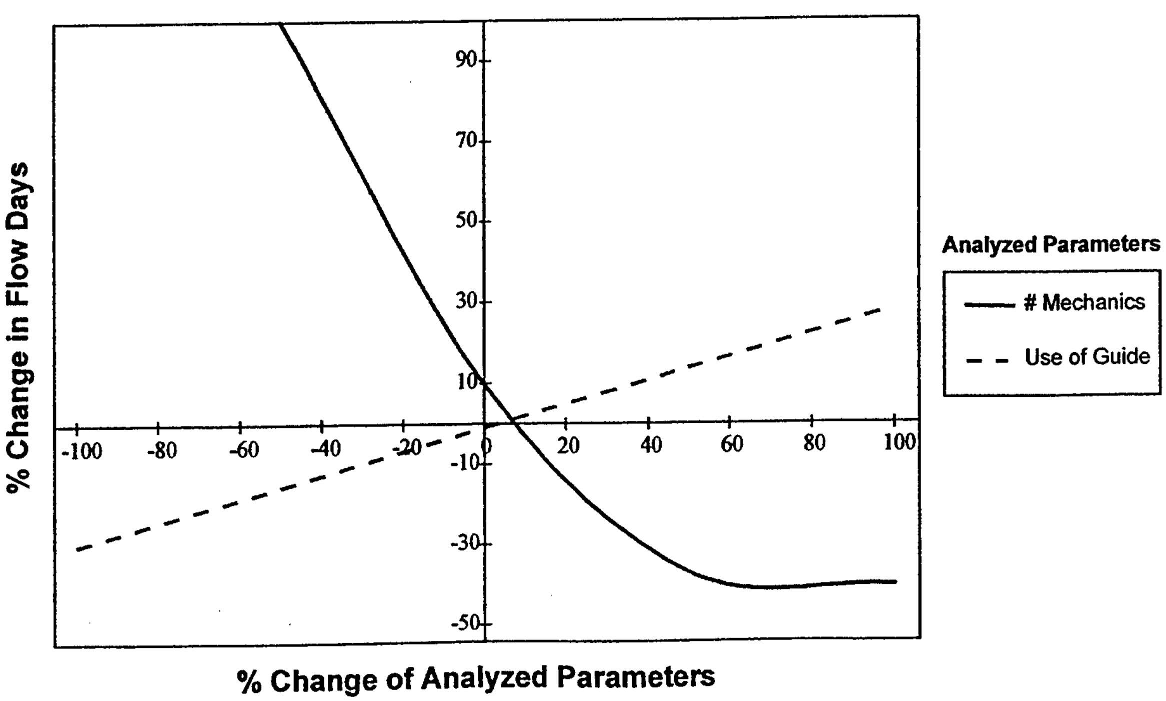

Figure G-2. "AS-IS" Sensitivity Analysis (Sensitive Parameters)

(EAR)]. This data element represented the number of work operations where a mechanic generated an EAR. The sensitivity analysis concluded that total flow days was not sensitive to the variability in this data. As shown in Figure G-1, when the frequency of the generation of an EAR increased by 100% of the nominal value, the flow days for the entire simulation increased less than 1%. However, the analysis did identify the network is very sensitive to the number of mechanics working on an aircraft and the amount of guidance they use to perform the required work, as shown in Figure G-2.

Figures G-3 and G-4 depict the sensitivity analysis results for the "TO-BE" network. The same type of regression analysis was conducted on the "TO-BE" data as was the "AS-IS" data. The x-axis identifies the percentage change in the parameter tested. The y-axis depicts the percentage change in flow days as a result of the parameter change. As shown in figure G-3, the simulation was not sensitive to many of the parameters defined by the subject matter experts. For example, as shown in the fourth data series (Select Part Order) in Figure G-3, as the time to select a part order increased by 20%, the flow days for the entire simulation increased less than 0.5%. The analysis did, however, identify the network is very sensitive to the number of mechanics working on an aircraft, the amount of guidance they use to perform the required work, and the availability of parts, as shown in Figure G-4. Analysis was also conducted to analyze areas outside the scope of the mechanic but with impact on PDM, such as the time required by the planner to review and approve/disapprove an over and above requirement.

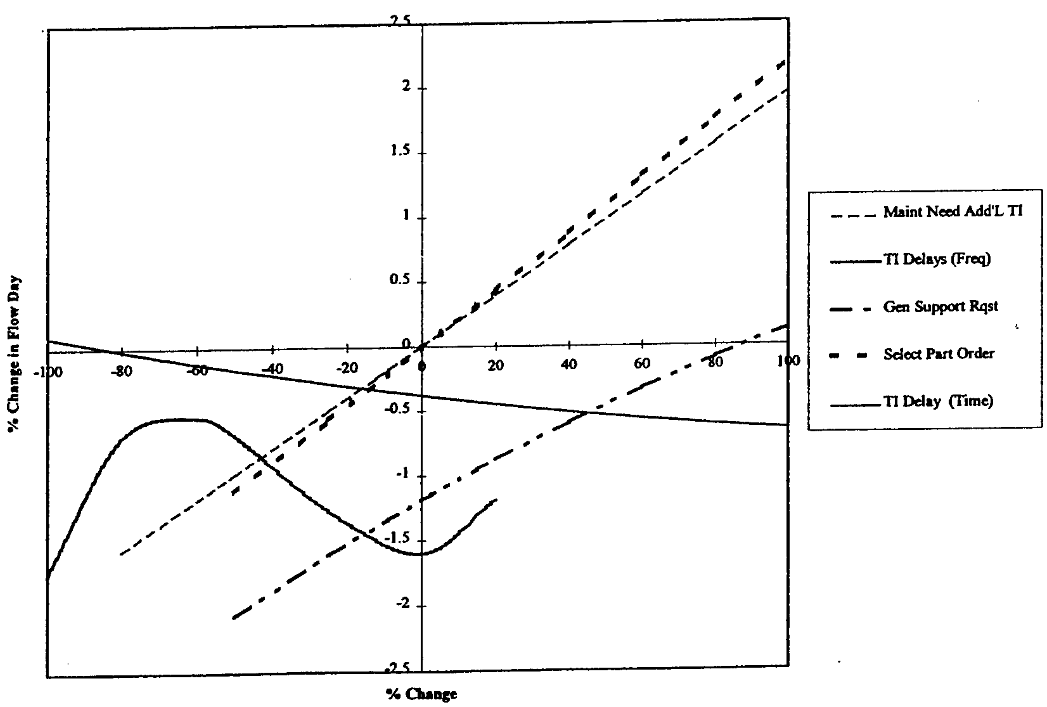

Figure G-3. "TO-BE" Sensitivity Analysis (Subject Matter Expert Defined Parameters)

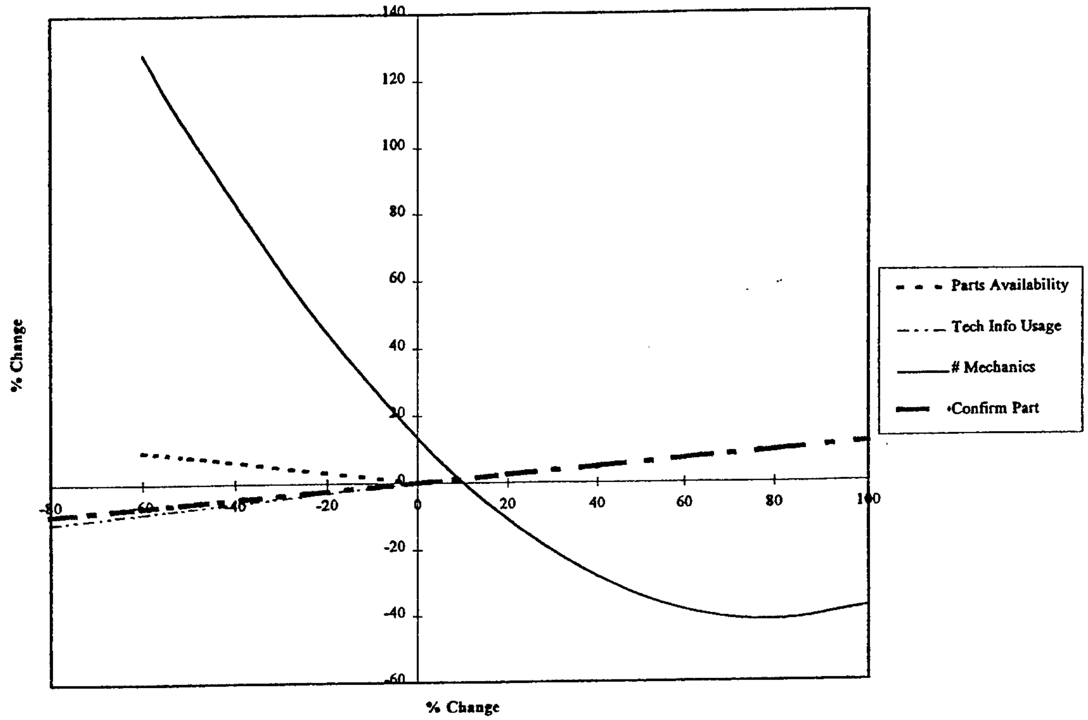

Figure G-4. "TO-BE: Sensitivity Analysis (Sensitive Parameters)

G.5 PERFORMANCE DATA

The dynamic characteristics of PDM were collected at each ALC. As discussed in section 3, the dynamic performance data collected and analyzed encompassed three types:

1. Duration,
2. Frequency of occurrence, and
3. Delay or response time.

This appendix includes a summary of all the dynamic performance data collected. The summary is entitled "Performance Data for "AS-IS" (see Table G-3)." The main part of the table is divided into ten columns:

Table G-3. Performance Data for "AS-IS"

Column	*Description*
1	The $IDEF_0$ FM node number reference.
2	The name of the FM activity. The first set of data for each FM activity is always duration. This column may also include a reference to other data types collected for this particular activity.
3	Type of statistics about the data provided: range, mean, and number of data points.
4-8	All data collected specific to the OC-ALC, OO-ALC, SA-ALC, SM-ALC, and WR-ALC respectively.
9	The summary of the total of all data collected for all ALCs.
10	The total number of data points collected per node for all data types for all ALCs.

The end of the tables provides statistics of the dynamic data by node number, data type, lowest level nodes, and those nodes used in the simulations.

PERFORMANCE DATA

FOR

"AS-IS"

Table G-3. Performance Data for "AS-IS"

Node Number	Activity Name		Oklahoma City	Ogden	San Antonio	Sacramento	Warner Robins	Total	Total per Node
A1	Plan Production	Range			2-3 mon	120 hrs		2 mon	
		Mean			2.5 mon	120 hrs		1.75 mon	
		# Data Points			1	1		2	2
A11	SPECIFY & ACCESS GUIDANCE MATERIALS	Range	0.5-10 hrs	0.5-1 wk			0.1-8hrs	0.1-1 wk	
		Mean	6.9	9.4			2.4	6.2 hrs	
		# Data Points	3	7			4	14	
	% EAR	Range	10-20%			10%	5-20%	10-20%	
		Mean	15%			10%	17%	16%	
		# Data Points	2			1	5	8	
	Delay for EAR	Range	0.1 hr - 8 wks	1hr-8wks		2-64 hrs	8-24 hrs	0.1-8wks	
		Mean	40	33		16	20.8	31.2 hrs	
		# Data Points	2	3		1	5	11	33
A121	SEPARATE RQMTS INTO OPERATIONS	Range	8 hrs	1-12 hrs			1 hr - 30 days	1 hr-30 days	
		Mean	8	8			80	25.5 hrs	
		# Data Points	1	3			2	6	
	% Previous Task Info	Range	65-80%			50-80%	50-90%	50-80%	
		Mean	73%			65%	70%	69%	
		# Data Points	2			2	2	6	12
A122	ACCESS APPLICABLE PLANS	Range	3 hrs	0.5-3 hrs			0.5-0.75 hrs	0.5-3 hrs	
		Mean	3	1.75			0.63	1.6 hrs	
		# Data Points	1	3			2	6	6
A123	DEFINE TASK BREAKDOWN	Range	16 hrs	2-25 hrs		0.1-1 hr	1-24 hrs	0.1-25 hrs	
		Mean	16	14		0.55	12.5	11.9	
		# Data Points	1	3		1	2	7	7

Table G-3. Performance Data for "AS-IS" (Continued)

Node Number	*Activity Name*		*Oklahoma City*	*Ogden*	*San Antonio*	*Sacramento*	*Warner Robins*	*Total*	*Total per Node*
A133	SPECIFY QUANTITY REQUIRED	Range	0.5 hr	0.5-2 hrs		1-12 hrs	0-2 hrs	0-12 hrs	
		Mean	0.5	1.25		6.5	1	2.3	
		# Data Points	1	1		1	1	4	4
A134	COMPILE MATERIAL REQUIREMENTS	Range	1 hr				0.5-25 hrs	0.5-25 hrs	
		Mean	1				10.25	7.2	
		# Data Points	1				2	3	3
A14	COMPILE COST DATA	Range	12 hrs	5-13 hrs			1-13 hrs	1-13 hrs	
		Mean	12	8.5			5	8	
		# Data Points	1	4			2	7	7
A15	STORE & DISTRIBUTE PLAN	Range	12 hrs	1-40 hrs			1-16 hrs	1-40 hrs	
		Mean	12	8.9			10	9.7	
		# Data Points	1	4			3	8	8
A2	Control Production	Range					5-174 hrs	5-174 hrs	
		Mean					101	101	
		# Data Points					3	3	3
A21	ASSIGN MAINTENANCE DATES	Range	4 hrs	0.1-25 hrs	2hrs		0.5-25 hrs	0.1-25 hrs	
		Mean	4	10.1	2		7.5	6.95	
		# Data Points	1	2	1		3	7	7
A221	INITIATE ASSET INDUCTION	Range		3-15 hrs			6-15 hrs	3-15 hrs	
		Mean		8.25			11..5	9.3	
		# Data Points		2			1	3	
	Delay for Warehouse Confirmation	Range	1-80 hrs	1-8 hrs			0.5-2 hrs	0.5-80 hrs	
		Mean	26.5	3			1.6	8.1	
		# Data Points	2	2			4	8	11

Table G-3. Performance Data for "AS-IS" (Continued)

Node Number	*Activity Name*		*Oklahoma City*	*Ogden*	*San Antonio*	*Sacramento*	*Warner Robins*	*Total*	*Total per Node*
A1241	ASSIGN SKILL REQUIREMENTS	Range	4 hrs	0.5-6 hrs			0.5-12 hrs	0.5-12 hrs	
		Mean	4	2.56			6.25	3.8	
		# Data Points	1	4			2	7	7
A1242	ESTABLISH LABOR STANDARDS	Range	8 hrs	0.1-19 hrs		0.1-2 hrs	0.1-0.25 hrs	0.1-19	
		Mean	8	10.51		1.05	0.18	6.9	
		# Data Points	1	5		1	2	9	9
A1243	IDENTIFY SPECIAL TOOLS & EQUIPMENT	Range	6 hrs	2-15 hrs		0-2 hrs	0.1-0.5 hrs	0-15 hrs	
		Mean	6	9.2		1	0.3	5	
		# Data Points	1	3		1	2	7	7
A1244	COMPILE LABOR REQUIREMENTS	Range	3 hrs	0.5-8 hrs		0.1-1 hr	0.25 hrs	0.1-8 hrs	
		Mean	3	2.7		0.55	0.25	2.16	
		# Data Points	1	5		1	1	8	8
A125	MERGE THE TASKS	Range		0.5-24 hrs			1-12 hrs	0.5-24 hrs	
		Mean		6.35			6.5	6.4	
		# Data Points		5			2	7	7
A13	Identify Material Requirements	Range		15-30 hrs				15-30 hrs	
		Mean		22.2				22.2	
		# Data Points		3				3	3
A131	IDENTIFY REPLACEMENT PARTS	Range	0.25 hr	0.15-1 hr			0.1-2 hrs	0.1-2 hrs	
		Mean	0.25	0.5			1.05	0.7	
		# Data Points	1	1			2	4	4
A132	IDENTIFY REQUIRED PARTS	Range	0.25 hr	0.5 hr			0-3 hrs	0-3 hrs	
		Mean	0.25	0.5			1	0.65	
		# Data Points	1	2			2	5	5

Table G-3. Performance Data for "AS-IS" (Continued)

Node Number	*Activity Name*		*Oklahoma City*	*Ogden*	*San Antonio*	*Sacramento*	*Warner Robins*	*Total*	*Total per Node*
A222	CLEAR TRANSACTION	Range		1-5 hrs			2-5 hrs	1-5 hrs	
		Mean		2.75			3.5	3.1	
		# Data Points		2			2	4	4
A223	INCREMENT ON-HAND WORK COUNT	Range		0.5-4 hrs			0.5-1 hr	0.5-4 hrs	
		Mean		1.4			0.75	1.1	
		# Data Points		2			2	4	4
A23	PREPOSITION PARTS	Range	0.5 hr	0.5-30 hrs		0-0.3 hr	20-30 hrs	0-30 hrs	
		Mean	0.5	6.8		0.15	25	7.6	
		# Data Points	1	4		1	1	7	
	% Prepositioning Occurs	Range					45%	45%	
		Mean					45%	45%	
		# Data Points					1	1	8
A24	COORDINATE ACTIVITIES	Range	0.75-5 hrs	1-8 hrs	9 hrs		0-4 hrs	0-9 hrs	
		Mean	2.25	2.4	9		1.9	2.7	
		# Data Points	3	4	1		5	13	13
A25	Assign Resources	Range		1-1.5 hrs	3 hrs		1-3 hrs	1-3 hrs	
		Mean		1.25	3		2	2.1	
		# Data Points		1	1		1	3	3
A251	DEFINE PRESENT NEED	Range	1.75 hrs	0.1-1.5 hrs		1-1.5 hrs		0.1-1.75 hrs	
		Mean	1.75	0.8		1.25		1.3	
		# Data Points	1	1		1		3	3
A252	IDENTIFY CANDIDATES	Range	0.5 hr			0.1-0.25 hr		0.1-0.5 hr	
		Mean	0.5			0.18		0.3	
		# Data Points	1			1		2	2
A253	SELECT CANDIDATE	Range	0.5 hr	0.1-0.25 hr		0.1-0.25 hr		0.1-0.5	
		Mean	0.5	0.15		0.18		0.3	
		# Data Points	1	1		1		3	3

Table G-3. Performance Data for "AS-IS" (Continued)

Node Number	Activity Name		Oklahoma City	Ogden	San Antonio	Sacramento	Warner Robins	Total	Total per Node
A254	PRIORITIZE ASSIGNMENTS	Range	0.75 hr			0.45-0.5 hr		0.45-0.75 hr	
		Mean	0.75			0.48		0.6	
		# Data Points	1			1		2	2
A26	Sell Components	Range		14-18 hrs				14-18 hrs	
		Mean		16				16	
		# Data Points		1				1	1
A261	INITIATE TURN-IN TO SUPPLY	Range	1.75 hrs	0.25-2 hrs		0.5-4 hrs	1-3 hrs	0.25-4 hrs	
		Mean	1.75	0.5		0.23	2	1.63	
		# Data Points	1	1		1	1	4	
	Delay for Warehouse Confirmation	Range		1-1.5 hrs			4 hrs	1-4 hrs	
		Mean		1.25			4	3.3	
		# Data Points		1			3	4	8
A262	DECREMENT ON-HAND ACCOUNT	Range	0.25 hr			1-8 hrs	0.1-0.25 hr	0.1-8 hrs	
		Mean	0.25			4.5	0.18	1.6	
		# Data Points	1			1	1	3	3
A263	ESTABLISH CREDIT	Range	0.25 hr			0.5-4 hrs	0.1-0.25	0.1-4 hrs	
		Mean	0.25			2.25	0.18	0.89	
		# Data Points	1			1	1	3	3
A31	DETERMINE ABILITY TO SUPPORT OPERATIONS	Range							
		Mean							
		# Data Points						0	
	% Parts Stocked	Range				75%		75%	
		Mean				75%		75%	
		# Data Points				1		1	

Table G-3. Performance Data for "AS-IS" (Continued)

Node Number	*Activity Name*		*Oklahoma City*	*Ogden*	*San Antonio*	*Sacramento*	*Warner Robins*	*Total*	*Total per Node*
A31 (Cont'd)	% Parts Need Stocked	Range				25%		25%	
		Mean				25%		25%	
		# Data Points				1		1	2
A32	REQUISITION ITEMS	Range							
		Mean							
		# Data Points						0	
	Delay for Part	Range					85%: 24 hrs 15%: backordered	85%: 24 hrs 15%: backordered	
		Mean					85%: 24 hrs 15%: backordered	85%: 24 hrs 15%: backordered	
		# Data Points					2	2	2
A331	DETERMINE ITEM LOCATION	Range				0.1-0.15 hr		0.1-0.15 hr	
		Mean				0.13		0.13	
		# Data Points				1		1	
	% to Supply	Range			20%	20%		20%	
		Mean			20%	20%		20%	
		# Data Points			1	1		2	
	% to be Issued	Range			80%	80%		80%	
		Mean			80%	80%		80%	
		# Data Points			1	1		2	5
A332	STORE ITEM	Range				0.25-0.5 hr		0.25-0.5 hr	
		Mean				0.38		0.38	
		# Data Points				1		1	1

Table G-3. Performance Data for "AS-IS" (Continued)

Node Number	Activity Name		Oklahoma City	Ogden	San Antonio	Sacramento	Warner Robins	Total	Total per Node
A333	RETRIEVE ITEM	Range				0.1-0.2 hr		0.1-0.2 hr	
		Mean				0.15		0.15	
		# Data Points				1		1	1
A334	TRACK INVENTORY	Range				0.1-0.25		0.1-0.25	
		Mean				0.18		0.18	
		# Data Points				1		1	1
A34	ISSUE ITEMS	Range				0.1-2.5 hrs		0.1-2.5 hrs	
		Mean				1.08		1.08	
		# Data Points				3		3	3
A4	Repair/Manufacture Components	Range	2-21 hrs		8.5-12 hrs			2-21 hrs	
		Mean	8.33		11.13			9.45	
		# Data Points	3		2			5	
	% Components to Repair	Range					95%	95%	
		Mean					95%	95%	
		# Data Points					1	1	
	% Components to Backshop	Range					5%	5%	
		Mean					5%	5%	
		# Data Points					1	1	7
A41	SELECT WORKLOAD	Range	0.5 hr	0.1-1.5 hr	1-3 hrs	1 hr	0.2-0.25 hr	0.1-3 hrs	
		Mean	0.5	0.37	1.75	1	0.22	0.6	
		# Data Points	1	3	2	1	5	12	12
A42	OBTAIN GUIDANCE	Range	0.25 hr	0.2-2 hrs		1 hr	0.25-0.5 hr	0.2-2 hr	
		Mean	0.25	0.43		1	0.44	0.48	
		# Data Points	1	3		1	4	9	
	% EARs	Range	25-40%				5-30%	5-40%	
		Mean	33%				9%	0.15	
		# Data Points	3				7	10	

Table G-3. Performance Data for "AS-IS" (Continued)

Node Number	*Activity Name*		*Oklahoma City*	*Ogden*	*San Antonio*	*Sacramento*	*Warner Robins*	*Total*	*Total per Node*
A42 (Cont'd)	Delay for EAR	Range	2 wks				8-80 hrs	8-80 hrs	
		Mean	80				46.4	7.8	
		# Data Points	1				5	6	25
A43	ORDER PARTS	Range	0.5 hr	0.1-1 hr	0.2-0.5 hr	0.5 hr	0.5-0.75	0.1-1 hr	
		Mean	0.5	0.41	0.35	0.5	0.55	0.48	
		# Data Points	2	4	1	1	5	13	
	% Parts Required	Range	60%			20%	20-100%	20-100%	
		Mean	60%			20%	15%	55%	
		# Data Points	1			1	6	8	
	Delay for Parts	Range					48 hrs	48 hrs	
		Mean					48	48	
		# Data Points					3	3	24
A44	PERFORM TASK	Range	4-21 hrs	0.1-10 hrs	2-40 hrs	0.5-4 hrs	2hr-118 days assume max = 40 hrs)	0.1-80 hrs	
		Mean	11.67	4.42	9.83	1.63	10.30	7.54	
		# Data Points	3	3	3	4	5	18	
	% Condemned	Range	5%			20%	5-20%	5-20%	
		Mean	5%			20%	13%	15%	
		# Data Points	2			2	2	6	
	% Parts Removed for Exchange or Routing	Range	15%			20%		15-20%	
		Mean	15%			20%		18%	
		# Data Points	1			1		2	

Table G-3. Performance Data for "AS-IS" (Continued)

Node Number	Activity Name		Oklahoma City	Ogden	San Antonio	Sacramento	Warner Robins	Total	Total per Node
A44 (Cont'd)	% Exchangeable	Range	80%				70%	70-80%	
		Mean	80%				70%	75%	
		# Data Points	1				1	2	
	% Routed	Range	20%				30%	20-30%	
		Mean	20%				30%	25%	
		# Data Points	1				1	2	
	% Need Parts	Range	20%			50%		20-50%	
		Mean	20%			50%		35%	
		# Data Points	1			1		2	32
A45	PROVIDE INDUSTRIAL SUPPORT	Range	3 hr			0.5-1 hr	0.25-0.8 hr	0.25-3 hr	
		Mean	3			0.75	0.51	0.94	
		# Data Points	1			2	4	7	
	% Condemned	Range	0%			1%		0-1%	
		Mean	0%			1		0.50%	
		# Data Points	1			1		2	
	% Need Parts	Range	10%			50%	10%	10-50%	
		Mean	10%			50%	10%	20%	
		# Data Points	1			1	2	4	13
A46	DOCUMENT WORK	Range	0.25 hr	0.2-0.3 hr	1 hr	1 hr	0.25 hr	0.2-1 hr	
		Mean	0.25	0.24	1	1	0.25	0.43	
		# Data Points	1	2	1	1	3	8	8
A51	SELECT TASK	Range	0.25-3 hr	0.1-1.5 hr		1 hr	0.1-3 hrs	0.1-3 hrs	
		Mean	1.38	0.64		1	0.45	0.64	
		# Data Points	2	4		1	6	13	13

Table G-3. Performance Data for "AS-IS" (Continued)

Node Number	Activity Name		Oklahoma City	Ogden	San Antonio	Sacramento	Warner Robins	Total	Total per Node
A52	Obtain Guidance	Range		0.2-0.4 hr			0.2-0.4 hr	0.2-0.4 hr	
		Mean		0.27			0.3	0.28	
		# Data Points		3			1	4	
	% Use/Select Guidance	Range			10%	25-30%		10-30%	
		Mean			10%	27.50%		0.19	
		# Data Points			1	1		2	6
A521	DETERMINE REPOSITORY FOR INFORMATION	Range	0.25 hr	0.1-0.15 hr		0.5 hr	0-0.75 hr	0-0.75 hr	
		Mean	0.25	0.13		0.50	0.35	0.33	
		# Data Points	1	1		1	5	8	8
A522	GO TO THE DESIGNATED REPOSITORY	Range	0.5 hr	0.15 hr		0.5 hr	0-0.1 hr	0-0.5 hr	
		Mean	0.50	0.15		0.50	0.08	0.23	
		# Data Points	1	1		1	3	6	6
A523	GAIN ACCESS TO INFORMATION	Range	1.5 hrs	0.1-1 hr		0.1-1.5 hrs	0.1-1.5 hrs	0.1-1.5 hrs	
		Mean	1.5	0.5		0.76	0.55	0.65	
		# Data Points	1	1		4	11	17	
	% EAR	Range	10%			10%	3-10%	3-10%	
		Mean	10%			10%	4%	6%	
		# Data Points	2			2	7	11	
	Delay for EAR	Range	80 hrs	8-120 hrs	12-16 hrs		48 hrs	8-120 hrs	
		Mean	80	66	14		48	52.25	
		# Data Points	1	2	1		4	8	36
A524	TRANSPORT MATERIAL TO SITE	Range	0.5 hr			0	0.25-1.5 hrs	0-1.5 hrs	
		Mean	0.5			0	0.58	0.41	
		# Data Points	1			1	2	4	4

Table G-3. Performance Data for "AS-IS" (Continued)

Node Number	Activity Name		Oklahoma City	Ogden	San Antonio	Sacramento	Warner Robins	Total	Total per Node
A53	Order Parts	Range	0.5 hr	0.2-2 hrs			8 hrs	0.2-8 hrs	
		Mean	0.5	0.74			8	1.62	
		# Data Points	1	6			1	8	
	Delay for Parts	Range		2-72 hrs			2-160 hrs	2-160 hrs	
		Mean		32.83			39.50	26.58	
		# Data Points		3			3	6	14
A531	RESEARCH PART DATA	Range	0.5 hr	1-4 hrs		1-2 hrs	0.25-3.5 hrs	0.25-4 hrs	
		Mean	0.5	2		1.5	0.77	0.94	
		# Data Points	1	1		2	10	14	14
A532	ENTER DATA	Range	0.25 hr	0.1-0.5 hr		1 hr	0.1-0.5 hr	0.1-1 hr	
		Mean	0.25	0.25		1	0.27	0.36	
		# Data Points	1	1		1	5	8	8
A533	SUBMIT REQUEST	Range	0.25 hr			1 hr	0.1-0.5 hr	0.1-1 hr	
		Mean	0.25			1	0.34	0.4	
		# Data Points	1			1	7	9	9
A54	Perform Task	Range		4-10 hrs			100-300 hrs	4-300 hrs	
		Mean		6.33			200	54.75	
		# Data Points		3			1	4	
	Delay for Over & Aboves	Range	24-80 hrs					24-80 hrs	
		Mean	24 hrs					24 hrs	
		# Data Points	1					1	
	% Over & Aboves Approved	Range			75%			75%	
		Mean			75			75	
		# Data Points			1			1	6
A541	Induct Aircraft	Range							
		Mean							
		# Data Points						0	

Table G-3. Performance Data for "AS-IS" (Continued)

Node Number	Activity Name		Oklahoma City	Ogden	San Antonio	Sacramento	Warner Robins	Total	Total per Node
A541 (Cont'd)	Delay for Over & Aboves	Range					0.1-0.2 hr	0.1-0.2 hr	
		Mean					0.17	0.17	
		# Data Points					3	3	
	% Over & Aboves Approved	Range					99%	99%	
		Mean					99	99	
		# Data Points					3	3	6
A5411	SAFE & SHUTDOWN A/C	Range	0.5-25 hrs		12 hrs		1.5-300 hrs	0.5-300 hrs	
		Mean	12.75		12		51.67	41.84	
		# Data Points	1		1		6	8	8
A5412	CONDUCT INVENTORY INSPECTION	Range	1-4 hrs			0-0.5 hr	2.2-8 hrs	0-8 hrs	
		Mean	2.33			0.20	3.77	2.52	
		# Data Points	3			3	6	12	12
A5413	PARTICIPATE IN DEBRIEF	Range	4 hrs		1 hr	0	0.5-1.5 hr	0-4 hrs	
		Mean	4		1	0	0.88	1.14	
		# Data Points	1		1	1	6	9	
	% Over & Above	Range				5%		5%	
		Mean				5%		5%	
		# Data Points				1		1	10
A5414	TRANSFER CUSTODY	Range	1.5-2 hrs			0	1-2 hrs	0-2 hrs	
		Mean	1.75			0	1.625	1.125	
		# Data Points	2			2	2	6	
	% Over & Above	Range	30%			10%		10-30%	
		Mean	30			10%		20	
		# Data Points	1			1		2	

Table G-3. Performance Data for "AS-IS" (Continued)

Node Number	Activity Name		Oklahoma City	Ogden	San Antonio	Sacramento	Warner Robins	Total	Total per Node
A5414 (Cont'd)	% Over & Above Approved	Range	60%				99%	60-99%	
		Mean	60%				99%	86%	
		# Data Points	1				2	3	
	Over & Above Delay	Range	8-16 hrs				0.1-0.2 hr	0.1-16 hrs	
		Mean	12				0.15	4.1	
		# Data Points	1				2	3	14
A542	INSPECT AIRCRAFT	Range	2-40 hrs			0.25-2 hrs	1-115 hrs	0.25-115 hrs	
		Mean	21			1.625	43.36	29.25	
		# Data Points	2			4	9	15	
	% Over & Aboves	Range	30%			30%		30%	
		Mean	30%			30%		30%	
		# Data Points	1			1		2	
	% Diagnostics Required	Range	10%					10%	
		Mean	10%					10%	
		# Data Points	1					1	18
A543	DIAGNOSE FAILURE	Range	2-4 hrs			2-3 hrs	0-100 hrs	0-100hrs	
		Mean	3			2.33	55.92	31.68	
		# Data Points	2			3	6	11	
	% Over & Aboves	Range	50%			25-50%		25-50%	
		Mean	50%			37.50%		42%	
		# Data Points	1			2		3	14
A5441	REFERENCE GUIDANCE MATERIAL	Range	0.5 hr			0.5 hr	0.3-1 hr	0.3-1 hr	
		Mean	0.5			0.5	0.65	0.53	
		# Data Points	2			2	1	5	

Table G-3. Performance Data for "AS-IS" (Continued)

Node Number	*Activity Name*		*Oklahoma City*	*Ogden*	*San Antonio*	*Sacramento*	*Warner Robins*	*Total*	*Total per Node*
A5441 (Cont'd)	% Add'l Guidance Needed	Range	5%			1%		1-5%	
		Mean	5%			1%		0.04	
		# Data Points	3			1		4	9
A5442	OBTAIN PART	Range	0.25-0.5 hr			0.5 hr	0-12 hr	0-12 hrs	
		Mean	0.38			0.50	3.35	1.89	
		# Data Points	2			2	4	8	
	% Add'l Parts Needed	Range	65-90%			1-80%	65%	1-90%	
		Mean	77.50%			45.50%	65%	60%	
		# Data Points	2			2	1	5	13
A5443	VERIFY PART CONFIGURATION	Range	0.25-0.5			1 hr	0.1-1 hr	0.1-1 hr	
		Mean	0.38			1.00	0.47	0.59	
		# Data Points	2			2	3	7	
	% Wrong Configuration	Range	5%			20-80%	3%	3-20%	
		Mean	5%			50%	3%	19%	
		# Data Points	2			2	2	6	13
A5444	DISASSEMBLE, OVERHAUL & ASSEMBLE ITEM	Range	0.25-80 hrs			0.5-2 hrs	0-24 hrs	0-80 hrs	
		Mean	21.71			1.13	6.38	10.32	
		# Data Points	6			4	8	18	
	% Over & Aboves	Range	15%			10%	10%	10-15%	
		Mean	15%			10%	10%	12%	
		# Data Points	1			1	1	3	
	% Over & Aboves Approved	Range	60%				99%	60-99%	
		Mean	60%				99%	91%	
		# Data Points	1				4	5	

Table G-3. Performance Data for "AS-IS" (Continued)

Node Number	Activity Name		Oklahoma City	Ogden	San Antonio	Sacramento	Warner Robins	Total	Total per Node
A5444 (Cont'd)	Over & Above Delay	Range	8-16 hrs				0.1-0.2 hr	0.1-16 hrs	
		Mean	12				0.17	3.13	
		# Data Points	1				3	4	
	% Add'l Parts Needed	Range	50%			15%	50%	15-50%	
		Mean	50%			15%	50%	38%	
		# Data Points	1			1	1	3	
	% Parts Removed for Exchange or Routing	Range	15%			10-20%	15%	10-20%	
		Mean	15%			13%	15%	14%	
		# Data Points	1			3	1	5	
	% Routed	Range				5-20%		5-20%	
		Mean				14%		14%	
		# Data Points				2		2	40
A5445	TURN IN COMPONENTS	Range	0.75 hr			1 hr	0.5-2 hrs	0.5-2 hrs	
		Mean	0.75			1	1.25	1	
		# Data Points	1			1	1	3	3
A5446	ROUTE COMPONENTS	Range	1 hr			1 hr	0.5-2 hrs	0.5-2 hrs	
		Mean	1			1	1.25	1.06	
		# Data Points	2			1	1	4	4
A545	PREPARE FOR OPERATION	Range	48 hrs	8-50 hrs	12 hrs		12-500 hrs	8-500 hrs	
		Mean	48	30	12		161	111.88	
		# Data Points	1	1	1		5	8	8
A546	SIGN-OFF TASK COMPLETION	Range	0.5 hrs			0.1 hr	0.25-4 hrs	0.1-4 hrs	
		Mean	0.5			0.1	2.53	1.89	
		# Data Points	1			1	5	7	7

Table G-3. Performance Data for "AS-IS" (Continued)

Node Number	Activity Name		Oklahoma City	Ogden	San Antonio	Sacramento	Warner Robins	Total	Total per Node
A551	INSPECT END ITEM	Range	0.75-56 hrs			0-2 hrs	0.5-100 hrs	0-100 hrs	
		Mean	28.375			1	28.25	19.25	
		# Data Points	2			2	2	6	
	% Fault Identified	Range	30%						
		Mean	30%						
		# Data Points	1					1	7
A552	PLAN FUNCTIONAL CHECK FLIGHT	Range	5-5.5 hrs		4 hrs	0	1-5.5 hrs	0-5.5 hrs	
		Mean	5.25		4	0	2.88	3.38	
		# Data Points	2		1	1	2	6	6
A553	EXECUTE FUNCTIONAL CHECK FLIGHT	Range	1-10 hrs			0	6-8 hrs	0-10 hrs	
		Mean	5.67			0	7	4.8	
		# Data Points	3			1	1	5	5
A554	CONDUCT DEBRIEF	Range	1-2 hrs				0.1-1.5 hr	0.1-2 hrs	
		Mean	1.33				0.64	0.94	
		# Data Points	3				4	7	
	% Faults Defined	Range	30%					30%	
		Mean	30%					30%	
		# Data Points	1					1	8
A56	DOCUMENT WORK	Range	32-84 hrs	0.2-8 hrs			3-160 hrs	0.2-160 hrs	
		Mean	66	1.49			103.80	60.69	
		# Data Points	4	4			5	13	13
	Total Data Points		137	126	22	108	295	688	688
	Total A1		22	56	1	10	43	132	132
	Total A2		14	24	3	8	29	78	78
	Total A3		0	0	2	11	2	15	15
	Total A4		25	15	9	17	55	121	121

Table G-3. Performance Data for "AS-IS" (Continued)

Node Number	*Activity Name*		*Oklahoma City*	*Ogden*	*San Antonio*	*Sacramento*	*Warner Robins*	*Total*	*Total per Node*
A56 (Cont'd)	Total A5		76	31	7	62	166	342	342
	Total Duration		92	115	17	73	207	504	
	Total Frequency		36	0	4	34	51	125	
	Total Delay		9	11	1	1	37	59	
		NUMBER OF DATA POINTS							
	ALL DATA	Sum	Mean	Std Dev	Minimum	Maximum	Nodes		
	Total Data Points	688	8.82	7.85	1	40	78		
	Total A1	132	7.76	6.97	2	33	17		
	Total A2	78	4.88	3.48	1	13	16		
	Total A3	15	2.14	1.46	1	5	7		
	Total A4	121	17.29	9.66	7	32	7		
	Total A5	342	11.03	8.12	3	40	31		
	LOWEST LEVEL NODES	Sum	Mean	Std Dev	Minimum	Maximum	Nodes		
	Total Data Points	637	9.37	8.16	1	40	68		
	Total A1	127	8.47	7.14	3	33	15		
	Total A2	71	5.46	3.60	2	13	13		
	Total A3	15	2.14	1.46	1	5	7		
	Total A4	114	19.00	9.34	8	32	6		
	Total A5	310	11.48	8.52	3	40	27		
	NODES USED IN SIMULATION	Sum	Mean	Std Dev	Minimum	Maximum	Nodes		
	Total Data Points	382	10.32	8.49	3	40	37		
	Total A1	120	8.57	7.40	3	33	14		
	Total A2	7	7.00	0.00	7	7	1		
	Total A5	255	11.59	9.24	3	40	22		

Appendix H

Data Management and System Strategy

H.1 OVERVIEW

The format prescribed in the former DoD 8020.1-M included a requirement that data management and information strategy and data and system changes be included in the body of the abbreviated functional economic analysis. However, in this case we have included it as this appendix. Section H.2 discusses the data management and information system strategy. Section H.3 discusses the data and system changes.

H.2 DATA MANAGEMENT AND INFORMATION SYSTEM STRATEGY

This section includes a summary of the overall technical strategy to provide effective data administration and information system support to provide for the functional activity, addressing architectural issues such as client server vs. peer-to-peer, mobile vs. stationary, information vs. data, and so forth (Office of the Secretary of Defense, 1993). Section H.2.1 includes an overview of the proposed system architecture for ITI-ALC system. Section H.2.2 includes pertinent issues for this system.

H.2.1 ITI-ALC System Architecture

One of the most important parts of the development of any system is the "system architecture" which identifies its components and structure. The *Corporate Information Management (CIM) Technical Reference Model* (DoD, March 1995) and the Department of Defense (DoD) Technical Architecture Framework for Information Management (TAFIM) (June 1994) documentation are excellent start to an overall system architecture for ITI-ALC and will help ensure that the ITI-ALC system is compliant with JLSC standards. The *CIM Technical Reference Model*, populated with approved standards, is shown in Table H-1 and is described in Section 3.3 of the *CIM Technical Reference Model* document. To add context to this table, note that the first two layers ("mission area" application and support applications) of the architecture (shown shaded) are the Computer Software Configuration Items (CSCIs) of the ITI-ALC system and are described in the ITI-ALC SSDD (SRA, 15 February 1996). Like the *CIM Technical Reference Model*, the TAFIM is a framework for building information systems that will be standardized within DoD.

In order to build flexibility and versatility into the ITI-ALC system, the architecture will consist of a three tier client/server environment. This allows for the distribution of operations across the network. The thrust behind client/server is to divide, or partition, application functions among multiple processors to put processing on the right machine for the job-at-hand. Application partitioning, that is partitioning the application across the three tiers, will be accomplished by distributing the three primary parts of an application, including data management, application logic, and presentation. By doing this we guard against the potential detrimental impact on an application resulting from the installation of an upgraded server or from randomly splitting the application across two machines for anticipated performance improvements.

Table H-1. The Standards Profile

"MISSION AREA" APPLICATIONS						
SUPPORT APPLICATIONS						
APPLICATION PROGRAM INTERFACE						
APPLICATION PLATFORM						
Programming Services	**End-user Interface Services**	**Data Mngt. Services**	**Data Interchange Services**	**Graphics Services**	**Network Services**	**Communication Services**
ADA	X-WINDOWS	SQL	ODA/ODIF/ODL	GKS	GOSIP	Communication Protocols for existing systems.
C	DoD HCI GUIDE	IRDS	SGML	PHIGS	TLSP NLSP	
C++	P1201.X	RDA	CGM		ISO SECURITY ARCHITECTURE	
CASE Tools	IETM-M	IETM-D	IGES		LAN SECURITY	
			EDI			
POSIX POSIX SECURITY EXTENSIONS		OPERATING SYSTEM SERVICES				GNMP
SECURITY SERVICES		CMW	SYSTEM MANAGEMENT SERVICES			

This architecture has the potential for a finer level of granularity as processing loads increase. It is simple to upgrade or add only the needed components. This technology also allows for segregation of user communities. This helps in isolating the impact of power users on the system. The client/server architecture also makes it easy to construct the server with all the information integrity rules on it. By having all the applications on the clients and having those clients access information from the server, all applications will have consistent access to current information. This also implies reusability of the server, improving development time for new applications that do not have to have all the integrity rules coded into the application. Lastly, there is tremendous potential for supporting applications developed with parallelism and concurrency in mind.

H.2.1.1 Mission Area Applications

Mission area applications implement specific end-user requirements or needs. This application software may be Commercial-off-the-Shelf (COTS) or Government-off-the-Shelf (GOTS), custom developed or a combination of these. Section 4.2 of ITI-ALC SSDD includes both the structure and the required functionality of this area of the overall system architecture.

H.2.1.2 Support Applications

Support applications are common applications that can be standardized across individual or multiple mission areas. The services they provide can be used to develop mission area specific applications or can be made available to the user. Support applications can also manage a complete processing or communications environment. As with the "Mission Area Applications," this part of the system architecture is derived from the application descriptions included in Section 4.2 of the ITI-ALC SSDD.

H.2.1.3 Application Platform

The application platform provides a uniform set of standard services in support of the objectives of application portability and system interoperability. Details of these services are provided in Section 3.4.3 of the ITI-ALC SSDD. These services are divided into the following areas of like functionality:

- Programming Services
- User Interface Services
- Data Management Services
- Data Interchange Services
- Graphics Services
- Network Services
- Communication Services

H.2.1.4 Operating System Services

Operating System Services are the core services needed to operate and administer the application platform and provide an interface between the application software and the platform. Details on these services are provided in Section 3.4.4 of the ITI-ALC SSDD. Application programmers will use operating system services to access the following operating system functions:

- Kernel Operations
- Shell and Utilities
- Security Services
- System Management Services

H.2.2 Technology Issues That Drive Cost

This section of the business case summarizes the most important technical cost drivers of the system and their benefits. To avoid the "technical solution bias," investment in technology has been considered like any other investment. Focus was on quantifying the benefits of the investment beyond simply choosing the lowest cost of any one part of an overall solution (PIP). How the investment will change the process and what it requires in terms of management are the questions which allow for justification of cost savings from investment and also for the management control of such investments. Given this, some of the solutions provided as part of the overall ITI-ALC process improvements or system may have components that are not the lowest cost, but the overall cost of investment as compared to the overall benefit, therefore are justified in an optimized, systematic manner. The issues discussed are:

- Client/Server vs. Peer-to-Peer Architecture

- Mobile vs. Stationary Computing
- Information vs. Data
- Standard System vs. Legacy Systems
- Interactive Electronic Technical Manuals (IETMs) vs. Electronic Technical Manuals (ETMs)
- Object-Oriented Database (OODB) vs. Relational Database (RDB)
- COTS vs. Specialized/Custom Components
- Secure vs. Non-secure System

H.2.2.1 Client/Server vs. Peer-to-Peer Architecture

A client/server architecture is a software partitioning paradigm in which a distributed system is split between one or more server tasks that accept requests, according to a protocol, from distributed client tasks. This architecture has the potential for a finer level of granularity as processing loads increase. It is simpler to upgrade or add only needed components. This technology also allows for segregation of user communities. This helps in isolating the impact of power users on the system. The client/server architecture also makes it easy to construct the server with all the information integrity rules on it. By having applications on the clients and having those clients access information from the server, all applications have access to current information. By distributing computational resource intensive parts of the system to the correct node of the system, this architecture has the potential for large gains in performance. If done correctly the gains can far exceed the overhead costs in performance for managing the client/server communications. This also implies reusability of the server, improving development time for new applications that do not have to have all the integrity rules coded into the application. Lastly, there is tremendous potential for supporting applications developed with parallelism and concurrence in mind.

A peer-to-peer architecture is one that employs communications using layered protocols. Each software or hardware component communicates only with its peers in the same layer via the connection provided by the lower layers. This is usually characterized as simple messages and as isolated processes that contain almost everything needed to perform a given task. Due to the isolation of applications and data, systems built on peer-to-peer architectures can be made very secure, reliable, and available.

To obtain the benefits highlighted in many of the BPIs, the ITI-ALC system must be based on a client/server architecture. The information feedback mechanism included in the planning process enhancement BPI, the BPI dealing with sharing data at all levels of maintenance and the type of coordination needed to implement the Production Responsibility Center are examples of the need for having "consistent access to current information." Furthermore, the potential for performance enhancements will be needed for some of the resource intensive applications highlighted in BPIs dealing with technical information and integrated diagnostics.
The challenge (and cost driver) in this area will be to develop a system using a client/server architecture without sacrificing security or reliability. One caution, many times systems are built

as a hybrid of these two models. The simplest being that within a hardware component the model used is client/server. From hardware-to-hardware components, the peer-to-peer model is used. Although, a hybrid solution may need to be proposed, this solution has all of the disadvantages of the peer-to-peer model and the only advantage it enjoys from the client/server model is during development. It has the large overhead performance cost of client/server within a given hardware component without having the advantage of distributing resource intensive processes. Due to this situation, many compromises would have to be made in functionality to gain acceptable performance. Finally, the cost of individual hardware components is sensitive to performance requirements.

Given this, the cost model included in this business case features a virtually pure client/server architecture with development effort (and cost) being used to solve the problems of security and reliability.

H.2.2.2 Mobile vs. Stationary Computing

Mobile computing uses a wireless network and portable computer device to allow the user to move around while obtaining the benefit of the capabilities of the system. Another configuration of this type of system is one that does not use a wireless network to keep the different components connected at all times but "batches" the data until different parts of the system can be reconnected. Many of the benefits identified for client/server architecture are also viable for mobile computing within the depot maintenance environment. The information feedback mechanism included in the planning process enhancement BPI, the BPI dealing with sharing data at all levels of maintenance and the type of coordination needed to implement the Production Responsibility Center are examples of the need for having "consistent access to current information." Furthermore, the potential for performance enhancements will be needed for some of the resource intensive applications highlighted in BPIs dealing with technical information and integrated diagnostics. Here the concept is to keep the mechanic at the work area with all the information he/she needs and with the ability to obtain all other resources required (i.e., tools, parts, and expert help) to perform the task. During the data collection at the ALCs it was found that from 16% to 30% of the time mechanics spend during a work day is spent on activities other than work on the aircraft. Furthermore, to gain non-intrusive and real-time data collection there must be some way to have the task captured while it is being done. If this is not the case then some of the benefit to the enhancement to planning will not be realized.

The benefits to stationary computing are that this type of computing is much more mature and reliable. Given this, both cost to develop and the risk that the development can be accomplished can be lower than with a mobile system. Furthermore, stationary computing would be much easier to make reliable.

Because of the risk involved with this issue, the cost analysis used in this business case was for a gradual introduction of the capability. PIP B used only stationary components, PIP C used a combination, and PIP D used a complete mobile system with wireless network. Costs and benefits were adjusted accordingly.

H.2.2.3 Information vs. Data

Data is "facts or truths obtained and used as a basis for conclusions." Information is "groupings of data to form a more sophisticated structure that includes context and usually imparts greater knowledge than the sum of its parts." For the ITI-ALC system and the identified BPIs to deliver much of their potential benefits, the system must be able to deliver information to the user, not just data. Because of this assumption, many of the interfaces will need to be more sophisticated than simple message transfers. ITI-ALC may also need to keep vital data from the various interfacing systems in shadow files so it is readily available and can be manipulated without corrupting the source interfacing system. A context translation function will have to be developed so that data from multiple systems can be merged to form information. Heavy use of artificial intelligence and expert systems will be used to give the user only the information that is needed to make a decision.

Some of the technology needed to obtain the type of information/decision support system required to obtain all the benefits described in the BPI, will have high risk associated with it and will be expensive. Given that, the level of sophistication of the information technology was gradually introduced from PIP B to PIP D.

H.2.2.4 Standard System vs. Legacy Systems

Today over 50 legacy systems exist pertaining to the depot maintenance process. Most of these systems were developed and implemented in the days before the open system architecture concept was in wide use. Given this, the costs to interface with them and to obtain meaningful data from them is high. In some cases the feasibility of the interface is very much in question. DoD has been working to standardize and modernize much of it's automated information systems for several years. It has some level of implementation in use for many of the interfacing systems identified as systems that ITI-ALC system will need data from or will have to supply data to when fully implemented. The assumption was that this effort would have been completed by the time an ITI-ALC system was implemented. As a result, ITI-ALC could reap the benefits in cost and risk reduction of the enhanced and modernized systems.

H.2.2.5 IETMs vs. ETMs

According to the CALS organization, existing technical manuals have many problems associated with them. Paper technical manuals are costly to produce and manage. Distributing changes is difficult and they are hard to use and comprehend. Also, they cannot be easily integrated with automated logistic processes. Work accomplished by Armstrong Laboratories and others points to the fact that non-IETM electronic technical manuals share the problem of usability and comprehensibility with their paper origins. Studies done on the F-14 flight control system, the AN/SPA-25D Radar Repeater (Jorgensen, 1994), and IMIS (Thomas, 1995) indicate IETMs will provide the following benefits:

- Faster and more accurate maintenance.
- Better performance with less experienced mechanics.
- Reduced technical manual weight and storage allocation for deployment.

- Decreased distribution of changes to technical manuals.
- Increased maintainer motivation to use technical data.

Class five (Jorgensen, 1994) IETMs will be needed to obtain all the benefits from the BPIs dealing with technical information and integrated diagnostics. Although, because the cost of converting paper technical manuals into IETMs is large and many older weapon systems may not readily make the capital investment soon, the implementation of this technology was gradually introduced from PIP B to PIP D. Furthermore, to ensure that the ITI-ALC system is robust and flexible, it was designed to deal with classes zero though five IETMs.

H.2.2.6 RDB vs. OODB

A relational database is one based on the relational model developed by E.F. Codd. A relational database allows the definition of data structure, storage and retrieval operations, and integrity constraints separate from the data itself. In such a database, the data and relations between them are organized in tables. A table is a collection of records. Each record in a table contains the same fields. Certain fields may be designated as keys, which means that searches for specific values of the field will use indexing to enhance the search. Records in different tables may be linked if they have the same value in one particular field in each table. The benefits of relational technology are the following (Burleson, 1995):

- Declarative data access (SQL)
- Flexibility: New tables can be freely added to a system, joins on the new tables are easily accomplished and the new table is seamlessly incorporated into the old structure.
- Mature technology with support from many tools and products.

An object-oriented database is a Database Management System (DBMS) facility in an object-oriented programming environment. Data is stored as objects and can be interpreted only using the methods specified by it's class. The relationship between similar objects is preserved (inherited) as are references between objects. Theoretically, queries can be faster because joins are often not needed as in a relational database. This is because objects can be retrieved directly without a search by using its object identification (Rudgers Internet On-Line Technical Dictionary, 1995).

Of the two technologies, the RDB technology is much more mature with many more standards and tools to support it. Furthermore, like much of object-oriented (OO) technology, testing of an OODB is many times more difficult than with RDBs. To avoid the "technical solution bias," investment in OODB technology was considered like any other investment and there was no corresponding benefit to match to cost. Given this the underlying assumption for the database of the ITI-ALC system in all of the PIPs is that it is based on a relational database designed using the ITI-ALC "TO-BE" Data Model (SRA, June 1995). This does not mean that object-oriented applications will not be used to fulfill the requirements of the ITI-ALC system.

H.2.2.7 COTS vs. Specialized/Custom Components

For years the government has recognized the cost and performance advantages to using non-development items (especially COTS) instead of custom components for the development of information system (Federal Computer Week, 8 May 1995). Not only are initial cost and risk lowered, but enhancement costs are also decreased. Furthermore, system based on COTS maintain currency and take longer to become obsolete because upgrades to given components can be introduced when available. Because the system is not developed using specialized items, more standardization can be achieved.

The design of the ITI-ALC system and the given environment it must work in allows for the extensive use of COTS items or modified COTS items. Because the design is a distributed, open system and uses specific classes of hardware devices for specific work areas, COTS, modified COTS, and custom built items can all be integrated into a single system. Furthermore, unlike the flight line, the depot environment is less harsh on computer system components (in most areas). The cost of hardware of the ITI-ALC system was derived using a market value analysis technique and the assumption was made that all items would be COTS or modified COTS items.

H.2.2.8 Secure vs. Non-secure System

Making a computer system secure is a very expensive effort and does not provide for any increase in functionality to the specific user. Regardless, the design and cost of the ITI-ALC system includes cost factors that allow for a Class C trusted system per the ISO standard 7498-2, and DoD Goal Security Architecture (DGSA). The cost drivers are based on the conservative view of obtaining the most secure system possible. According to data collected during the ITI-ALC data collection trips, the amount of documentation and information that requires a secure information system is a very small percent of the total amount of information required to perform PDM. Given this, considerations should be made to eliminating security requirements for the ITI-ALC system.

H.3 DATA AND SYSTEM CHANGES

This section includes the data and system changes to support the functional process improvement. DoD directives require a summary of the technical changes to data and information system support that will be required to implement the process improvement proposals described in this document.

The following Section H.3.1 includes a short description of the ITI-ALC system. This description is based on the results from the work accomplished in the ITI-ALC SSS, SSDD, and the System Model. Also included is a description of each PIP that includes ITI-ALC technology.

NOTE: The overview given in the first part of this section is a representation of the full-up ITI-ALC solution; therefore, best describes PIP D. The information in this section is used as part of a Function Point (FP) analysis that is the basis for the system cost analysis featured in Section 4.

Section H.3.2 will summarize the changes that must be made to each of the 15 emerging standard systems envisioned as interfaces to an ITI-ALC system. Details of those external systems are documented in the *ITI-ALC Architecture Report* (SRA, June 1995) and requirements for these interfaces are included in the ITI-ALC SSS (SRA, October 1995).

H.3.1 ITI-ALC System Overview

The ITI-ALC system is a set of hardware, software, and processes that support depot maintenance. The intent of ITI-ALC is to provide timely, efficient access to information needed to support depot maintenance, and to provide this information through an integrated system of hardware and software that augments depot maintenance process improvements.

A key aspect of ITI-ALC is the presentation of technical information and work operations to depot maintenance personnel to support specific tasks. ITI-ALC is comprised of six major integrated hardware components that support the depot maintenance process. These hardware components and purposes of each are:

1. Maintenance Support Device (MSD) – The MSD is designed to support maintenance tasks accomplished by mechanics through presentation of work operations and technical information, and through the recording of completed work operations.
2. Mobile Management Device (MMD) – The MMD is designed to support managers as a tool for displaying status information and allocating resources without restricting managers to a specific location to get status.
3. ITI-ALC Communications Network (ICN) – The ICN is the network that facilitates rapid, reliable, and robust communication among the segments, eliminating the need for local mass storage capabilities on the mobile devices.
4. ITI-ALC Workstation Device (IWD) – The IWD is the primary tool for accessing all ITI-ALC capabilities and will be used by planners, controllers, and stationary mechanics for development and display of maintenance plans, work operations, and technical information.
5. ITI-ALC Server Device (ISD) – The ISD controls the ICN, compiles maintenance status for continuous update of the WSD, and maintains the ITI-ALC database, providing data to the MSD, MMD, and IWD upon request. The ISD also interfaces with external systems through the base Local Area Network (LAN) to provide and obtain information necessary to the depot maintenance process.
6. Work Status Device (WSD) – The WSD is a status board strategically placed throughout the production environment to provide continuous status on the progress of end-items through the maintenance process.

Figure H-1 depicts the ITI-ALC system segments and their connectivity.

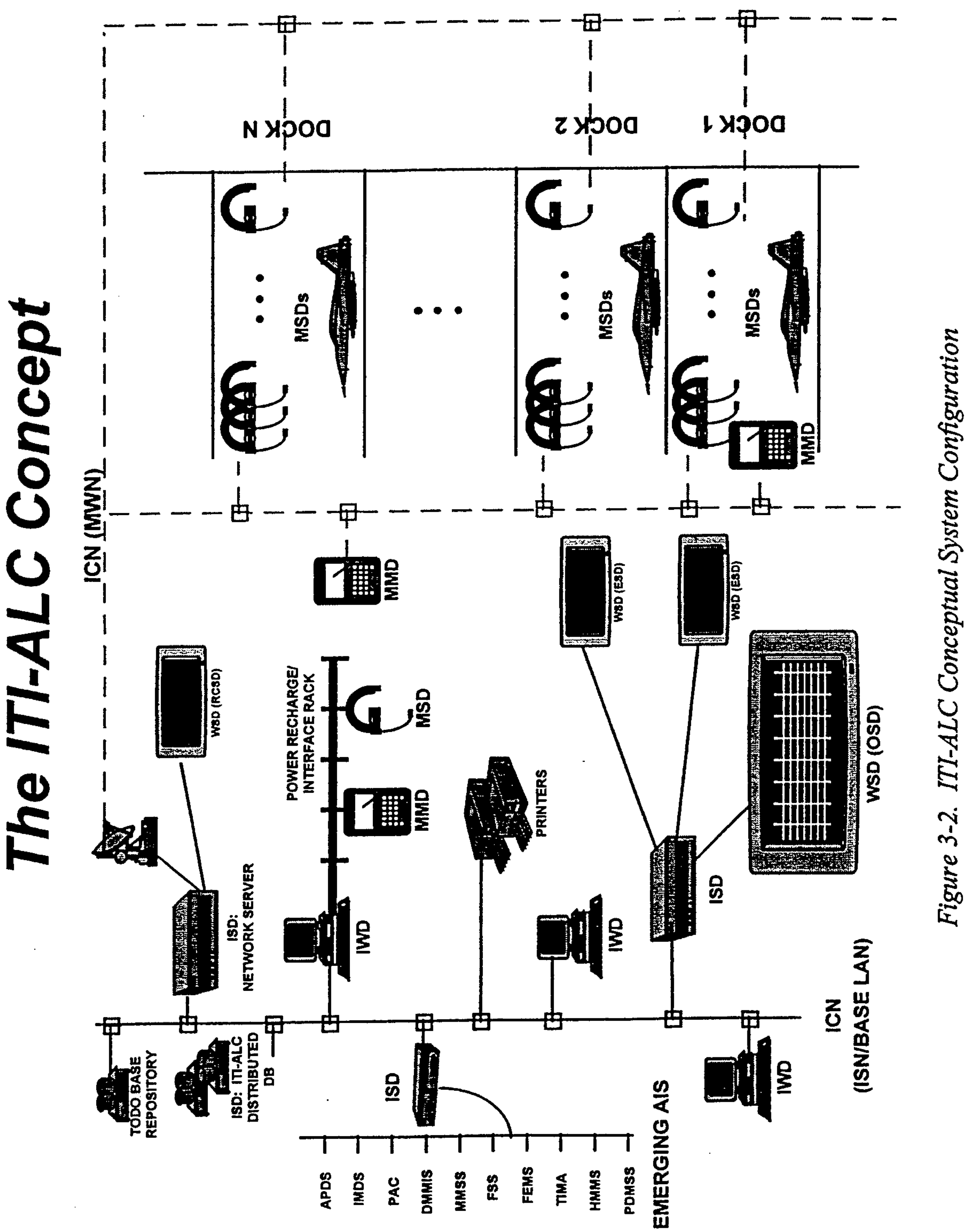

Figure H-1. ITI-ALC Conceptual System Configuration

The system will be comprised of eight major CSCIs. Figure H-2 shows how the system processes are ordered and what components make up a given process. In some instances the figure goes even further showing what subcomponents make up a component. The ITI-ALC SSDD further describes the process, their components and all the requirements for the ITI-ALC system as specified in the ITI-ALC SSS.

ITI-ALC SYSTEM HIERARCHY CHART

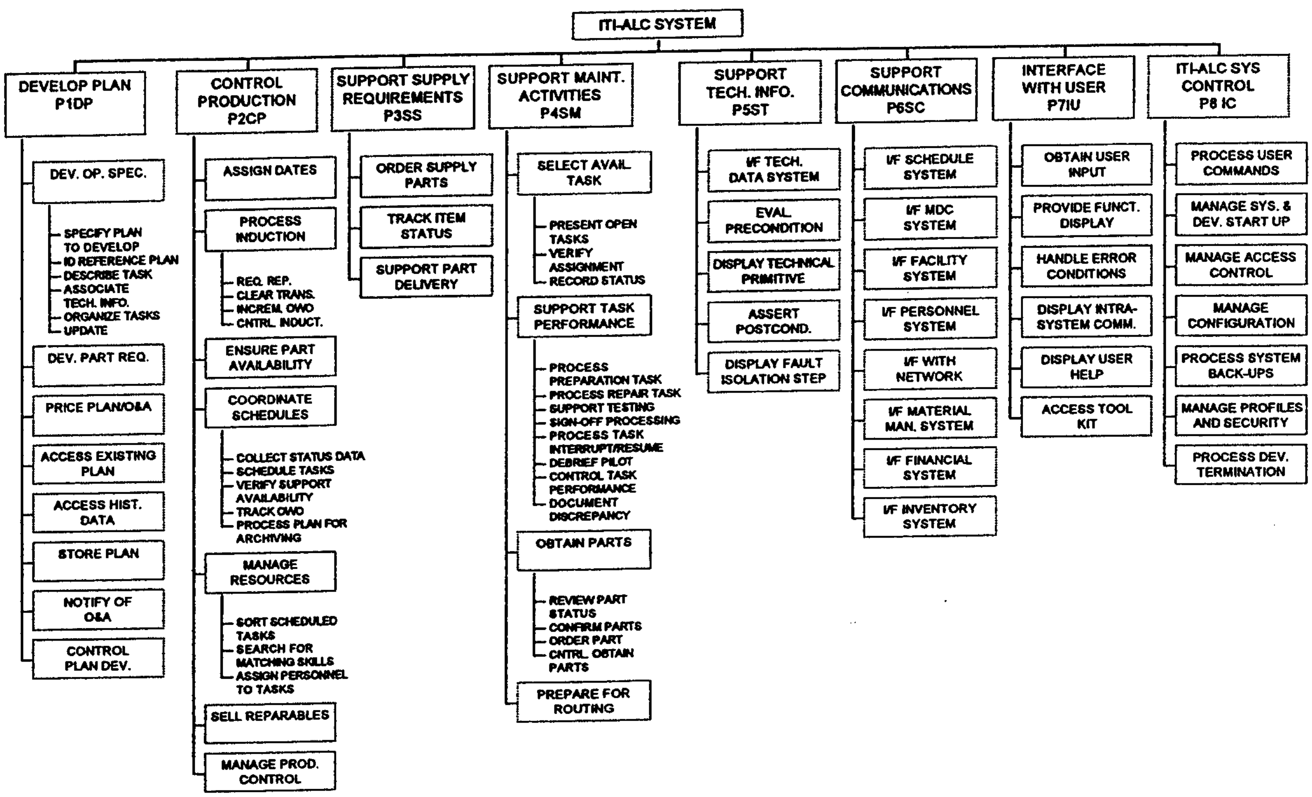

Figure H-2. ITI-ALC System Hierarchy Chart

The ITI-ALC System Control (P8) process controls the system by receiving user commands and enabling other processes based on those commands. It also handles device log-ons. At system start-up, it enables the Interface With User (P7) process to receive user commands and data. It also enables the Support Communications (P6) and Support Supply Requirements (P3) processes to initiate communications with interfacing systems. The Support Tech Info (P5) process is enabled when updates to technical information are received from the technical data system.

The Develop Plan (P1) process is enabled upon ITI-ALC System Control (P8) receiving a user selection to activate the planning mode. This provides the system functionality used mainly by a planner. It interfaces with Support Tech Info (P5) to obtain the technical information used to develop and update plans. It also interacts with the Interface With User (P7) process to obtain user input and to display information.

The Control Production (P2) process is enabled upon ITI-ALC System Control (P8) receiving a user selection to activate the scheduling mode. It provides the functionality used by controllers and managers to regulate the production process. It enables Support Supply Requirements (P3) to handle requests for stock parts, to schedule kits, and to obtain material status. It sends commands to archive work plans to Support Communications (P6), and obtains user input and displays information to the user via Interface With User (P7).

The Support Supply Requirements (P3) process is enabled by Control Production (P2) and Support Maintenance Activities (P4) to request stock parts, schedule kits, or obtain material status. It obtains inventory stock data and supply transactions from the inventory systems (MMSS, HMMS, and APDS). Part requests, part delivery requests, and status updates are sent to the inventory systems (MMSS, HMMS, and APDS) via this process.

The Support Maintenance Activities (P4) process is enabled upon ITI-ALC System Control (P8) receiving a user selection to activate the standard operational mode. It provides the functionality used by mechanics to perform maintenance operations. It enables the Support Supply Requirements (P3) process to handle requests for stock parts and to obtain status on material availability. It also interfaces with Support Tech Info (P5) to obtain the technical information needed to perform work operations. It receives user input and displays data to the user via Interface With User (P7).

The Support Tech Info (P5) process is enabled by Develop Plan (P1) and Support Maintenance Activities (P4) to obtain and display various types of technical information to the user. Furthermore, this process is enabled at start-up by ITI-ALC System Control (P8) to receive any updates to technical information from the technical data system interface.

The Interface With User (P7) process is enabled by ITI-ALC System Control (P8) at start-up to receive user input and by the Develop Plan (P1), Control Production (P2), and Support Maintenance Activities (P4) processes to display data and supply user input.

The Support Communications (P6) process is enabled by ITI-ALC System Control (P8) at start-up to initiate communications with external interfaces. Upon receiving interface directive commands from the Develop Plan (P1), Control Production (P2), or Support Maintenance Activities (P4) processes. It solicits information from the various external systems identified in Section 6.3 and fills internal data stores, or it sends data updates to the external interfaces.

H.3.1.1 ITI-ALC System PIP B

In general, as one moves from PIP B to the ultimate ITI-ALC solution (PIP D), the following basic truisms distinguish one PIP from another by:

- Benefit increases,
- Risk increases,
- Cost increases,

- Implementation time increases, and
- Increased dependence on emerging technologies.

PIP B, the first PIP that includes the ITI-ALC system does more than introduce some of the technologies that will be needed to complete a full implementation of the ITI-ALC BPIs and the ITI-ALC system requirements. It allows for some benefits to be obtained from the BPIs. The interfaces to external systems are very simple and straightforward, and would only be to a limited set of AISs. There is no integration of the data in the different systems, but there is a common user interface. The PDM Planning Function is not integrated into the ITI-ALC system and must depend on a query/response interface. This will mean that there will be no integration of technical manuals with the work operations package. This version of the ITI-ALC system works from ETMs vs. IETMs, which keeps cost and risk down; however, it also does not get the full benefits that have been well documented by the IMIS project (Thomas, 1995). All the hardware components of ITI-ALC are stationary, again keeping both cost and risk down, but sacrificing the benefit of having "real-time" data collection and dissemination. The system hardware would consist of ISD, ICN, and the IWD components.

H.3.1.2 ITI-ALC System PIP C

PIP C is the first step to true data integration at the depot. It would include all of the capabilities of the system represented in PIP B along with many others to gain significant benefits from the more sophisticated technology. Integrated diagnostics and IETMS are included in this version of the system (although the diagnostics are at present day capabilities and will be improved in PIP D). Interfaces with external systems are more sophisticated; therefore, allowing for data from multiple sources to be integrated to form new information. This means that context resolution will have to be performed to ensure the merged information is meaningful. One of the major new interfaces in this version of the ITI-ALC is the link to the organizational level of maintenance. This allows users of the ITI-ALC system and the IMDS (including CAMS and IMIS) system to send and receive pertinent maintenance and configuration data between the two maintenance operations. The Planning Mode interface is more robust, allowing for simple links between the plans created by PDMSS (or other scheduling system) and the technical information needed to perform the work operation. This version still does not provide an integrated workstation to the Planner allowing for the full benefit of IETMs to be utilized during the planning function. For acquiring parts, the interface with MMSS is very simple with basically the ability to order a part included. This sacrifices some of the benefits of many of the BPIs that deal with parts. This version of ITI-ALC does not include an interface with the APDS, the aircraft, SE/T, equipment or parts. A portable, hand-held device is introduced in this version of the ITI-ALC system allowing for technical information to be presented at the worksite. This version of the ITI-ALC system does not include a wireless network nor does it include a "hands-free" component. Benefits would be obtained and increased for all the BPIs except for the BPI dealing with three shifts of effort. Due to the complexity of the PDM process, it is assumed that a fully implemented ITI-ALC system will be needed to coordinate the expanded staff.

H.3.1.3 ITI-ALC System PIP D

This version of the ITI-ALC system represents the ultimate solution. It fulfills all of the requirements specified in the ITI-ALC SSS and allows for the full implementation of all of the BPIs gaining the complete benefit of each and the benefit of the combined set. The overview given at the beginning of this section represents this version of the ITI-ALC system.

H.3.2 Emerging And Planned Standard Systems

One of the major benefits of the ITI-ALC system is to provide access to integrated information needed in the maintenance process. ITI-ALC will need to interface with several "external maintenance systems," users, and support downloading diagnostic data from weapon systems. The ITI-ALC system will:

- Provide a single point of access to information from external systems.
- Present each user with the required information in a format tailored to the user's specific needs.

Users will not have to know how to access these external systems, nor will they need to sort through large amounts of extraneous information. ITI-ALC will access the external systems and manage the extraction of pertinent data. Because of this, some of these system may have to be modified to ensure that the maintenance process is done effectively and efficiently. These modifications will be included in the cost to implement the different PIPs that include ITI-ALC technology and will support the cost analysis included in Section 4 of this business case. The costs are based on best engineering and functional expert judgment, supplemented by information done by other organizations (e.g., JLSC, individual ALC, etc.).

Figure H-3 shows the emerging systems, the weapon system (reparable), the user, parts, and tools that will need to interface with the ITI-ALC system to enable the full potential of the BPIs described in this document and to fulfill all the requirements specified in the ITI-ALC SSS.

An emerging standard system is a planned and approved Automated Information System (AIS) that has been officially designated as the single AIS to support standard processes for a functional activity. Emerging standard systems will be developed in accordance with the DoD technical architecture, *CIM Technical Reference Model*, and DoD-wide standard data definitions. These systems and the proposed modifications follow:

H.3.2.1 Depot Maintenance-Hazardous Material Management System (DM-HMMS)

DM-HMMS provides an on-line system for tracking and managing the use of Hazardous Material (HAZMAT) throughout the depot. Functions of DM-HMSS include:

- Recording receipt and issue of all HAZMAT.
- Providing visibility of HAZMAT and restricting issue to authorized users and units.
- Maintaining inventory of all HAZMAT at the depot.

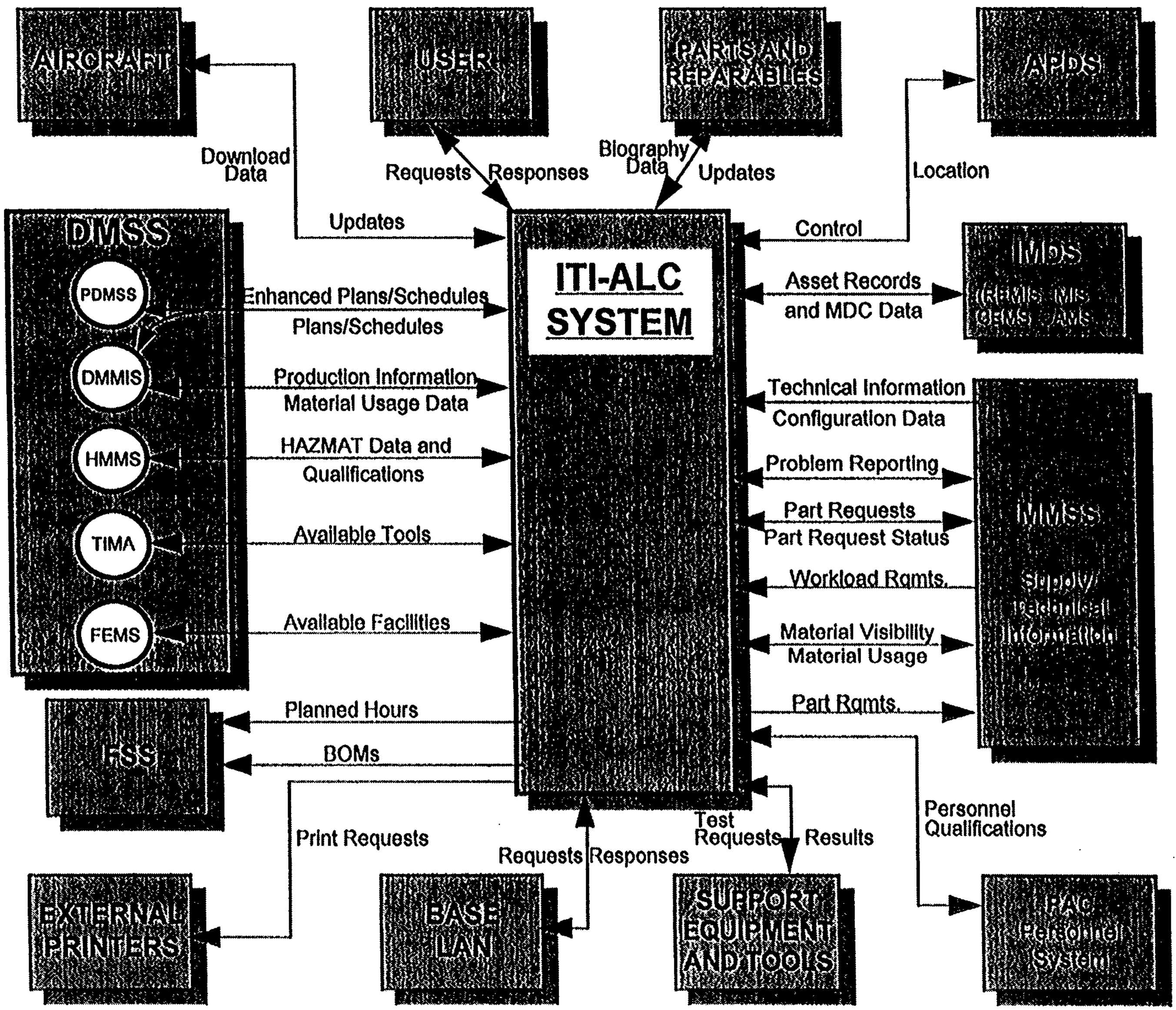

Figure H-3. ITI-ALC External Interfaces

The cost of change for DM-HMMS so that it can interface with the ITI-ALC system is driven by the architecture of the DM-HMMS. Given that it is a component of the DMSS, it has been built using open system concepts, therefore making the interface effort easy and straightforward. This assessment is based on work done as part of the SPARES program (Spare Parts Production & Reproduction). In this program SRA used Open Database Connectivity (ODBC) and the PIXM C-Callable Library (COTS API) to gain connectivity to the DM-HMMS system. The modified library code was used as a pseudo-server on the DM-HMMS host machine to allow a seamless interface. The cost (including product cost, modifications, integration, testing, and installation) is approximately $10,000 FY94 dollars. Documentation costs were included in the cost of documenting the ITI-ALC system development.

H.3.2.2 Integrated Maintenance Data System (IMDS)

The proposed IMDS is to be based on COTS software and is to provide a means to access legacy systems such as CAMS, REMIS, IMIS, CEMS, and/or G081 as a single, logical database. The system will be designed to run on Air Force standard platforms and networks with an open system architecture.

The system will incorporate IMIS technology including interactive electronic technical manuals with smart diagnostics and improved and automated maintenance data collection. The schedule for IMDS begins with conceptual demonstrations during FY95 and proposed deployment in FY96 and beyond.

In deriving the estimate for the cost of change for IMDS so that it can interface with the ITI-ALC system it was assumed that the cost of all communications hardware/software for this connection will be absorbed by the IMDS program except for the ITI-ALC side of the connection which is already included in the development estimate for ITI-ALC. Given this, the cost estimate is again driven by the architecture of IMDS. Based on knowledge gained as part of the IMDS demonstrations, it will be built using open system concepts, therefore making the interface effort easy and straightforward. One difference between this and interfacing with components of the DMSS is that the ITI-ALC system must be able to interface with at least four components of IMDS (IMIS, REMIS, CEMS, and CAMS). The cost (including product cost, modifications, integration, testing, and installation) is approximately $10,000 FY94 dollars for a single component of DMSS so for this interface the cost will be approximately $40,000 (FY94 dollars). Documentation cost for this effort are included in the cost of documenting the ITI-ALC system development. Although the API product may not be the same as on the SPARES program, it is assumed that a similar library can be found for this specific system.

H.3.2.3 Depot Maintenance - Facility Equipment Management System (DM-FEMS)

DM-FEMS provides an on-line system for integrated tracking and control of equipment and facilities. Functions of DM-FEMS include:

- Integrated tracking and control system for equipment and facilities.
- Preventive maintenance and calibration scheduling of precision measurement equipment.

- Reduction of spare parts.
- Reduction of material purchases.
- Reduction of maintenance labor.
- Reduction of calibration labor.
- Reduction of capital equipment acquisition.

The cost of change for DM-FEMS so that it can interface with the ITI-ALC system is driven by the architecture of the DM-FEMS. Given that it is a component of the DMSS, it will be built using open system concepts, therefore making the interface effort easy and straightforward. This assessment is based on work done as part of the SPARES program previously described. The cost (including product cost, modifications, integration, testing, and installation) is approximately $10,000 FY94 dollars. Documentation cost for this effort are included in the cost of documenting the ITI-ALC system development. Although the API product may not be the same as on the SPARES program, it is assumed that a similar library can be found for this specific system.

H.3.2.4 Financial Standard System (FSS)

FSS is an anticipated system that will provide a uniform cost accounting system for organizations working on a reimbursable funds basis. All costs for work performed are identified with direct and indirect job orders and to both end-products and performing organizations. All charges necessary to perform a function are collected and billed to the requesting organization. FSS will compute and report the cost of actual material consumed by depot maintenance in the process of restoring reparable Air Force equipment to serviceable condition.

The cost of change for FSS so that it can interface with the ITI-ALC system is driven by the architecture of the FSS. Given that it is a standard system, it will be built using open system concepts, therefore should make the interface effort easy and straightforward. This assessment is based on work done as part of the JLSC program. Based on working knowledge and interviews done with JLSC staff, the cost to interface with this system should be similar to costs incurred when interfacing with the DM-HMMS (SPARES). The cost (including product cost, modifications, integration, testing, and installation) is approximately $10,000 FY94 dollars. Documentation cost for this effort are included in the cost of documenting the ITI-ALC system development. Although the API product may not be the same as on the SPARES program, it is assumed that a similar library can be found for this specific system.

H.3.2.5 Materiel Management Standard System (MMSS)

The MMSS, when integrated, will provide seamless support of the functionality of the three business areas; Requirements Determination, Asset Management, and Supply and Technical Data Support. This interface will supply the users of ITI-ALC with technical data in the form of IETM information, inventory information, and material information. Some of the most important information this interface will supply will be the technical information based on the JCALS initiative. JCALS is a DoD initiative to develop a system that will procure, catalog, archive, manage, and distribute IETM-compatible, electronic-format, technical manual data. This information will allow the ITI-ALC system to receive, assemble, and present the IETM data that will be essential to the functionality of the ITI-ALC system at the job site, either interactively or off-line.

IETM data will be vital to fault isolation, work operations, and inspection steps that are key tasks in the debriefing, maintenance instruction, diagnostics, and planning capabilities of the ITI-ALC. Furthermore, the supply interface capability will require Illustrated Parts Breakdown (IPB) as a source of parts reference data.

The IETM management capability of the ITI-ALC system will also use the MMSS interface. Controls on the use of data, user profiles, compliance with IETM data and IETM directives, and processing of changes to this form of data are within this part of the technical information management capability of ITI-ALC.

Most of the requirements for an interface between the ITI-ALC and MMSS can be fulfilled with a bulk transfer of IETM data to the ITI-ALC system, including IETM data changes. Feedback, such as that provided with an AFTO Form 22 to the developers of IETM data, will be sent to Depot Engineering through the base network, which is the extent of ITI-ALC involvement.

One MMSS component of special interest to ITI-ALC is the DoD Standard Procurement System (SPS) which, when fully integrated, will provide functionality for the support of contract placement and contract administration activities. This interface will supply ITI-ALC users with the data necessary to monitor and track the availability of parts required for future workloads.

The cost of change for MMSS so that it can interface with the ITI-ALC system is driven by the architecture of the MMSS. Given that it is a standard system, it will be built using open system concepts, therefore making the interface effort easy and straightforward. One difference between this and interfacing with components of the DMSS is that the ITI-ALC system must be able to interface with three components of MMSS. The cost (including product cost, modifications, integration, testing, and installation) is approximately $10,000 FY94 dollars for a single component of DMSS so for this interface the cost will be approximately $30,000 (FY94 dollars). Documentation cost for this effort are included in the cost of documenting the ITI-ALC system development. Although the API product may not be the same as on the SPARES program, it is assumed that a similar library can be found for this specific system.

H.3.2.6 Depot Maintenance - Programmed Depot Maintenance Scheduling System (DM-PDMSS)

DM-PDMSS provides an on-line, flexible, configuration-based project management system enabling projects to be planned, monitored, and controlled. The project management functionality to support major end item repair will be accomplished with this portion of the DMSS. Some parts of DM-PDMSS functionality have already been implemented at several sites as a stand-alone capability.

The DM-PDMSS to ITI-ALC interface is extremely important because good planning is crucial to performing an efficient and effective PDM. ITI-ALC and DM-PDMSS must work closely to form an integrated work environment for planners. This work environment will combine the DM-PDMSS scheduling and control capabilities to the data integration and technical information presentation and handling capabilities of ITI-ALC. Furthermore, the management of reparable and assets plans will be crucial for enabling planners to reuse existing plans and for systematically including lessons learned from previous PDMs.

The cost to obtain this type of functionality is included in the development cost of the ITI-ALC system. No additional cost should be needed.

H.3.2.7 Depot Maintenance - Depot Maintenance Management Information System (DM-DMMIS - G402B)

DM-DMMIS provides on-line production management for D-level reparables including capabilities for production and capacity planning and master scheduling, shop floor control, asset and production status, materiel and production forecasting, time and attendance accounting, and budget and general ledger accounting. Functions of DMMIS include:

- Production management for D-level reparables.
- Production and capacity planning and master scheduling.
- Shop floor production control.
- Current, actual asset, and production status.
- Materiel and production forecasting.
- Labor standards maintenance.
- Time and attendance accounting.
- Job order control, costing, and routing.
- Budget and general ledger accounting.

Due to the proprietary nature of this system, this interface will be less straightforward then other components of the DMSS. For this estimate it was assumed that the effort would be approximately five times more costly than the effort to interface with DM-HMMS or $50,000 FY94 dollars. This assumption was based on information obtained through discussions with individuals at JLSC who are dealing with the modifications of this system.

H.3.2.8 Automated Parts Distribution System (APDS)

APDS is an anticipated system that would be integrated into the repair process to improve materiel handling and management. The system would include an automated storage and retrieval capability and a conveyance system using automated guided vehicles for delivery of items required during the maintenance process. Many ALCs already have some form of this system, but it is not standard across all ALCs.

It is assumed that any costs to give the various APDS instances this type of capability will be absorbed by the owning organization of the APDS. There will be no additional cost associated with changing any of the APDS systems so that they can interface with the ITI-ALC system except for the cost of connecting the APDS to the ITI-ALC wireless network. The estimation of these costs are: $500/vehicle by 20 vehicles per ALC or $10,000 (this is a non-recurring cost). All other costs associated with connections and communications for this interface is included in the development cost of ITI-ALC.

H.3.2.9 Production Acceptance Certification (PAC) System

PAC is used to track training and certification of depot maintenance personnel. Some ALCs use CAMS and others use local systems to track the same information. This information is important to the production control activity of depot maintenance and, therefore, this interface is important to the implementation of the ITI-ALC system.

The cost to obtain this type of functionality is included in the development cost of the ITI-ALC system, no additional cost should be needed.

H.3.2.10 Depot Maintenance - Tool Inventory and Management Application (DM-TIMA)

DM-TIMA provides an on-line capability that standardizes and controls the tool and support equipment management process. Functions of DM-TIMA include:

- Reduction of lost tools.
- Reduction of tool room personnel.
- Better visibility of tool assets resulting in reduction of new requirements.
- Improved control of tools requiring certification.
- Compliance with Foreign Object Damage (FOD) control.
- Tracking and control of nuclear contaminated tools.
- Tracking of warranties.
- Support for tracking of tool histories, repairs, and calibrations.

The cost of change for DM-TIMA so that it can interface with the ITI-ALC system is driven by the architecture of the DM-TIMA. Given that it is a component of the DMSS, it will be built using open system concepts, therefore making the interface effort easy and straightforward. (This assessment is based on work done as part of the SPARES program. The costs should be similar to that effort. The cost [including product cost, modifications, integration, testing, and installation] is approximately $10,000 FY94 dollars. Documentation cost for this effort are included in the cost of documenting the ITI-ALC system development. Although the API product may not be the same as on the SPARES program, it is assumed that a similar library can be found for this specific system.

H.3.2.11 Base Local Area Network

The process of sending feedback, such as that provided with an electronic version of the AFTO Form 22 to the developers of IETM data may be facilitated by the interface with the Base LAN. This data will be sent to the depot engineering function through the Base LAN and will pass beyond ITI-ALCs domain at that point. Furthermore, this network can be used to gain access to other required external systems (for example, DM-FEMS and DM-TIMA) that may also be connected to the base LAN.

There will be no cost associated with changing the base network so that the ITI-ALC system can be connected. All costs associated with the connections and communications for this interface are included in the development cost of the ITI-ALC.

H.3.2.12 Support Equipment/Tools (SE/T)

The ITI-ALC system may interface with future SE/T systems in much the same manner as it will interface with future weapon systems. To the extent feasible, this interface will support the exchange of SE/T data such as status and configuration. Furthermore, this interface would be used to obtain Non-Destructive Inspection (NDI) data from "smart" NDI equipment. However, a direct interface capability requires that the SE/T have processing capability, storage capability, and an interface for the ITI-ALC system to obtain the data. If the SE/T includes the capabilities and interfaces, ITI-ALC will perform the following functions:

- Interrogate Built-In Test (BIT) at the SE/T to help users troubleshoot defective units.
- Query individual pieces of SE/T to obtain current configuration and health.
- Obtain data from the equipment that will help in the depot maintenance process.

ITI-ALC will also supply data that can improve the performance of off-equipment testing. ITI-ALC will display relevant in-flight and historical data from ITI-ALC's internal database and other external systems to assist in fault analysis. If feasible (depending on the type of automated test equipment), data from automatic tests may be either manually or automatically input into the ITI-ALC system.

The physical interface with SE/T systems depends on the capabilities of the SE/T. Hardware front end communications modules and software modules could be developed and added to ITI-ALC on a case-by-case basis depending on current and future developments in SE/T systems. Also, existing hardware and software modules already being used or those being planned could be incorporated into the ITI-ALC system. The capability to interface with SE/T system may not be required in the future because many of the new SE/T systems will include their own diagnostics and technical information presentation capabilities.

It is assumed that any costs to give SE/T these types of capabilities will be absorbed by the developing organization of the SE/T. There will be no additional cost associated with changing any of the SE/T so that they can interface with the ITI-ALC system. All costs associated with connections and communications for this interface are included in the development cost of the ITI-ALC.

H.3.2.13 Parts and Reparables

Currently in depot maintenance, materiel, paperwork for the materiel and computer data for the materiel move in parallel. If this process breaks down at any point, then the need to recapture data that has already been identified occurs, and errors can be introduced in that data. The cost in staff-hours, delays and missing resources is very high. A solution to this problem may be to have the biographies of parts and reparables travel with the given item. The range of biography data would include NSN, data of manufacture, serial number, transportation data, accounting data, controlled item codes, in-use logs, quality information, HAZMAT information, repair history and disposal requirements. The on-board data method may be as sophisticated as a smart card or as simplistic as bar code labels. In either case, ITI-ALC should interface with the item to gain access to the biography data and to update it if the method used to store the biography data allows for updates.

The interface method may be a simple port to allow for a bar code reader wand (along with software to interpret the data), or it could be a magnetic strip reader/inscriber if the smart card concept is used. The following requirements do not pertain to the aircraft interface that is specified in Section H.3.2.14. They do however pertain to any other reparable that may include on-board biography data.

It is assumed that any costs to give parts and reparables this type of capability will be absorbed by the managing organization of these items. There will be no additional cost associated with changing any of these items so that they can interface with the ITI-ALC system. All costs associated with connections and communications for this interface are included in the development cost of the ITI-ALC.

H.3.2.14 Aircraft Interface

The ITI-ALC system will interface to the weapon system being maintained. This interface supports the user of ITI-ALC in production control, debriefing, and general maintenance. This interface allows an ITI-ALC user to:

- Analyze in-flight recorded parameter and failure data.
- Analyze on-board historical data.
- Upload and download aircraft software.
- Initiate and interpret on-aircraft tests.
- Upload configuration data.

- Download maintenance data.
- Use crypto keying.

It is assumed that any costs to give aircraft this type of capability will be absorbed by the developing organization of the aircraft. There will be no additional cost associated with changing any of the aircraft so that they can interface with the ITI-ALC system. All costs associated with connections and communications for this interface are included in the development cost of the ITI-ALC.

H.3.2.15 External Printing Interface

The ITI-ALC system will use existing printing devices within the depot environment. ITI-ALC allows the user to print from existing print devices through the connection to the base LAN or directly if the printer device is connected to a component of ITI-ALC. This supports performing daily maintenance activities as well as providing hard-copy backup to many of the on-line functions of ITI-ALC. The speed and other characteristics of this interface are dictated by the external printer devices and are not levied on the ITI-ALC system except in the area of this interface. The set of external printing devices to be accommodated by this interface includes standard printers, plotters, and part-labeling devices.

There will be no cost associated with changing any of the external printers so that they can be used by the ITI-ALC system. All costs associated with the print drivers, connections and communications are included in the development cost of the ITI-ALC.

Appendix I

ITI-ALC Software Estimates

I.1 OVERVIEW

This appendix includes a brief description of the method used to generate the software costs for the development of an ITI-ALC system. A quick overview of the function point methodology and the Checkpoint® analysis tool are provided. Also included in this appendix are the assumptions that were made for generating the cost estimates and the background data needed to derive the ITI-ALC cost estimate.

I.2 FUNCTION POINT ANALYSIS

Function points were invented by A.J. Albrecht of IBM in the middle 1970s, and enhanced during the 1980s and 1990s as an alternative to using software lines of codes as an estimating method. Since that time, the technique has been accepted as a valued and reasonable alternative for estimating the effort associated with various components of information systems.

A function point is a synthetic metric comprised of the weighted totals of the inputs, outputs, inquiries, logical files or user data groups, and interfaces belonging to an application (Caper Jones Software Productivity Research, Inc., 1991). Once an application's function point total is known, the metric can be used for a variety of useful economic purposes including studies of the following:

- Software production/cost estimate
- Software consumption
- Software quality

For the ITI-ALC project, function point analyses are used to study software production and cost estimation. The function point count is done using the ITI-ALC System Model as the basis for the analyses. This count gives the relative size of an Automated Information System (AIS) that will support the requirements as identified by the ITI-ALC "TO-BE" Functional Model and "TO-BE" Data Model (as documented in the ITI-ALC SSS), and as depicted in the software design documented in the ITI-ALC System Model. The size metric for software is an important input for the CheckPoint Analysis tool.

The size metric measures an application based on two areas of evaluation. The first area results in the unadjusted function point count and reflects the specific countable functionality provided to the user by application. The second area of evaluation, which produces the Value Adjustment Factor (VAF), evaluates in general the high-level characteristics of the application.

To derive the unadjusted function point count, user functionality is evaluated in terms of what is delivered by the application, not how it is delivered. Only user-requested and visible aspects of the system are counted. The metric defined from the function point count is comprised of the weighted totals of the following:

- Inputs. Screens or forms through which the user of an application adds new or updates existing system data. This is not every input into the system, but all functional inputs into the system. For the ITI-ALC project, this metric corresponds to the input data flows shown in the ITI-ALC System Model diagram (see Figures I-1, I-2, and I-3).

- Outputs. Screens or reports the application produces for the user or for other systems. As with "Inputs," these are counted only at the functional level and correspond to the output data flows shown in the ITI-ALC System Model diagram.

- Inquiries. A specific type of input/output combination that allows the user to interrogate an application (such as a help request). For the ITI-ALC project, this metric corresponds to the input and output data flows shown in the ITI-ALC System Model diagram.

- Logical Files. Collections of records the application modifies or updates. This metric corresponds to the data stores shown in the ITI-ALC System Model diagram.

- Interfaces. Interfaces are files, databases, and systems that share data with ITI-ALC. This metric corresponds to all the terminals shown in the ITI-ALC System Model diagram.

The weighting of the counts of the five metrics indicated above allow for a more robust estimate of the size of an application. Weighting is calculated by adding a complexity factor to each of the metrics. This complexity factor indicates whether the metric is low, medium, or high in complexity based on the objective indicators identified in A. J. Albrecht's (1984) revision of the function point technique.

These 14 general system characteristics are used to calculate the Value Adjustment Factor (VAF) and are evaluated on a scale of 0 to 5, with 0 used to eliminate factors not present in the application:

1. Data Communications
2. Distributed Functions
3. Performance Objectives
4. Heavily Used Configuration
5. Transaction Rate
6. On-line Data Entry
7. User Efficiency
8. On-line Updates
9. Complex Processing
10. Reusability
11. Installation Ease
12. Operational Ease
13. Multiple Sites
14. Change Facilitation

In considering the value of the 14 characteristics, the general guidelines are to give a score of 0 if the factor has no impact on the application, a score of 5 if the factor has a strong and pervasive impact, and a score of 2, 3, and 4 or some intervening decimal value such as 2.5 if the impact is something between these two extremes. Although subjective in nature, the guidelines for assigning scores to these characteristics are well-documented, allowing for controlled or normalized subjectivity (Caper Jones Software Productivity Research, Inc., 1991).

I.3 CHECKPOINT ANALYSIS TOOL

CheckPoint is an analysis and estimating tool produced by Caper Jones Software Productivity Research, Inc., and is widely accepted as a standard for applying the function point technique to information system estimating and measurement. CheckPoint uses a description of a software project to estimate cost, quality, schedule, and other aspects of a project. The project description includes project classification, project magnitude, project development process, and project profile. This information is then parametrically matched to projects or partial projects within the CheckPoint database of over 5000 completed military and commercial applications.

The Project Classification description is defined as the nature, scope, class, and type of project. The nature parameter identifies the four major flavors of software projects that are common throughout industry and tend to have different cost and productivity profiles: new, enhancement, maintenance, and conversion. The scope parameter describes the software by covering the range of possibilities from disposable prototypes through major system/release. CheckPoint recognizes eight different scope categories. In general, the class parameter is associated with the business aspects of the software project and influences the rigor and cost of project paperwork and the overall quality of the given software. The class parameter includes 15 different software classes. The type parameter is significant in determining the difficulty and complexity of the code itself by grouping programs into 14 high-level types from nonprocedural (SQL query, spreadsheets, and the like) to artificial intelligence (including hybrid systems).

The Project Magnitude description indicates the complexity, size, and programming language level of a software project. The complexity metric is equivalent to an estimate of cyclomatic complexity for the given applications as defined by DeMarco (1982). This metric is estimated by determining the complexity of the problem being addressed, the complexity of the code algorithms, and the complexity of the data for the system. DeMarco indicates that a system with a complexity of 10 or greater should be redesigned into smaller, less complex components. The size of a project is measured in function points, and the programming language level is a combination of up to 50 programming languages recognized by CheckPoint including some composite generic language categories. These 50 programming languages account for 95% of all software that has ever been written.

The Project Development Process description identifies the tasks and documentation that will be performed or developed on a software project. The process used will greatly affect the cost and schedule of the project as well as the quality of the application. CheckPoint recognizes over 108 individual tasks that can be combined to cover any of the different software development standards used in the industry.

The Project Profile description parametrically indicates the experience and the quality of the software organization used to develop the application. The four major categories are personnel, technology, process, and environment. The Project Profile can be roughly equated to the Software Engineering Institute (SEI) and Capability Maturity Model (CMM) maturity levels.

I.4 PROJECT DESCRIPTION

The following is a summary of the checkpoint project description to build a production-level ITI-ALC system. This description was used for all the PIPs that incorporate ITI-ALC technology (PIPs B, C, and D).

Baseline Estimation System Project Description

Project Classification

Nature: New Program Development

Scope: Major System

Class: External - Government Contract

Type: Hybrid - 70% Interactive Database Application, 30% Scientific/Mathematical

Project Magnitude

Complexity: 9

Size: Based on function point counts

Reuse: 25%

Programming Language Level: 4.5 (Ada Language)

Project Development Process

The development process used in the estimate was MIL-STD-2167A.

Project Profile

The project profile used in the estimate was equivalent to SEI level 3.

I.5 ITI-ALC SOFTWARE COST ESTIMATE

The remainder of this appendix contains the data used for, and the resulting CheckPoint estimate of, software schedule, effort, and costs for PIPs B, C, and D. The following information is included for each PIP estimate:

- A function point count summary.
- A System Model diagram indicating the scope of the system for that particular PIP.
- Function point count worksheets used in the estimate.
- A report detailing the estimate calculated by Checkpoint.

PIP B

Software Estimating Data

FUNCTION POINT ANALYSIS SUMMARY FOR PIP B

Project: 1370001	**Phase:** Req	**Project Name:**	ITI-ALC
Application ID:		**Application:**	ITI-ALC PIP B
Counter:	Ron Kelly	**Expert:**	Connie Hoyland

Notes: Based on the ITI-ALC SM, 15 Feb 96 and the ITI-ALC SSS, 31 Oct 95
The count pertains to a system that would support PIP B

FP COUNT

Type ID	TYPE	LOW	MID	HIGH	TOTAL
EI	Input	111	144	24	279
EQ	Inquiry	99	60	0	159
EO	Output	476	150	0	626
ILF	Files	49	50	15	114
EFI	Interface	30	21	0	51

Total Unadjusted Function Points: 1229

GSC

ID	LABEL	RATING		ID	LABEL	RATING
C1	Data Communication	3		C8	On-Line Update	5
C2	Distributed Func.	2		C9	Complex Process	2
C3	Performance	5		C10	Reusability	3
C4	Heavily Used	2		C11	Installation Ease	5
C5	Trans. Rate	3		C12	Operational Ease	4
C6	On-Line Data Entry	5		C13	Multiple Sites	5
C7	End-User Efficiency	5		C14	Facilitate Change	2

Total Rating: 51

Value Adjust. Factor = Total Rating X .01 +.65: 1.16

Unadjusted Function Points X Value Adjustment Factor X Growth Factor =

TOTAL FUNCTION POINTS: 1782

Growth Factor:

Requirements Definition:	**1.25**
After LLD:	**1.10**
End Of Project:	**1.00**

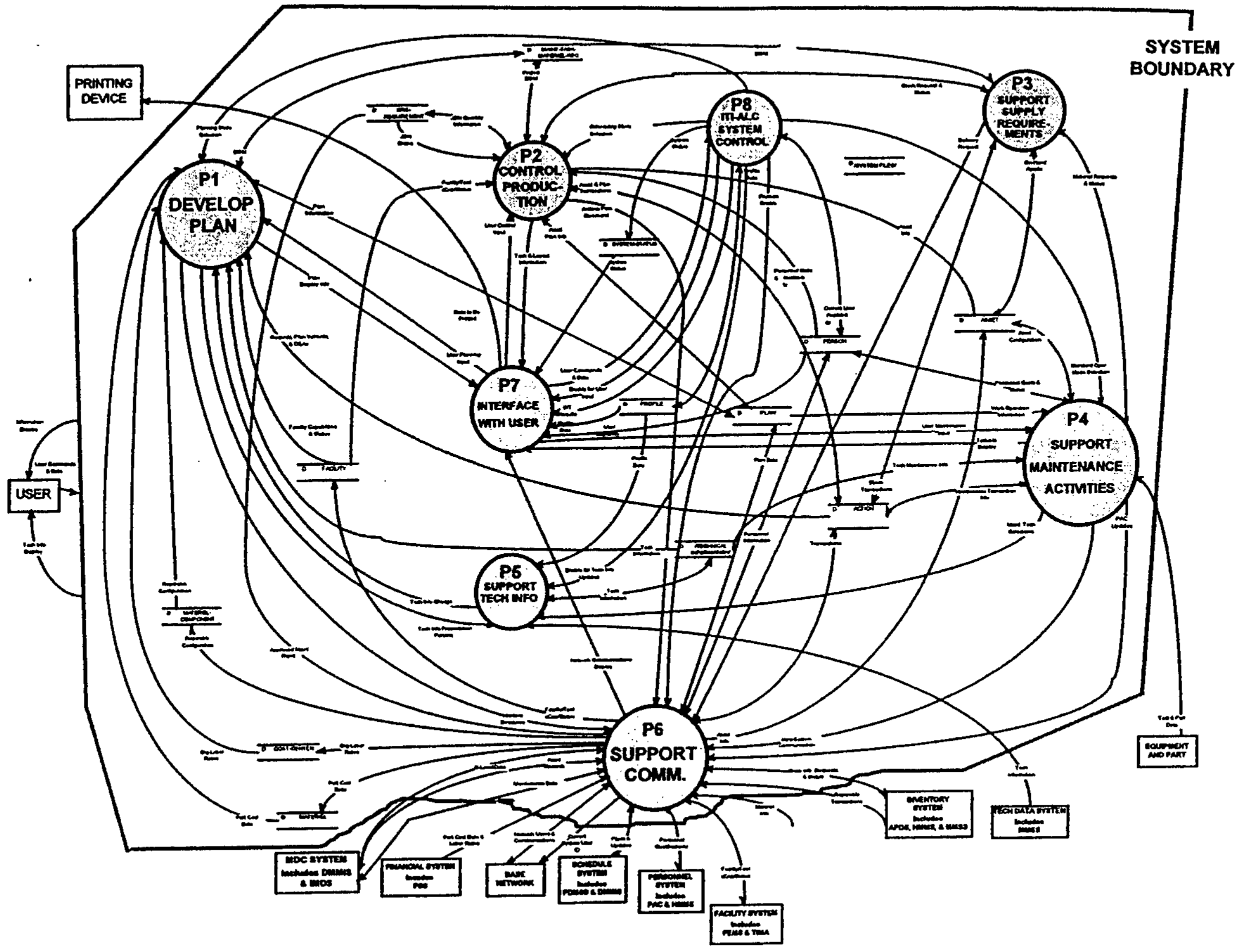

Figure I-1. ITI-ALC System Function Point Scope for PIP B

PIP B incorporates only some of the technologies of a fully developed ITI-ALC system. However, PIP B does provide benefits from some of the BPIs (refer to Appendix C for a description of BPIs and their relationship to PIPs).

PIP B consists of the following:

- Simple and straightforward interfaces to external systems. Interfaces are to a limited set of external systems.
- Data is not integrated between ITI-ALC and the external systems, but there is a common user interface.
- Technical manuals are not integrated with work operation packages.
- The PDM planning function is not integrated into the ITI-ALC system and must depend on a query/response interface.

- The ITI-ALC system will use ETM, not IETM data, which keeps cost and risk down, but also does not provide the all the benefits that have been well documented by the IMIS project (Thomas, 1995).
- All ITI-ALC hardware components are stationary, again keeping both cost and risk down, but sacrificing the benefit of having real-time data collection and dissemination. The system hardware would consist of the ITI-ALC Server Device (ISD), ITI-ALC Communications Network (ICN), and the ITI-ALC Workstation Device (IWD).

ITI-ALC PIP B FUNCTION POINT COUNT WORKSHEET

#	LABEL	FUNCTION POINT COUNT														
		INPUT			INQUIRY			OUTPUT			FILES			I/F		
		L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
1	MDC SYSTEM													1		
2	DMMIS															
3	BASE NETWORK													1		
4	SCHEDULE SYSTEM													1		
5	PDMSS															
6	DMMIS															
7	PERSONNEL SYSTEM													1		
8	PAC															
9	HMMS															
10	FACILITY SYSTEM													1		
11	FEMS															
12	TIMA															
13	MAT. MANAGEMENT SYSTEM														1	
14	MMSS															
15	INVENTORY SYSTEM														1	
16	MMSS															
17	HMMS															
18	TECH DATA SYSTEM (MMSS)														1	
19	PRINTER DEVICE													1		
20	ACTION											1				
21	PROFILE											1				
22	SYSTEM-STATUS											1				
23	SYSTEM FILES															
24	BACK-UP CRITERION										1					
25	CALENDAR & SHIFT DATA										1					
26	CONFIGURATION												1			
27	ERROR										1					
28	ERROR-LOG										1					
29	SECURITY											1				
30	COMMUNICATION FILE											1				
31	TECHNICAL INFORMATION															
32	TECHNICAL-TASK										1					
33	TECHNICAL-PRIMITIVE										1					
34	TECHNICAL-TASK-COMPONENT										1					
35	Current System User ID	1				1			1							
36	Data to Be Printed					1			1							
37	Facility/Tools Cap/Status				4			2								
38	Maintenance Data															
39	Raw Maintenance Data					1			2							
40	Materiel Info		1					1								
41	Network Users & Communications		1	1				6								
42	Tech Information															
43	Postcondition Expression		2					1								
44	Precondition Expression		2					1								
45	System State		2					1								
46	System State Update		2					1								
47	Tech Primitive Data		2					1								

ITI-ALC PIP B FUNCTION POINT COUNT WORKSHEET

#	LABEL	FUNCTION POINT COUNT														
		INPUT			INQUIRY			OUTPUT			FILES			I/F		
		L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
48	Tech Task Info		2					1								
49	Personnel Qualifications				1			1								
50	Plans & Updates															
51	Plan Updates and Requests															
52	Plan Update Notification	2	1						3							
53	Reparable Transactions	2						3								
54	Stock Info, Requests, & Status															
55	Requisitions & Delivery Request							1								
56	Stock Item Information	2			1											
57	User Commands & Data															
58	Back-up Data	1	1													
59	Configuration Data	1	1													
60	Profile & Security Data	1	1													
61	Other System Commands	1	2			3										
62	User Control Input															
63	Induction Inputs															
64	JON & Item Received	2														
65	JON/Quantity Selection	2														
66	Part Scheduling Input	2														
67	Sell Selections	1	1													
68	User Maintenance Input															
69	Part Selection Info															
70	Confirmation/Rejection	1														
71	Part Selection	1														
72	User Routing Choices & Inputs	1	1													
73	User Task Data															
74	Discrepancy Info															
75	Discrepancy Description	2														
76	O & A Description Info	2														
77	Work Oper. Selection/Rejection	2														
78	Pilot Debrief Info		2													
79	Prep Input															
80	Configuration Input	1	1													
81	Step Completion	1														
82	Sign-off Input															
83	Certifier Selection	1														
84	Sign-off Verification	1														
85	Task Performance Input															
86	Diagnostic Results	1	1													
87	Fault Detected	1	1													
88	Step Completion	1														
89	Task Input	1														
90	Test Input		1	1												
91	Functional Context	1														
92	Help Request				2											
93	Profile Data															
94	Profile Information		2													

ITI-ALC PIP B FUNCTION POINT COUNT WORKSHEET

#	LABEL	FUNCTION POINT COUNT														
		INPUT			INQUIRY			OUTPUT			FILES			I/F		
		L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
95	Project & User Access Info		2													
96	Project & Profile Information		2													
97	Routed Reparable Selection		1	1												
98	Certification Candidates		1	1												
99	Tool Selection	1														
100	Tech Info Display															
101	Tech Info Presentation Params															
102	IPB Presentation Parameters							2								
103	Tech Info ID							1								
104	Tech Info Selection															
105	Fault Isolation Step to Display							2								
106	IPB to Display							2								
107	Tech Primitive Data							1								
108	Tech Primitive Precondition							1								
109	Tech Primitives to Display							2								
110	Tech Task Info							1								
111	Tech Info Change							2								
112	Fault Isolation Step to Display							1								
113	Fault Isolation Task Info							2								
114	Postcondition Expression							1								
115	Postcondition Required							1								
116	Precondition Expression							1								
117	Information Display															
118	Error Display							2	1							
119	Help Display							2	1							
120	Intra-System Comm. Display					2		2	1							
121	Tool Display					2		2	1							
122	Error Condition							2	1							
123	Error Data							2								
124	Error Display					2		2								
125	Error Occurrence Data							2								
126	Network Communications Display					2		2	1							
127	Plan Display Info															
128	O&A Notification to Display				1			2								
129	Operation Cost Report							2								
130	Plan Storage Display Params							2								
131	Plan for Display															
132	Plan Spec. for Display				1			2								
133	Reference Plan Info to Display				1			2								
134	Task Desc. Info for Display				1			2								
135	Task Organization Display				1			2								
136	Tech Info Change Notification				1			2								
137	Task/Part Pres. Params							1								
138	System Status				1			2	1							
139	Task & Layout Information															
140	Asset Plan to Display															
141	Plan & Status to Display				1			2								

ITI-ALC PIP B FUNCTION POINT COUNT WORKSHEET

#	LABEL	FUNCTION POINT COUNT: INPUT			INQUIRY			OUTPUT			FILES			I/F		
		L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
142	Resource Info for Display				1			2								
143	Task Priority Data for Display				1			2								
144	Induction Info to Display															
145	JON List/Data for Display				1			2	1							
146	OWO For Display				1			2	1							
147	JON Info For Display					1		2	1							
148	Part Display Parameters							2	1							
149	Task & Skill Info to Display				1			2	1							
150	Tasks to Display															
151	Part Routing Display				1			3								
152	Parts Data for Display															
153	Part Status for Display				1			3								
154	Task Displays															
155	Certification Info for Display				1			2	1							
156	Debrief Display				1			2	2							
157	Discrepancy Display															
158	O & A Documentation Screen				1			2	1							
159	Work Operation List for Display				1			2	1							
160	Prep Displays															
161	Asset Record Displays				1			2	1							
162	Task Step Display				1			2	1							
163	Task Step Display				1			2	1							
164	Task List to Display				1			2	1							
165	Tool Display				1			2	1							
166	User Capability				1			2	1							
		INPUT			INQUIRY			OUTPUT			FILES			I/F		
		L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
	UN-WEIGHTED FUNCTION POINT GRAND TOTALS:	37	36	4	33	15	0	119	30	0	7	5	1	6	3	0

Security level	ITI-ALC SYSTEM
Project	C:\CHECK\USR\RONK\ITI-ALC
Version label	PIP B Intro System (FPs:1782)
L ation	DAYTON

CHECKPOINT(R) 2.1.9 REPORT(S)

PIP B ESTIMATE

Security level	ITI-ALC SYSTEM	7/31/95 12:15:53pm
Project	C:\CHECK\USR\RONK\ITI-ALC	
Version label	PIP B Intro System (FPs:1782)	
Location	DAYTON	

TOTALS

Project Profile

CLASSIFICATION

Nature	1]	New program development
Scope	7]	Major system
Class	14]	Ext: Government contract
Type	5]	*Interactive dbase applic
Goals	4]	Hi quality/normal staff

DEVELOPMENT

Schedule Months	53.7■
Person Months	1,395.1■
Delivered KLOC	164.8■
Document pages	15,724■

ATTRIBUTES

Personnel	3.00
Technology	3.00
Process	3.00
Environment	3.00
Assessment Index	3.00
SPR Level	3.00
Risk	3.00
Value	3.00

QUALITY

Removal efficiency	85.1■%

PRODUCTIVITY

KLOC / person Month	0.12■

Security level	ITI-ALC SYSTEM	7/31/95 12:15:5
Project	C:\CHECK\USR\RONK\ITI-ALC	
Version label	PIP B Intro System (FPs:1782)	
L ıtion	DAYTON	

Quality

	Defects
Defect potentials	6,007■
- Defects removed	5,383■
+ Bad fixes	269■
Delivered defects	893■
Potential defects per KLOC	36.45■
Delivered defects per KLOC	5.42■
Cumulative removal efficiency	85.13■%
Removal cost per KLOC	11,895.79■
Removal effort per KLOC	447.81■

Reliability

	Time
Months to stabilization	8.0■
Mean CPU hours till failure	
At delivery	5.0■
At stabilization	86.0■

Size

Code Class	F.P.	KLOC	Source Lines per F.P.
New	1,337	134.7■	100.7■
Reused	446	30.1■	67.6■
Prototyped	80■	8.1■	100.7■
Base	0	0.0	0.0
Changed	0	0.0	0.0
Deleted	0	0.0	0.0
Delivered	1,783	164.8■	92.4■
Project	1,783	164.8■	92.4■

Security level	ITI-ALC SYSTEM	7/31/95 12:15:53pm
Project	C:\CHECK\USR\RONK\ITI-ALC	
Version label	PIP B Intro System (FPs:1782)	
Location	DAYTON	

Productivity

	Ratios
KLOC per person	2.09■
KLOC per person Month	0.12■
KLOC per calendar Month	3.07■
Development cost per KLOC	35.74■
User cost per KLOC	0.42■
Maintenance cost per KLOC	13.16■
Total cost per KLOC	36.15■

Security level	ITI-ALC SYSTEM	7/31/95 12:15:53
Project	C:\CHECK\USR\RONK\ITI-ALC	
Version label	PIP B Intro System (FPs:1782)	
L ation	DAYTON	

TASK ANALYSIS

Schedule/Effort/Cost

Task	Begin Date	Schedule Months	Effort Months	Staffing Headcount	Cos Thous
Development plan	12/23/94	4.2■	3.9■	1.0■	1
Review/inspection plan	1/27/95	2.1■	3.9■	2.0■	1
Test plan	10/04/96	4.6■	4.2■	1.0■	1
Quality assurance plan	2/14/95	1.9■	1.7■	1.0■	
Maint/cust support pln	12/04/98	1.1■	1.0■	1.0■	
Training plans	1/05/99	1.6■	1.5■	1.0■	
Personnel management	11/01/94	53.7■	69.0■	3.0■	29
Progress reports	4/30/95	47.8■	5.6■	3.0■	2
Project cost estimates	11/11/94	53.4■	1.8■	3.0■	
Capital expend reqsts	2/14/95	50.2■	3.0■	3.0■	1
Project audit	1/12/99	0.4■	0.4■	1.0■	
Rvw/inspec status rpts	2/13/95	39.0■	3.4■	3.0■	1
Test status reports	5/15/98	10.4■	0.7■	1.0■	
Quality assurance rvw	2/22/99	0.8■	3.9■	4.0■	1
Configuration control	6/01/95	45.8■	14.3■	1.0■	6
.TAD requirements spec	11/01/94	3.5■	34.0■	9.0■	12
quirements review	1/19/95	0.9■	3.9■	9.0■	1
Prototyping	12/23/94	1.6■	3.0■	2.0■	1
Purchase applic acquis	11/01/94	1.3■	3.6■	3.0■	1
Initl functional spec	1/19/95	8.8■	96.6■	12.0■	36
Final functional spec	10/13/95	4.7■	60.6■	14.0■	24
Initl funct design rvw	6/01/95	4.4■	4.8■	19.0■	1
Final funct design rvw	1/28/96	1.2■	5.1■	22.0■	2
Data design spec	11/17/95	6.8■	43.8■	7.0■	17
Program logic spec	2/28/96	7.8■	64.7■	9.0■	25
Detailed module design	7/20/96	6.3■	28.8■	5.0■	11
Data struct design rvw	4/20/96	1.7■	2.3■	12.0■	
Logic design review	8/24/96	2.0■	2.6■	15.0■	1
Module design review	12/10/96	1.6■	2.3■	8.0■	
Coding	10/04/96	19.3■	332.3■	20.0■	1,43
Reusable code acquis	12/31/96	0.9■	0.8■	1.0■	
Unit testing	2/28/97	14.5■	17.3■	20.0■	7
Code inspections	7/25/97	9.7■	76.2■	39.0■	33
New function testing	12/19/97	4.8■	57.8■	16.0■	26
Regression testing	4/15/98	1.5■	36.7■	28.0■	16
Integration	2/28/97	15.0■	13.6■	1.0■	5
Integration testing	5/15/98	4.4■	60.3■	16.0■	27
Stress/perform testing	8/23/98	4.5■	42.9■	11.0■	19
System testing	12/04/98	2.6■	59.5■	27.0■	28
Acceptance testing	2/20/99	1.2■	4.7■	11.0■	2
Introduction	1/27/97	4.2■	3.8■	1.0■	1
stallation guide	8/23/98	1.3■	1.1■	1.0■	
..er's guide	7/25/97	5.7■	36.7■	7.0■	16
Programmer's guide	1/27/97	4.6■	12.7■	3.0■	5
System progrmr's guide	1/27/97	4.3■	7.9■	2.0■	3

Security level	**ITI-ALC SYSTEM**	**7/31/95 12:15:53pm**
Project	**C:\CHECK\USR\RONK\ITI-ALC**	
Version label	**PIP B Intro System (FPs:1782)**	
Location	**DAYTON**	

Operator's guide	6/16/97	6.2■	17.0■	3.0■	73.5■
Msg/return code ref	6/16/97	3.4■	6.2■	2.0■	26.3■
Maintenance manual	6/16/97	4.8■	17.7■	4.0■	75.6■
End-user train manual	8/23/98	5.1■	14.2■	3.0■	66.0■
Product I/O screens	1/29/95	2.0■	13.1■	7.0■	49.7■
On-line tutorial	1/27/97	2.7■	17.5■	7.0■	74.5■
HELP screens	7/25/97	2.3■	10.5■	5.0■	44.7■
Icon/Graphic screens	1/29/95	2.7■	2.5■	1.0■	9.5■
On-line error messages	8/23/98	1.6■	4.3■	3.0■	19.4■
Video training tapes	8/23/98	1.6■	5.8■	4.0■	26.2■
Video training discs	8/23/98	1.6■	5.8■	4.0■	26.2■
User document review	10/20/97	0.6■	6.4■	18.0■	27.9■
Maint document review	8/28/97	1.3■	4.8■	6.0■	20.5■
System document rvw	8/06/97	1.1■	10.0■	15.0■	42.6■
Installation	2/20/99	2.0■	1.9■	1.0■	9.0■
User training	2/22/99	0.9■	3.3■	4.0■	15.9■
Totals		179.5■	1,380.1■	69.0■	5,890.0■
Overlapped schedule		53.7■		22.4■ FTE	
Unpaid overtime			335.4■		

Security level	ITI-ALC SYSTEM	7/31/95 12:33:4
Project	C:\CHECK\USR\RONK\ITI-ALC	
Version label	PIP B Intro System (FPs:1782)	
I ation	DAYTON	

MAINTENANCE

Staff/Effort/Cost

Year	Staff	Effort Months	Cost $ Thousands
1999	10■	83.4■	409.9■
2000	10■	77.8■	405.3■
2001	9■	72.9■	402.6■
2002	8■	54.7■	320.4■
2003	7■	51.2■	317.6■
2004	7■	47.7■	313.8■
Totals		387.8■	2,169.6■

Maint effort/KLOC	2.4■	Maint cost/KLOC	13.2■
Maint effort/F.P.	0.2■	Maint cost/F.P.	1.2■
Maint effort/defect	0.7■	Maint cost/defect	3.7■

Cost by Activity

Year	Central Maintenance	Field Maintenance	Customer Support	Maintenance Management	Total $ Thousand
1999	176.9■	165.5■	18.3■	49.2■	409.9
2000	187.5■	152.7■	16.5■	48.6■	405.3
2001	198.8■	140.7■	14.8■	48.3■	402.6
2002	140.5■	128.3■	13.2■	38.4■	320.4
2003	148.9■	118.6■	11.9■	38.1■	317.6
2004	157.8■	107.7■	10.6■	37.7■	313.8
Totals	1,010.5■	813.4■	85.4■	260.3■	2,169.6

Effort by Activity

Year	Central Maintenance	Field Maintenance	Customer Support	Maintenance Management	Total Months
1999	36.0■	33.7■	3.7■	10.0■	83.4
2000	36.0■	29.3■	3.2■	9.3■	77.8
2001	36.0■	25.5■	2.7■	8.7■	72.9
2002	24.0■	21.9■	2.3■	6.6■	54.7
2003	24.0■	19.1■	1.9■	6.1■	51.2
2004	24.0■	16.4■	1.6■	5.7■	47.7
'otals	180.0■	145.9■	15.4■	46.5■	387.8

PIP C

Software Estimating Data

FUNCTION POINT ANALYSIS SUMMARY FOR PIP C

Project: 1370001	**Phase:** Req	**Project Name:**	ITI-ALC
Application ID:		**Application:**	ITI-ALC PIP C
Counter:	Ron Kelly	**Expert:**	Connie Hoyland

Notes: Based on the ITI-ALC SM, 15 Feb 96 and the ITI-ALC SSS, 31 Oct 95.
The count pertains to a system that would support PIP C

FP COUNT

Type ID	TYPE	LOW	MID	HIGH	TOTAL
EI	Input	150	148	72	370
EQ	Inquiry	93	72	12	177
EO	Output	516	205	28	749
ILF	Files	112	130	30	272
EFI	Interface	5	49	0	74

Total Unadjusted Function Points: 1642

GSC

ID	LABEL	RATING	ID	LABEL	RATING
C1	Data Communication	4	C8	On-Line Update	5
C2	Distributed Func.	3	C9	Complex Process	3
C3	Performance	5	C10	Reusability	3
C4	Heavily Used	3	C11	Installation Ease	5
C5	Trans. Rate	3	C12	Operational Ease	4
C6	On-Line Data Entry	5	C13	Multiple Sites	5
C7	End-User Efficiency	5	C14	Facilitate Change	3

Total Rating: 56

Value Adjust. Factor = Total Rating X .01 +.65: 1.21

Unadjusted Function Points X Value Adjustment Factor X Growth Factor =
TOTAL FUNCTION POINTS: 2484

Growth Factor:

Requirements Definition:	1.25
After LLD:	1.10
End Of Project:	1.00

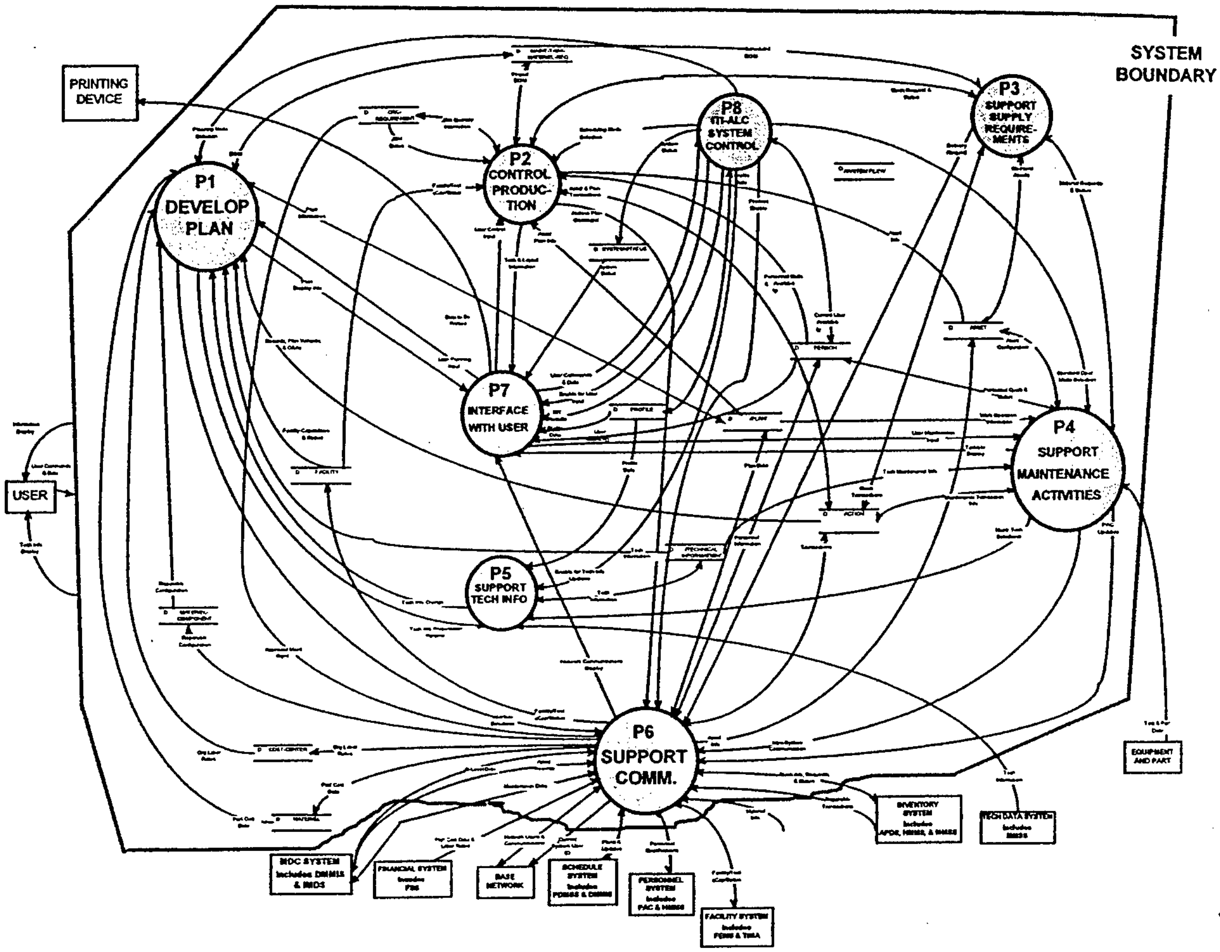

Figure I-2. ITI-ALC System Function Point Scope for PIP C

PIP C includes all of the ITI-ALC system capabilities represented in PIP B, along with many others to gain significant benefits from the more sophisticated technology.

PIP C consists of the following:

- Integrated diagnostics and IETM data (although the diagnostics are at present day capabilities and are improved in PIP D).

- Interfaces with external systems. These interfaces are more sophisticated than those in PIP B, allowing data from multiple sources to be integrated to form new information. This means that context resolution is needed to ensure the merged information is meaningful.

- A major interface that links Depot-level (D-level) maintenance to Operational level (O-level) maintenance. The two maintenance organizations would be able to send and receive pertinent maintenance and configuration data using ITI-ALC and the Integrated Maintenance Data System (IMDS), which includes the Core Automated Maintenance System (CAMS) and the Integrated Maintenance Information System (IMIS) (refer to Section H.3).

- A more robust Planning function interface than the one in PIP B. This interface allows simple links to be made between plans created in Programmed Depot Maintenance Scheduling System (PDMSS) (or other scheduling systems) and the technical information needed to perform the work operation (refer to Section H.3). However, in this PIP, ITI-ALC does not provide the planner with an integrated workstation for using IETM data during the planning function.

- A simple interface with the Materiel Management Standard System (MMSS) that allows only for ordering parts. This PIP does include the benefit of tracking the part status or other benefits associated with the Acquire Parts BPI (refer to Section E.3).

Not included are interfaces to the Automated Parts Delivery System (APDS). Interfaces to the aircraft, support equipment and tools, and other equipment or parts are also not included in this PIP C.

ITI-ALC PIP C FUNCTION POINT COUNT WORKSHEET

		FUNCTION POINT COUNT														
		INPUT			INQUIRY			OUTPUT			FILES			I/F		
#	LABEL	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
1	MDC SYSTEM															1
2	DMMIS															
3	IMDS															
4	FINANCIAL SYSTEM (FSS)													1		
5	BASE NETWORK														1	
6	SCHEDULE SYSTEM														1	
7	PDMSS															
8	DMMIS															
9	PERSONNEL SYSTEM														1	
10	PAC															
11	HMMS															
12	FACILITY SYSTEM														1	
13	FEMS															
14	TIMA															
15	MAT. MANAGEMENT SYSTEM														1	
16	MMSS															
17	IMDS															
18	INVENTORY SYSTEM														1	
19	MMSS															
20	HMMS															
21	TECH DATA SYSTEM (MMSS)															1
22	PRINTER DEVICE														1	
23	ACTION											1				
24	ASSET										1					
25	COST-CENTER										1					
26	FACILITY										1					
27	MATERIEL											1				
28	MATERIEL-COMPONENT										1					
29	ORG-REQUIREMENT											1				
30	PERSON										1					
31	PROFILE											1				
32	SYSTEM-STATUS											1				
33	SYSTEM FILES															
34	BACK-UP CRITERION										1					
35	CALENDAR & SHIFT DATA										1					
36	CONFIGURATION												1			
37	ERROR										1					
38	ERROR-LOG										1					
39	FILTER CRITERION										1					
40	SEARCH CRITERION										1					
41	SECURITY											1				
42	SORT CRITERION										1					
43	CONTEXT CONVERSION FILE											1				
44	COMMUNICATION FILE											1				
45	TECHNICAL INFORMATION															
46	POSTCONDITION											1				

ITI-ALC PIP C FUNCTION POINT COUNT WORKSHEET

		FUNCTION POINT COUNT														
		INPUT			INQUIRY			OUTPUT			FILES			I/F		
#	LABEL	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
47	PRECONDITION											1				
48	STATE-TABLE												1			
49	TECHNICAL-TASK											1				
50	TECHNICAL-PRIMITIVE											1				
51	TECHNICAL-TASK-COMPONENT											1				
52	PLAN															
53	ASSET-PLAN										1					
54	MAINT-TASK-MATERIEL-REQ										1					
55	MAINT-TASK-TECH-INFO										1					
56	MAINTENANCE-TASK										1					
57	Current System User ID	1				1			1							
58	Data to Be Printed					1			1							
59	Facility/Tools Cap/Status					4		2								
60	Maintenance Data															
61	Raw Maintenance Data						1			2						
62	Materiel Info			1				1								
63	Network Users & Communications		1	1				6								
64	Tech Information															
65	Postcondition Expression		1	1				1								
66	Precondition Expression		1	1				1								
67	System State		1	1				1								
68	System State Update		1	1				1								
69	Tech Primitive Data		1	1				1								
70	Tech Task Info		1	1				1								
71	O-Level Data & Asset Records															
72	Asset Records															
73	Asset Record Update	1		1				1		1						
74	O-Level Data						1									
75	Part Cost Data & Labor Rates															
76	Org Labor Hrs							1								
77	BOM							1								
78	Personnel Qualifications				3			1								
79	Plans & Updates															
80	Plan		3					2	1							
81	Plan Updates and Requests															
82	Plan Update Notification	2	1						3							
83	Request for Existing Plan							3								
84	Reparable Transactions	1	1					1	2							
85	Stock Info, Requests, & Status															
86	Requisitions & Delivery Request							1								
87	Stock Item Information		2		1											
88	User Commands & Data															
89	Back-up Data	1	1													
90	Configuration Data	1	1													
91	Profile & Security Data	1	1													
92	Other System Commands	1	2			3										

ITI-ALC PIP C FUNCTION POINT COUNT WORKSHEET

#	LABEL	FUNCTION POINT COUNT														
		INPUT			INQUIRY			OUTPUT			FILES			I/F		
		L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
93	User Control Input															
94	Induction Inputs															
95	JON & Item Received	2														
96	JON/Quantity Selection	2														
97	Part Scheduling Input	2														
98	Plan Coordination Input															
99	Plan Selection Criteria	1														
100	Resource Assignment Selections	1														
101	Task Scheduling Inputs	1														
102	Plan Selection, Date Updates	2														
103	Resource Management Input															
104	Resource Assignment Input	1														
105	Sorting Parameters	1														
106	Sell Selections	1	1													
107	User Maintenance Input															
108	Part Selection Info															
109	Confirmation/Rejection	1														
110	Part Selection	1														
111	Task & Filter Selection															
112	Task Filter Criteria	1	1													
113	Task Selection	1														
114	User Routing Choices & Inputs	1	1													
115	User Task Data															
116	Discrepancy Info															
117	Discrepancy Description	2														
118	O & A Description Info	2														
119	Work Oper. Selection/Rejection	2														
120	Pilot Debrief Info		2													
121	Prep Input															
122	Configuration Input	1	1													
123	Step Completion	1														
124	Sign-off Input															
125	Certifier Selection	1														
126	Sign-off Verification	1														
127	Task Performance Input															
128	Diagnostic Results	1	1													
129	Fault Detected	1	1													
130	Step Completion	1														
131	Task Input	1														
132	Test Input		1	1												
133	User Planning Input															
134	Task Specification Input															
135	Plan Identification Parameters	1														
136	Task Description Information	1														
137	Task Identification Parameters	1														
138	Task Organization Input	1														

ITI-ALC PIP C FUNCTION POINT COUNT WORKSHEET

#	LABEL	FUNCTION POINT COUNT														
		INPUT			INQUIRY			OUTPUT			FILES			I/F		
		L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
139	Tech Info Update Inputs	2	1													
140	Functional Context	1														
141	Help Request				2											
142	Profile Data															
143	Profile Information		2													
144	Project & User Access Info		2													
145	Project & Profile Information		2													
146	Routed Reparable Selection		1	1												
147	Certification Candidates		1	1												
148	Tool Selection	1														
149	Tech Info Display															
150	Tech Info Presentation Params															
151	IPB Presentation Parameters							1	1							
152	Tech Info ID							1								
153	Tech Info Selection															
154	Fault Isolation Step to Display							1	1							
155	IPB to Display							1	1							
156	Tech Primitive Data								1							
157	Tech Primitive Precondition								1							
158	Tech Primitives to Display							1	1							
159	Tech Task Info								1							
160	Tech Info Change							1	1							
161	Fault Isolation Step to Display								1							
162	Fault Isolation Task Info							1	1							
163	Postcondition Expression							1								
164	Postcondition Required							1								
165	Precondition Expression							1								
166	System State									1						
167	System State Update							1								
168	Information Display															
169	Error Display							2	1							
170	Help Display							2	1							
171	Intra-System Comm. Display					2		2	1							
172	Tool Display					2		2	1							
173	Error Condition							2	1							
174	Error Data							2								
175	Error Display					2		2								
176	Error Occurrence Data							2								
177	Network Communications Display					2		2	1							
178	Plan Display Info															
179	O&A Notification to Display				1			3								
180	Operation Cost Report							3								
181	Plan Storage Display Params							3								
182	Plan for Display															
183	Plan Spec. for Display				1			3								
184	Reference Plan Info to Display				1			3								

ITI-ALC PIP C FUNCTION POINT COUNT WORKSHEET

#	LABEL	FUNCTION POINT COUNT: INPUT			INQUIRY			OUTPUT			FILES			I/F		
		L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
185	Task Desc. Info for Display				1			3								
186	Task Organization Display				1			3								
187	Tech Info Change Notification				1			3								
188	Task/Part Pres. Params							3								
189	System Status				1			2	1							
190	Task & Layout Information															
191	Asset Plan to Display															
192	Plan & Status to Display				1			3								
193	Resource Info for Display				1			3								
194	Task Priority Data for Display				1			3								
195	Induction Info to Display															
196	JON List/Data for Display				1			2	1							
197	OWO For Display				1			2	1							
198	JON Info For Display					1		2	1							
199	Part Display Parameters							2	1							
200	Task & Skill Info to Display				1			2	1							
201	Tasks to Display															
202	Part Routing Display				1			3								
203	Parts Data for Display															
204	Part Status for Display				1			3								
205	Task Displays															
206	Certification Info for Display				1			2	1							
207	Debrief Display				1			2	2							
208	Discrepancy Display															
209	O & A Documentation Screen				1			2	1							
210	Work Operation List for Display				1			2	1							
211	Prep Displays															
212	Asset Record Displays				1			2	1							
213	Task Step Display				1			2	1							
214	Task Step Display				1			2	1							
215	Task List to Display				1			2	1							
216	Tool Display				1			2	1							
217	User Capability				1			2	1							
		INPUT			INQUIRY			OUTPUT			FILES			I/F		
		L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
	UN-WEIGHTED FUNCTION POINT GRAND TOTALS:	50	37	12	31	18	2	129	41	4	16	13	2	1	7	2

Security level	ITI-ALC SYSTEM	7/31/95 12:13:16]
Project	C:\CHECK\USR\RONK\ITI-ALC	
Version label	PIP C Integrated Systems (FPs: 2484)	
J ation	DAYTON	

CHECKPOINT(R) 2.1.9 REPORT(S)

PIP C ESTIMATE

Security level	ITI-ALC SYSTEM	7/31/95 12:13:16pm
Project	C:\CHECK\USR\RONK\ITI-ALC	
Version label	PIP C Integrated Systems (FPs: 2484)	
Location	DAYTON	

TOTALS

Project Profile

CLASSIFICATION

Nature	1]	New program development
Scope	7]	Major system
Class	14]	Ext: Government contract
Type	5]	*Interactive dbase applic
Goals	4]	Hi quality/normal staff

ATTRIBUTES

Personnel	3.00
Technology	3.00
Process	3.00
Environment	3.00
Assessment Index	3.00
SPR Level	3.00
Risk	3.00
Value	3.00

DEVELOPMENT

Schedule Months	57.0■
Person Months	2,058.1■
Delivered KLOC	229.6■
Document pages	22,107■

QUALITY

Removal efficiency	82.7■%

PRODUCTIVITY

KLOC / person Month	0.11■

Security level	ITI-ALC SYSTEM	7/31/95 12:13:16p
Project	C:\CHECK\USR\RONK\ITI-ALC	
Version label	PIP C Integrated Systems (FPs: 2484)	
I ation	DAYTON	

Quality

	Defects
Defect potentials	9,152■
- Defects removed	7,980■
+ Bad fixes	407■
Delivered defects	1,579■
Potential defects per KLOC	39.86■
Delivered defects per KLOC	6.88■
Cumulative removal efficiency	82.75■%
Removal cost per KLOC	12,923.09■
Removal effort per KLOC	482.74■

Reliability

	Time
Months to stabilization	8.0■
Mean CPU hours till failure	
At delivery	5.0■
At stabilization	81.0■

Size

Code Class	F.P.	KLOC	Source Lines per F.P.
New	1,863	187.7■	100.7■
Reused	621	42.0■	67.6■
Prototyped	112■	11.3■	100.7■
Base	0	0.0	0.0
Changed	0	0.0	0.0
Deleted	0	0.0	0.0
Delivered	2,484	229.6■	92.4■
Project	2,484	229.6■	92.4■

Security level	ITI-ALC SYSTEM	7/31/95 12:13:16pm
Project	C:\CHECK\USR\RONK\ITI-ALC	
Version label	PIP C Integrated Systems (FPs: 2484)	
Location	DAYTON	

Productivity

	Ratios
KLOC per person	2.34■
KLOC per person Month	0.11■
KLOC per calendar Month	4.03■
Development cost per KLOC	38.09■
User cost per KLOC	0.43■
Maintenance cost per KLOC	16.01■
Total cost per KLOC	38.52■

Security level	ITI-ALC SYSTEM	7/31/95 12:13:16
Project	C:\CHECK\USR\RONK\ITI-ALC	
Version label	PIP C Integrated Systems (FPs: 2484)	
I -ation	DAYTON	

TASK ANALYSIS

Schedule/Effort/Cost

Task	Begin Date	Schedule Months	Effort Months	Staffing Headcount	Cos Thous
Development plan	12/26/94	3.1■	5.6■	2.0■	2
Review/inspection plan	1/31/95	2.9■	5.4■	2.0■	2
Test plan	10/18/96	3.3■	6.1■	2.0■	2
Quality assurance plan	2/20/95	2.7■	2.4■	1.0■	
Maint/cust support pln	2/08/99	1.5■	1.4■	1.0■	
Training plans	3/24/99	2.2■	2.0■	1.0■	
Personnel management	11/01/94	56.9■	99.8■	4.0■	42
Progress reports	3/28/95	52.1■	8.2■	4.0■	3
Project cost estimates	11/12/94	56.6■	2.5■	4.0■	1
Capital expend reqsts	2/20/95	53.3■	4.2■	4.0■	1
Project audit	3/23/99	0.4■	0.4■	1.0■	
Rvw/inspec status rpts	2/19/95	40.5■	4.9■	5.0■	2
Test status reports	7/04/98	11.4■	1.1■	1.0■	
Quality assurance rvw	5/30/99	0.8■	5.3■	6.0■	2
Configuration control	6/08/95	48.3■	21.2■	2.0■	9
JAD requirements spec	11/01/94	3.7■	47.9■	12.0■	18
quirements review	1/23/95	0.9■	5.6■	12.0■	2
Prototyping	12/26/94	2.3■	4.2■	2.0■	1
Purchase applic acquis	11/01/94	1.3■	3.6■	3.0■	1
Initl functional spec	1/23/95	9.0■	139.9■	17.0■	52
Final functional spec	10/23/95	4.9■	89.5■	20.0■	35
Initl funct design rvw	6/08/95	4.5■	7.1■	27.0■	2
Final funct design rvw	2/11/96	1.2■	7.5■	31.0■	3
Data design spec	11/29/95	7.2■	66.0■	10.0■	26
Program logic spec	3/17/96	7.9■	94.6■	13.0■	38
Detailed module design	8/08/96	5.9■	43.0■	8.0■	17
Data struct design rvw	5/11/96	1.8■	3.4■	16.0■	1
Logic design review	9/14/96	2.0■	3.9■	21.0■	1
Module design review	12/19/96	1.5■	3.5■	13.0■	1
Coding	10/18/96	20.5■	494.6■	28.0■	2,15
Reusable code acquis	1/19/97	0.7■	1.1■	2.0■	
Unit testing	3/23/97	15.4■	25.2■	28.0■	11
Code inspections	8/26/97	10.3■	106.6■	53.0■	47
New function testing	1/29/98	5.2■	88.9■	23.0■	40
Regression testing	6/03/98	1.7■	57.0■	40.0■	25
Integration	3/23/97	16.0■	20.1■	2.0■	8
Integration testing	7/05/98	4.6■	91.2■	23.0■	41
Stress/perform testing	10/18/98	5.0■	64.3■	15.0■	30
System testing	2/08/99	2.9■	95.9■	39.0■	45
Acceptance testing	5/06/99	1.4■	9.8■	16.0■	4
Introduction	2/02/97	5.8■	5.3■	1.0■	2
nstallation guide	10/18/98	1.7■	1.6■	1.0■	
ser's guide	8/26/97	5.9■	53.8■	10.0■	23
Programmer's guide	2/02/97	4.8■	17.8■	4.0■	7
System progrmr's guide	2/02/97	6.0■	11.0■	2.0■	4

ecurity level	ITI-ALC SYSTEM		7/31/95 12:13:16pm
roject	C:\CHECK\USR\RONK\ITI-ALC		
ersion label	PIP C Integrated Systems (FPs: 2484)		
ocation	DAYTON		

Operator's guide	6/29/97	5.6■	25.6■	5.0■	110.5■
Msg/return code ref	6/29/97	3.4■	9.2■	3.0■	39.3■
Maintenance manual	6/29/97	4.8■	26.6■	6.0■	114.3■
End-user train manual	10/18/98	4.6■	21.3■	5.0■	101.3■
Product I/O screens	2/16/95	2.3■	19.3■	9.0■	73.1■
On-line tutorial	2/02/97	3.1■	25.7■	9.0■	109.4■
HELP screens	8/26/97	2.3■	14.6■	7.0■	62.4■
Icon/Graphic screens	2/16/95	2.0■	3.6■	2.0■	13.6■
On-line error messages	10/18/98	1.6■	6.0■	4.0■	28.4■
Video training tapes	10/18/98	1.6■	5.8■	4.0■	27.3■
Video training discs	10/18/98	1.6■	5.8■	4.0■	27.3■
User document review	11/23/97	0.6■	9.2■	26.0■	41.4■
Maint document review	9/10/97	1.2■	7.0■	9.0■	29.6■
System document rvw	8/19/97	1.2■	15.1■	21.0■	64.2■
Installation	5/06/99	2.9■	2.6■	1.0■	12.5■
User training	5/30/99	1.0■	4.6■	5.0■	22.1■
Totals		188.2■	2,036.6■	81.0■	8,746.0■
Overlapped schedule		57.0■		31.2■ FTE	
Unpaid overtime			495.0■		

Security level	ITI-ALC SYSTEM	7/31/95 12:31:37
Project	C:\CHECK\USR\RONK\ITI-ALC	
Version label	PIP C Integrated Systems (FPs: 2484)	
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MAINTENANCE

Staff/Effort/Cost

Year	Staff	Effort Months	Cost $ Thousands
1999	17■	142.4■	711.0■
2000	16■	132.4■	700.6■
2001	14■	110.1■	617.6■
2002	13■	102.8■	611.1■
2003	10■	82.5■	520.0■
2004	10■	77.1■	515.2■
Totals		647.2■	3,675.6■

Maint effort/KLOC	2.8■	Maint cost/KLOC	16.0■
Maint effort/F.P.	0.3■	Maint cost/F.P.	1.5■
Maint effort/defect	0.6■	Maint cost/defect	3.6■

Cost by Activity

ℓear	Central Maintenance	Field Maintenance	Customer Support	Maintenance Management	Total $ Thousand
1999	299.6■	295.8■	31.9■	83.7■	711.0
2000	317.6■	271.9■	28.7■	82.4■	700.6
2001	269.3■	249.8■	25.8■	72.7■	617.6
2002	285.5■	230.3■	23.4■	71.9■	611.1
2003	227.0■	210.9■	21.0■	61.2■	520.0
2004	240.6■	195.0■	19.0■	60.6■	515.2
Totals	1,639.5■	1,453.8■	149.9■	432.4■	3,675.6

Effort by Activity

Year	Central Maintenance	Field Maintenance	Customer Support	Maintenance Management	Total Months
1999	60.0■	59.2■	6.4■	16.8■	142.4
2000	60.0■	51.4■	5.4■	15.6■	132.4
2001	48.0■	44.5■	4.6■	12.9■	110.1
2002	48.0■	38.7■	3.9■	12.1■	102.8
2003	36.0■	33.5■	3.3■	9.7■	82.5
2004	36.0■	29.2■	2.8■	9.1■	77.1
ɔtals	288.0■	256.5■	26.5■	76.1■	647.2

PIP D

Software Estimating Data

FUNCTION POINT ANALYSIS SUMMARY FOR PIP D

Project: 1370001	**Phase:** Req	**Project Name:**	ITI-ALC
Application ID:		**Application:**	ITI-ALC PIP D
Counter: Ron Kelly		**Expert:** Connie Hoyland	
Notes:	Based on the ITI-ALC SM, 15 Feb 96 and the ITI-ALC SSS, 31 Oct 95 The count pertains to a system that would support PIP D		

FP COUNT

Type ID	TYPE	LOW	MID	HIGH	TOTAL
EI	Input	195	176	150	521
EQ	Inquiry	81	92	36	209
EO	Output	452	330	77	859
ILF	Files	28	220	75	323
EFI	Interface	5	35	70	110

Total Unadjusted Function Points: 2022

GSC

ID	LABEL	RATING	ID	LABEL	RATING
C1	Data Communication	5	C8	On-Line Update	5
C2	Distributed Func.	5	C9	Complex Process	4
C3	Performance	5	C10	Reusability	3
C4	Heavily Used	3	C11	Installation Ease	5
C5	Trans. Rate	3	C12	Operational Ease	4
C6	On-Line Data Entry	5	C13	Multiple Sites	5
C7	End-User Efficiency	5	C14	Facilitate Change	3

Total Rating: 60

Value Adjust. Factor = Total Rating X .01 +.65: 1.25

Unadjusted Function Points X Value Adjustment Factor X Growth Factor =

TOTAL FUNCTION POINTS: 3159

Growth Factor:

Requirements Definition:	**1.25**
After LLD:	**1.10**
End Of Project:	**1.00**

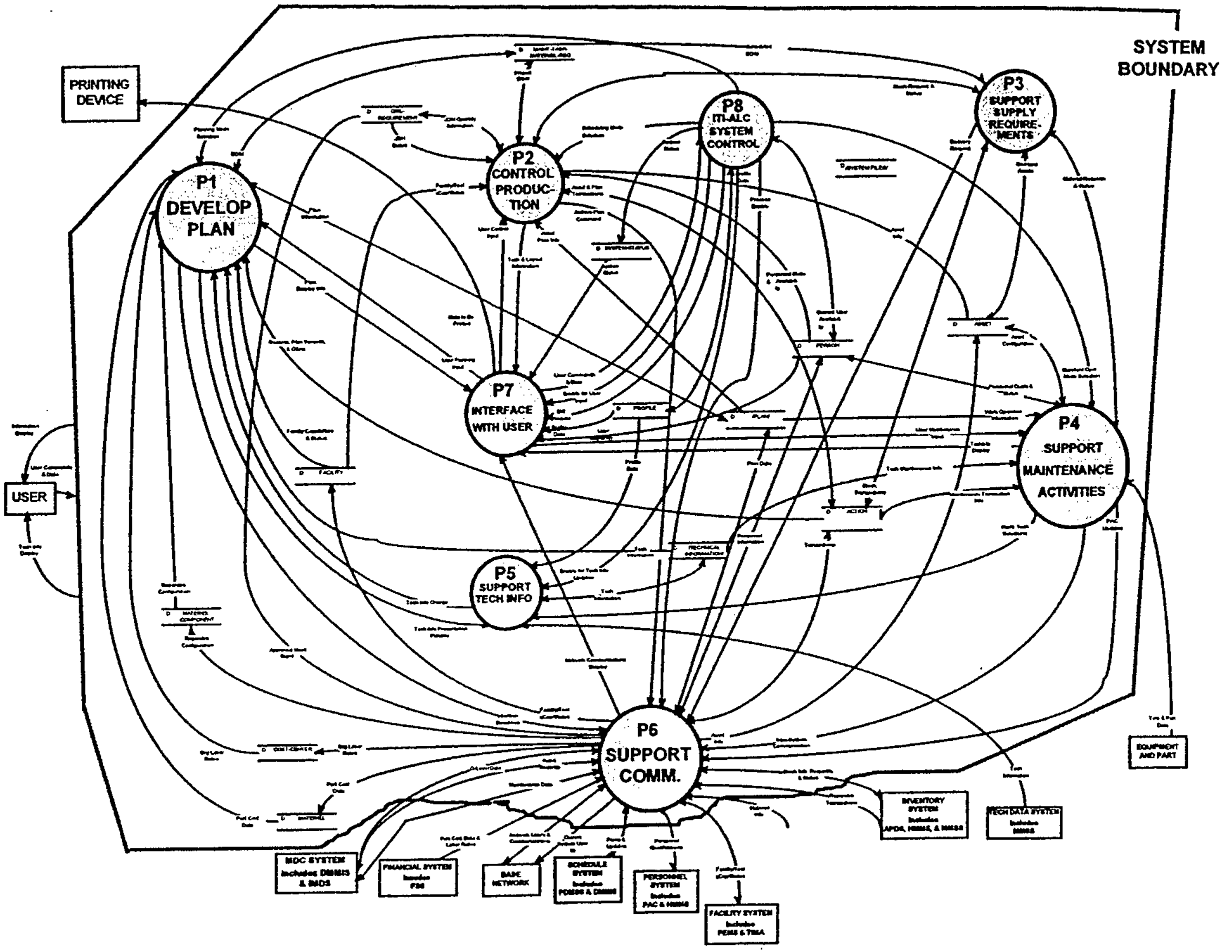

Figure I-3. ITI-ALC System Function Point Scope for PIP D

PIP D represents a fully developed ITI-ALC system consisting of a set of hardware, software, and processes that support depot maintenance. The intent of this version of the ITI-ALC system is to provide timely and efficient access to information needed to support depot maintenance, and to provide this information through an integrated system of hardware and software that augments all depot maintenance BPIs identified in this document.

The ITI-ALC system represented by PIP D fulfills all of the requirements specified in the ITI-ALC SSS and fully implements all the BPIs, resulting in the benefits each BPI provides as well as the synergistic effect of combining all BPIs.

ITI-ALC FULL SYSTEM (PIP D) FUNCTION POINT COUNT WORKSHEET

#	LABEL	FUNCTION POINT COUNT														
		INPUT			INQUIRY			OUTPUT			FILES			I/F		
		L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
1	MDC SYSTEM															1
2	DMMIS															
3	IMDS															
4	FINANCIAL SYSTEM (FSS)													1		
5	BASE NETWORK														1	
6	SCHEDULE SYSTEM															1
7	PDMSS															
8	DMMIS															
9	PERSONNEL SYSTEM														1	
10	PAC															
11	HMMS															
12	FACILITY SYSTEM														1	
13	FEMS															
14	TIMA															
15	MAT. MANAGEMENT SYSTEM															1
16	MMSS															
17	IMDS															
18	INVENTORY SYSTEM															1
19	MMSS															
20	HMMS															
21	APDS															
22	TECH DATA SYSTEM (MMSS)															1
23	EQUIPMENT/PART/ITEM INTERFACE															
24	PARTS														1	
25	A/C															1
26	SE/T															1
27	PRINTER DEVICE														1	
28	ACTION											1				
29	ASSET											1				
30	COST-CENTER											1				
31	FACILITY											1				
32	MATERIEL												1			
33	MATERIEL-COMPONENT											1				
34	ORG-REQUIREMENT											1				
35	PERSON											1				
36	PROFILE											1				
37	SYSTEM-STATUS											1				
38	SYSTEM FILES															
39	BACK-UP CRITERION										1					
40	CALENDAR & SHIFT DATA										1					
41	CONFIGURATION												1			
42	ERROR										1					
43	ERROR-LOG										1					
44	FILTER CRITERION											1				
45	SEARCH CRITERION											1				
46	SECURITY											1				
47	SORT CRITERION											1				
48	CONTEXT CONVERSION FILE												1			
49	COMMUNICATION FILE												1			

ITI-ALC FULL SYSTEM (PIP D) FUNCTION POINT COUNT WORKSHEET

#	LABEL	FUNCTION POINT COUNT														
		INPUT			INQUIRY			OUTPUT			FILES			I/F		
		L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
50	TECHNICAL INFORMATION															
51	POSTCONDITION											1				
52	PRECONDITION											1				
53	STATE-TABLE												1			
54	TECHNICAL-TASK											1				
55	TECHNICAL-PRIMITIVE											1				
56	TECHNICAL-TASK-COMPONENT											1				
57	PLAN															
58	ASSET-PLAN											1				
59	MAINT-TASK-MATERIEL-REQ											1				
60	MAINT-TASK-TECH-INFO											1				
61	MAINTENANCE-TASK											1				
62	Current System User ID	1				1			1							
63	Data to Be Printed					1			1							
64	Facility/Tools Cap/Status						4	2								
65	Maintenance Data															
66	Maintenance Trend Data			1				1								
67	Raw Maintenance Data						1			2						
68	Materiel Info			1				1								
69	Network Users & Communications		1	1				6								
70	Tech Information															
71	Postcondition Expression		1	1				1								
72	Precondition Expression		1	1				1								
73	System State		1	1				1								
74	System State Update		1	1				1								
75	Tech Primitive Data		1	1				1								
76	Tech Task Info		1	1				1								
77	O-Level Data & Asset Records															
78	Asset Records															
79	Asset Record Update	1		1				1		1						
80	O-Level Data						1									
81	Part Cost Data & Labor Rates															
82	Org Labor Hrs								1							
83	BOM								1							
84	Personnel Qualifications					3			1							
85	Plans & Updates															
86	Plan			3					2	1						
87	Plan Updates and Requests															
88	Plan Update Notification		2	1						3						
89	Request for Existing Plan							3								
90	Reparable Transactions	1		1					1	2						
91	Stock Info, Requests, & Status															
92	Requisitions & Delivery Request								1							
93	Stock Item Information			2		1										
94	Test & Part Data															
95	Part Data		1						1							
96	Test Data		1	1		1		1								
97	I/O Pertaining to A/C Interface		1	2		1		1	3	1						
98	I/O Pertaining to APDS Interface	5				1			5							

ITI-ALC FULL SYSTEM (PIP D) FUNCTION POINT COUNT WORKSHEET

#	LABEL	FUNCTION POINT COUNT														
		INPUT			INQUIRY			OUTPUT			FILES			I/F		
		L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
99	User Commands & Data															
100	Back-up Data	1	1													
101	Configuration Data	1	1													
102	Profile & Security Data	1	1													
103	Other System Commands	1	2			3										
104	User Control Input															
105	Induction Inputs															
106	JON & Item Received	2														
107	JON/Quantity Selection	2														
108	Part Scheduling Input	2														
109	Plan Coordination Input															
110	Archive Selections	2														
111	Plan Selection Criteria	2														
112	Resource Assignment Selections	2														
113	Task Scheduling Inputs	2														
114	Plan Selection, Date Updates	1	1													
115	Resource Management Input															
116	Resource Assignment Input	2														
117	Sorting Parameters	2														
118	Sell Selections	1	1													
119	User Maintenance Input															
120	Part Selection Info															
121	Confirmation/Rejection	1														
122	Part Selection	1														
123	Task & Filter Selection															
124	Task Filter Criteria		2													
125	Task Selection	1														
126	User Routing Choices & Inputs	1	1													
127	User Task Data															
128	Discrepancy Info															
129	Discrepancy Description	2														
130	O & A Description Info	2														
131	Work Oper. Selection/Rejection	2														
132	Pilot Debrief Info		2													
133	Prep Input															
134	Configuration Input	1	1													
135	Step Completion	1														
136	Sign-off Input															
137	Certifier Selection	1														
138	Sign-off Verification	1														
139	Task Performance Input															
140	Diagnostic Results	1	1													
141	Fault Detected	1	1													
142	Step Completion	1														
143	Task Input	1														
144	Test Input		1	1												
145	User Planning Input															
146	Part Requirement Input	1	2	1												
147	Plan Storage/Release Inputs	1	2	1												

ITI-ALC FULL SYSTEM (PIP D) FUNCTION POINT COUNT WORKSHEET

#	LABEL	FUNCTION POINT COUNT														
		INPUT			INQUIRY			OUTPUT			FILES			I/F		
		L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
148	Task Specification Input															
149	Plan Identification Parameters	2														
150	Task Description Information	2														
151	Task Identification Parameters	2														
152	Task Organization Input	2														
153	Tech Info Update Inputs	1	2													
154	Workload Dates & Quantities	1	1													
155	User Routing Choices & Inputs	1	1													
156	Functional Context	1														
157	Help Request				2											
158	Profile Data															
159	Profile Information		2													
160	Project & User Access Info		2													
161	Project & Profile Information		2													
162	Routed Reparable Selection		1	1												
163	Certification Candidates		1	1												
164	Tool Selection	1														
165	Tech Info Display															
166	Tech Info Presentation Params															
167	IPB Presentation Parameters							1	1							
168	Tech Info ID							1								
169	Tech Info Selection															
170	Fault Isolation Step to Display							1	1							
171	IPB to Display							1	1							
172	Tech Primitive Data								1							
173	Tech Primitive Precondition								1							
174	Tech Primitives to Display							1	1							
175	Tech Task Info								1							
176	Tech Info Change							1	1							
177	Fault Isolation Step to Display								1							
178	Fault Isolation Task Info							1	1							
179	Postcondition Expression							1								
180	Postcondition Required							1								
181	Precondition Expression							1								
182	System State									1						
183	System State Update							1								
184	Information Display															
185	Error Display							2	1							
186	Help Display							2	1							
187	Intra-System Comm. Display					2		2	1							
188	Tool Display					2		2	1							
189	BIT Results					2		2	1							
190	Error Condition							2	1							
191	Error Data							2								
192	Error Display					2		2								
193	Error Occurrence Data							2								
194	Network Communications Display					2		2	1							
195	Plan Display Info															
196	O&A Notification to Display				1			2	1							

ITI-ALC FULL SYSTEM (PIP D) FUNCTION POINT COUNT WORKSHEET

#	LABEL	FUNCTION POINT COUNT														
		INPUT			INQUIRY			OUTPUT			FILES			I/F		
		L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
197	Operation Cost Report							2	1							
198	Plan Storage Display Params							2	1							
199	Plan for Display															
200	Plan Spec. for Display				1			2	1							
201	Reference Plan Info to Display				1			2	1							
202	Task Desc. Info for Display				1			2	1							
203	Task Organization Display				1			2	1							
204	Tech Info Change Notification				1			2	1							
205	Task/Part Pres. Params							2	1							
206	System Status				1			2	1							
207	Task & Layout Information															
208	Asset Plan to Display															
209	Plan & Status to Display				1			2	1							
210	Resource Info for Display				1			2	1							
211	Task Priority Data for Display				1			2	1							
212	Induction Info to Display															
213	JON List/Data for Display				1			2	1							
214	OWO For Display				1			2	1							
215	JON Info For Display					1		2	1							
216	Part Display Parameters							2	1							
217	Task & Skill Info to Display				1			2	1							
218	Tasks to Display															
219	Part Routing Display				1			2	1							
220	Parts Data for Display															
221	Part Status for Display				1			2	1							
222	Task Displays															
223	Certification Info for Display				1			2	1							
224	Debrief Display				1			2	2							
225	Discrepancy Display															
226	O & A Documentation Screen				1			2	1							
227	Work Operation List for Display				1			2	1							
228	Prep Displays															
229	Asset Record Displays				1			2	1							
230	Task Step Display				1			2	1							
231	Task Step Display				1			2	1							
232	Task List to Display				1			2	1							
233	Tool Display				1			2	1							
234	User Capability				1			2	1							

	INPUT			INQUIRY			OUTPUT			FILES			I/F		
	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
UN-WEIGHTED FUNCTION POINT GRAND TOTALS:	65	44	25	27	23	6	113	66	11	4	22	5	1	5	7

Security level	ITI-ALC SYSTEM	7/31/95 12:11:15pm
Project	C:\CHECK\USR\RONK\ITI-ALC	
Version label	PIP D Full System (FPs: 3159)	
L· ·ation	DAYTON	

CHECKPOINT(R) 2.1.9 REPORT(S)

PIP D FULL SYSTEM

Security level	ITI-ALC SYSTEM	7/31/95 12:11:15]
Project	C:\CHECK\USR\RONK\ITI-ALC	
Version label	PIP D Full System (FPs: 3159)	
Location	DAYTON	

TOTALS

<u>**Project Profile**</u>

CLASSIFICATION

Nature	1]	New program development
Scope	7]	Major system
Class	14]	Ext: Government contract
Type	5]	*Interactive dbase applic
Goals	4]	Hi quality/normal staff

DEVELOPMENT

Schedule Months	59.9■
Person Months	2,739.5■
Delivered KLOC	292.0■
Document pages	28,335■

ATTRIBUTES

Personnel	3.0(
Technology	3.0(
Process	3.0(
Environment	3.0(
Assessment Index	3.0(
SPR Level	3.0(
Risk	3.0(
Value	3.0(

QUALITY

Removal efficiency	81.5(

PRODUCTIVITY

KLOC / person Month	0.1:

Security level	ITI-ALC SYSTEM	7/31/95 12:11:15pm
Project	C:\CHECK\USR\RONK\ITI-ALC	
Version label	PIP D Full System (FPs: 3159)	
Location	DAYTON	

Quality

	Defects
Defect potentials	12,046■
- Defects removed	10,358■
+ Bad fixes	537■
Delivered defects	2,225■
Potential defects per KLOC	41.25■
Delivered defects per KLOC	7.62■
Cumulative removal efficiency	81.53■%
Removal cost per KLOC	13,588.44■
Removal effort per KLOC	503.65■

Reliability

	Time
Months to stabilization	8.0■
Mean CPU hours till failure	
At delivery	5.0■
At stabilization	79.0■

Size

Code Class	F.P.	KLOC	Source Lines per F.P.
New	2,369	238.7■	100.7■
Reused	790	53.4■	67.6■
Prototyped	142■	14.3■	100.7■
Base	0	0.0	0.0
Changed	0	0.0	0.0
Deleted	0	0.0	0.0
Delivered	3,159	292.0■	92.4■
Project	3,159	292.0■	92.4■

7/31/95 12:11:15

Security level	ITI-ALC SYSTEM
Project	C:\CHECK\USR\RONK\ITI-ALC
Version label	PIP D Full System (FPs: 3159)
Location	DAYTON

Productivity

	Ratios
KLOC per person	2.34■
KLOC per person Month	0.11■
KLOC per calendar Month	4.87■
Development cost per KLOC	40.16■
User cost per KLOC	0.44■
Maintenance cost per KLOC	17.45■
Total cost per KLOC	40.59■

Security level	ITI-ALC SYSTEM	7/31/95 12:11:15pm
Project	C:\CHECK\USR\RONK\ITI-ALC	
Version label	PIP D Full System (FPs: 3159)	
L ation	DAYTON	

TASK ANALYSIS

<u>Schedule/Effort/Cost</u>

Task	Begin Date	Schedule Months	Effort Months	Staffing Headcount	Cost $ Thousands
Development plan	12/28/94	2.8■	7.7■	3.0■	29.0■
Review/inspection plan	2/02/95	2.7■	7.4■	3.0■	27.9■
Test plan	11/23/96	4.2■	7.7■	2.0■	32.7■
Quality assurance plan	2/23/95	3.4■	3.1■	1.0■	11.7■
Maint/cust support pln	4/04/99	1.9■	1.7■	1.0■	8.2■
Training plans	5/31/99	2.8■	2.6■	1.0■	12.3■
Personnel management	11/01/94	59.8■	148.8■	5.0■	634.7■
Progress reports	3/22/95	55.2■	10.8■	5.0■	46.7■
Project cost estimates	11/12/94	59.5■	3.3■	5.0■	14.3■
Capital expend reqsts	2/23/95	56.1■	5.5■	5.0■	23.6■
Project audit	5/22/99	0.4■	0.4■	1.0■	1.9■
Rvw/inspec status rpts	2/22/95	42.2■	6.5■	7.0■	27.1■
Test status reports	8/28/98	12.0■	1.5■	2.0■	7.0■
Quality assurance rvw	8/24/99	0.7■	6.7■	8.0■	31.8■
Configuration control	6/19/95	50.3■	28.5■	2.0■	122.9■
TAD requirements spec	11/01/94	3.8■	61.5■	15.0■	232.8■
quirements review	1/25/95	1.0■	7.3■	15.0■	27.8■
Prototyping	12/28/94	2.0■	5.6■	3.0■	21.3■
Purchase applic acquis	11/01/94	1.3■	3.6■	3.0■	13.8■
Initl functional spec	1/25/95	9.5■	183.9■	21.0■	697.5■
Final functional spec	11/11/95	4.9■	121.0■	27.0■	485.4■
Initl funct design rvw	6/19/95	4.8■	9.3■	34.0■	35.5■
Final funct design rvw	3/01/96	1.2■	9.9■	40.0■	39.6■
Data design spec	12/18/95	7.3■	87.4■	13.0■	350.7■
Program logic spec	4/07/96	8.5■	125.3■	16.0■	508.5■
Detailed module design	9/09/96	6.2■	56.7■	10.0■	237.3■
Data struct design rvw	6/02/96	1.8■	4.6■	21.0■	18.3■
Logic design review	10/18/96	2.1■	5.2■	26.0■	21.6■
Module design review	1/28/97	1.5■	4.6■	16.0■	19.6■
Coding	11/23/96	21.2■	655.2■	36.0■	2,864.5■
Reusable code acquis	2/27/97	0.8■	1.4■	2.0■	6.1■
Unit testing	5/03/97	15.9■	32.0■	36.0■	141.4■
Code inspections	10/11/97	10.6■	137.0■	67.0■	615.1■
New function testing	3/21/98	5.3■	119.5■	30.0■	538.7■
Regression testing	7/27/98	1.7■	76.6■	51.0■	345.1■
Integration	5/03/97	16.5■	25.6■	2.0■	113.0■
Integration testing	8/29/98	4.7■	120.4■	30.0■	560.9■
Stress/perform testing	12/13/98	4.9■	84.7■	20.0■	404.5■
System testing	4/04/99	3.2■	133.6■	49.0■	638.5■
Acceptance testing	7/09/99	1.6■	16.0■	20.0■	76.5■
Introduction	3/16/97	3.8■	7.0■	2.0■	29.8■
stallation guide	12/13/98	2.2■	2.0■	1.0■	9.7■
ser's guide	10/11/97	6.3■	69.2■	12.0■	309.8■
Programmer's guide	3/16/97	5.3■	24.4■	5.0■	103.8■
System progrmr's guide	3/16/97	5.5■	15.1■	3.0■	64.0■

Security level	ITI-ALC SYSTEM	7/31/95 12:11:15pm
Project	C:\CHECK\USR\RONK\ITI-ALC	
Version label	PIP D Full System (FPs: 3159)	
Location	DAYTON	

Operator's guide	8/24/97	5.9■	32.5■	6.0■	143.5
Msg/return code ref	8/24/97	3.2■	11.8■	4.0■	50.9
Maintenance manual	8/24/97	4.8■	35.3■	8.0■	154.8
End-user train manual	12/13/98	4.9■	27.1■	6.0■	129.5
Product I/O screens	2/12/95	2.3■	24.9■	12.0■	94.3
On-line tutorial	3/16/97	3.0■	33.2■	12.0■	141.3
HELP screens	10/11/97	2.4■	19.5■	9.0■	86.4
Icon/Graphic screens	2/12/95	2.5■	4.6■	2.0■	17.4
On-line error messages	12/13/98	1.8■	8.3■	5.0■	39.5
Video training tapes	12/13/98	1.7■	9.4■	6.0■	45.0
Video training discs	12/13/98	1.7■	9.4■	6.0■	45.0
User document review	1/14/98	0.6■	11.8■	32.0■	53.3
Maint document review	11/05/97	1.2■	9.0■	12.0■	40.5
System document rvw	10/11/97	1.1■	18.2■	27.0■	79.0
Installation	7/09/99	3.6■	3.3■	1.0■	15.9
User training	8/24/99	0.9■	5.9■	7.0■	28.1
Totals		196.9■	2,711.9■	103.0■	11,727.3
Overlapped schedule		59.9■		39.5■	FTE
Unpaid overtime			659.1■		

Security level	ITI-ALC SYSTEM	7/31/95 12:30:37pm
Project	C:\CHECK\USR\RONK\ITI-ALC	
Version label	PIP D Full System (FPs: 3159)	
Location	DAYTON	

MAINTENANCE

Staff/Effort/Cost

Year	Staff	Effort Months	Cost $ Thousands
2000	23■	199.8■	1,011.3■
2001	21■	172.0■	922.9■
2002	18■	159.7■	908.6■
2003	16■	135.7■	817.9■
2004	14■	113.2■	723.4■
2005	13■	105.0■	711.5■
Totals		885.3■	5,095.5■

Maint effort/KLOC	3.0■	Maint cost/KLOC	17.4■
Maint effort/F.P.	0.3■	Maint cost/F.P.	1.6■
Maint effort/defect	0.6■	Maint cost/defect	3.5■

Cost by Activity

Year	Central Maintenance	Field Maintenance	Customer Support	Maintenance Management	Total $ Thousands
2000	425.3■	422.8■	45.6■	117.6■	1,011.3■
2001	386.4■	388.1■	41.1■	107.3■	922.9■
2002	409.6■	356.5■	36.8■	105.6■	908.6■
2003	361.8■	327.8■	33.3■	95.1■	817.9■
2004	306.8■	302.4■	30.1■	84.1■	723.4■
2005	325.2■	276.5■	27.1■	82.7■	711.5■
Totals	2,214.9■	2,074.2■	213.9■	592.5■	5,095.5■

Effort by Activity

Year	Central Maintenance	Field Maintenance	Customer Support	Maintenance Management	Total Months
2000	84.0■	83.5■	9.0■	23.2■	199.8■
2001	72.0■	72.3■	7.7■	20.0■	172.0■
2002	72.0■	62.7■	6.5■	18.6■	159.7■
2003	60.0■	54.4■	5.5■	15.8■	135.7■
2004	48.0■	47.3■	4.7■	13.2■	113.2■
2005	48.0■	40.8■	4.0■	12.2■	105.0■
Totals	384.0■	361.0■	37.4■	102.9■	885.3■

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Appendix J

ITI-ALC Hardware Cost Estimates

J.1 OVERVIEW

This appendix contains hardware item listings for PIP B, PIP C, and PIP D (refer to Tables J-1, J-2, and J-3.). The hardware estimates are based on the Hardware Configuration Items (HWCIs) identified in the ITI-ALC SSDD. The hardware is estimated in sufficient quantities to support all the system requirements in the ITI-ALC SSS for SM-ALC's PDM effort. The number of units required is based on the existing F-15 PDM staff at SM-ALC modified to include changes due to the BPIs. For the final analysis these numbers have been extrapolated to include the cost of the ITI-ALC system for all four PDM lines at SM-ALC (refer to Section 4), but some development numbers will not recur after the first ITI-ALC installation. This is also true for the three PDM lines at WR-ALC.

The tables list each hardware item, an example from today's market of that class of device, the vendor who supplies the example, number of units to support one PDM effort, unit cost, total cost, and comments on how the estimate was derived. Each table includes both recurring costs and development costs. In Section 4 of this document, the recurring costs have been derived for both SM-ALC and WR-ALC. Non-recurring hardware development costs are not significantly different for the two ALCs in a ROM estimate.

NOTE: The hardware items listed in the Example column are not intended to indicate that the listed item will be the specific hardware used for the ITI-ALC system. The example is for costing purposes only.

Table J-1. ITI-ALC Hardware Worksheet for PIP B

HARDWARE ITEM	EXAMPLE	VENDOR	NO.	UNIT COST	COST	COMMENT
RECURRING HARDWARE COSTS						
IWD	SPARC-STATION 20	SUN				1 / PLANNER (14) + 1 / DOCK (20)
PROCESSOR UNIT			34	$1,200	$40,800	INCLUDING ALL CABLES,
DATA ENTRY DEVICE			34	$100	$3,400	CONNECTORS & OS
DOCK ASSEMBLY			34	$500	$17,000	
MONITOR			34	$1,000	$34,000	
BASE NETWORK I/F			34	$300	$10,200	
UPS			34	$500	$17,000	
ICN						
ISN	Base 10	NOVELL				2 UNITS (BACKUP)
BASE			2	$400	$800	
WIRE AND CONNECTORS			2	$400	$800	
UPS			2	$200	$400	
REPEATERS			10	$350	$3,500	
ISD	SPARC-SERVER 2000	SUN				1 COMM/ 2 DB/ 1 NETWORK/1 PRINTER
PROCESSING UNIT			5	$5,000	$25,000	INCLUDING OS
REMOVABLE STORAGE			2	$10,000	$20,000	
PRINTER DEVICE			2	$2,000	$4,000	
EXTERNAL AIS I/F			8	$500	$4,000	
BASE NETWORK I/F			5	$500	$2,500	
UPS			5	$1,000	$5,000	
RECURRING COSTS SUBTOTAL FOR ONE A/C AT ONE ALC					$188,400	
RECURRING COSTS SUBTOTAL FOR ALL A/C AT SM-ALC (4 A/C TYPES)					$753,600	
DEVELOPMENT COSTS						
HARDWARE DEV./SUPPORT						
IWD			2	$3,600	$7,200	COTS
ICN-ISN			1	$1,700	$1,700	COTS
ISD			2	$19,000	$38,000	COTS
INTEGRATION					$1,353,000	135.3 EM* FROM CHECKPOINT
TEST PLANNING & TESTING					$1,992,000	199.2 EM FROM CHECKPOINT
SHIPPING & HANDLING					$500,000	50 EM FROM CHECKPOINT
INSTALLATION					$0	INCLUDED IN SYSTEM INSTALLATION
PRIME ITEM DEV SPEC & REV					$1,789,000	178.9 EM FROM CHECKPOINT
DEVELOPMENT COSTS SUBTOTAL					$5,680,900	
TOTAL FOR ONE A/C AT ONE ALC					$5,869,300	
TOTAL FOR ALL A/C AT SM-ALC					$6,434,500	

*EM = Effort Month

Table J-2. ITI-ALC Hardware Worksheet for PIP C

HARDWARE ITEM	EXAMPLE	VENDER	NO.	UNIT COST	COST	COMMENT
RECURRING HARDWARE COSTS						
MMD						1 PER "MANAGER" (DIV.) OR 26
UNIT	CRUISEPAD	ZENITH	26	$1,212	$31,512	INCLUDING OS
EXTRA BATTERY PACK			52	$40	$2,080	
IWD	SPARC-STATION 20	SUN				1 / PLANNER (14) + 1 / DOCK (20)
PROCESSOR UNIT			34	$1,200	$40,800	INCLUDING ALL CABLES,
DATA ENTRY DEVICE			34	$100	$3,400	CONNECTORS & OS
DOCK ASSEMBLY			34	$500	$17,000	
MONITOR			34	$1,000	$34,000	
BASE NETWORK INTERFACE			34	$300	$10,200	
UPS			34	$500	$17,000	
ICN						
ISN	Base 10	NOVELL				2 UNITS (BACKUP)
BASE			2	$400	$800	
WIRE AND CONNECTORS			2	$400	$800	
UPS			2	$200	$400	
REPEATERS			10	$350	$3,500	
ISD	SPARC-SERVER 2000	SUN				1 COMM/ 2 DB/ 1NETWORK/ 1PRINTER/
PROCESSING UNIT			5	$5,000	$25,000	INCLUDING OS
REMOVABLE STORAGE			2	$10,000	$20,000	
PRINTER DEVICE			2	$2,000	$4,000	
EXTERNAL AIS INTERFACES			12	$500	$6,000	
BASE NETWORK INTERFACE			5	$500	$2,500	
UPS			5	$1,000	$5,000	
RECURRING COSTS SUBTOTAL FOR ONE A/C AT ONE ALC					$223,992	
RECURRING COSTS SUBTOTAL FOR ALL A/C AT SM-ALC (4 A/C TYPES)					$895,968	
DEVELOPMENT COSTS						
HARDWARE DEV./SUPPORT						
MMD			4	$20,000	$80,000	MODIFIED COTS
IWD			2	$3,600	$7,200	COTS
ICN-ISN			1	$1,700	$1,700	COTS
ISD			2	$19,000	$38,000	COTS

Table J-2. ITI-ALC Hardware Worksheet for PIP C (Continued)

HARDWARE ITEM	EXAMPLE	VENDER	NO.	UNIT COST	COST	COMMENT
INTEGRATION					$1,353,000	135.3 EM* FROM CHECKPOINT
TEST PLANNING & TESTING					$1,992,000	199.2 EM FROM CHECKPOINT
SHIPPING & HANDLING					$500,000	50 EM FROM CHECKPOINT
INSTALLATION					$0	INCLUDED IN SYSTEM INSTALLATION
PRIME ITEM DEV SPEC & REVIEWS					$1,789,000	178.9 EM FROM CHECKPOINT
DEVELOPMENT COSTS SUBTOTAL					$5,760,900	
TOTAL FOR ONE A/C AT ONE ALC					$5,984,892	
TOTAL FOR ALL A/C AT SM-ALC					$6,656,868	

*EM = Effort Month

Table J-3. ITI-ALC Hardware Worksheet for PIP D

HARDWARE ITEM	EXAMPLE	VENDER	NO.	UNIT COST	COST	COMMENT
RECURRING HARDWARE COSTS						
MMD						1 PER "MANAGER" (DIV.) OR 26
UNIT	CRUISEPAD	ZENITH	26	$1,212	$31,512	INCLUDING OS
EXTRA BATTERY PACK			52	$40	$2,080	
MSD	SYSTEM SIX	INTERVISION				1 PER MECHANIC (DIV.)
HEAD MOUNTED COMPONENT			500	$1,012	$506,000	
WEARABLE COMPUTER			500	$750	$375,000	INCLUDING OS
EXTRA BATTERY PACK			1000	$40	$40,000	
TOOL INTERFACE			500	$100	$50,000	
REPARABLE INTERFACE			500	$200	$100,000	
NDI SYSTEM INTERFACE			500	$100	$50,000	
IWD	SPARC-STATION 20	SUN				1 / PLANNER (29) + 1 / DOCK (5)
PROCESSOR UNIT			34	$1,200	$40,800	INCLUDING ALL CABLES,
DATA ENTRY DEVICE			34	$100	$3,400	CONNECTORS & OS
DOCK ASSEMBLY			34	$500	$17,000	
WIRELESS COMM INTERFACE			34	$500	$17,000	
MONITOR			34	$1,000	$34,000	
BASE NETWORK INTERFACE			34	$300	$10,200	
UPS			34	$500	$17,000	
ICN						
ISN	Base 10	NOVEL				2 UNITS (BACKUP)
BASE			2	$400	$800	
WIRE AND CONNECTORS			2	$400	$800	
UPS			2	$200	$400	
REPEATERS			10	$350	$3,500	
MWN	AIRLAN	SOLETEK				2 UNITS (BACKUP)
ANTENNA			2	$422	$844	
BASE			2	$1,370	$2,740	
UPS			2	$492	$984	
REPEATERS			10	$450	$4,500	ROM BASED ON REQ & COTS CAPABILITIES TODAY
ISD	SPARC-SERVER 2000	SUN				1 COMM/ 2 DB/ 1NETWORK/ 1PRINTER
PROCESSING UNIT			5	$5,000	$25,000	INCLUDING OS
REMOVABLE STORAGE			2	$10,000	$20,000	
PRINTER DEVISE			2	$2,000	$4,000	
EXTERNAL AIS INTERFACES			12	$500	$6,000	
BASE NETWORK INTERFACE			5	$500	$2,500	
WIRELESS COMM INTERFACE			5	$500	$2,500	
UPS			5	$1,000	$5,000	

Table J-3. ITI-ALC Hardware Worksheet for PIP D (Continued)

HARDWARE ITEM	EXAMPLE	VENDER	NO.	UNIT COST	COST	COMMENT
WSD	BIG SCREENS	SONY				1 DOCK (5)/1 PER DIV/1 PER HANGER
OSD			1	$10,000	$10,000	
RCSD			1	$4,000	$4,000	
ESD			5	$4,000	$20,000	
RECURRING COSTS SUBTOTAL FOR ONE A/C AT ONE ALC					$1,407,560	
RECURRING COSTS SUBTOTAL FOR ALL A/C AT SM-ALC (4 A/C TYPES)					$5,630,240	
DEVELOPMENT COSTS						
HARDWARE DEV./SUPPORT						
MMD			4	$20,000	$80,000	MODIFIED COTS
MSD			4	$24,000	$96,000	MODIFIED COTS
IWD			2	$4,100	$8,200	COTS
ICN-ISN			1	$1,700	$1,700	COTS
ICN-MWN			1	$10,000	$10,000	MODIFIED COTS
ISD			2	$19,500	$39,000	COTS
WSD-OSD			1	$30,000	$30,000	MODIFIED COTS
WSD-RCSD			1	$25,000	$25,000	MODIFIED COTS
WSD-ESD			2	$1,000	$2,000	COTS
INTEGRATION					$1,353,000	135.3 EM* FROM CHECKPOINT
TEST PLANNING & TESTING					$1,992,000	199.2 EM FROM CHECKPOINT
SHIPPING & HANDLING					$500,000	50 EM FROM CHECKPOINT
INSTALLATION					$0	INCLUDED IN SYSTEM INSTALL
PRIME ITEM DEV SPEC & REVIEWS					$1,789,000	178.9 EM FROM CHECKPOINT
DEVELOPMENT COSTS SUBTOTAL					$5,925,900	
TOTAL FOR ONE A/C AT ONE ALC					$7,333,460	
TOTAL FOR ALL A/C AT SM-ALC					$11,556,140	

*EM = Effort Month

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Appendix K

Acronym List

ACRONYM LIST

The following is a list of the acronyms and abbreviations used in this Business Case.

Acronym/ Abbreviation	Definition
A/C	Aircraft
AFMC	Air Force Materiel Command
AIS	Automated Information Systems
ALC	Air Logistic Center
AL/HRGO	Armstrong Laboratory/Logistics Research Division, Operational Logistics Branch
APDS	Automated Parts Distribution System
API	Applications Programming Interface
BPI	Business Process Improvement
CALS	Computer-aided Acquisition and Logistics Support
CDRL	Contract Data Requirements List
CIM	Corporate Information Management
COTS	Commercial-Off-The-Shelf
DLA	Defense Logistics Agency
D-level	Depot-level
DM-FEMS	Depot Maintenance-Facility Equipment Management System
DM-HMMS	Depot Maintenance-Hazardous Material Management System
DM-DMMIS	Depot Maintenance-Depot Maintenance Management Information System
DMMIS/MRP II	DMMIS/Materiel Requirements Planning
DMOI	Depot Maintenance Operations Indicator
DM-PDMSS	Depot Maintenance-Programmed Depot Maintenance Scheduling System
DMSS	Depot Maintenance Standard System
DM-TIMA	Depot Maintenance-Tool Inventory and Management Application
DoD	Department of Defense
DPAH	Direct Product Actual Hours
DPEH	Direct Product Earned Hours
EAR	Engineering Assistance Request
EM	Effort Month
ETM	Electronic Technical Manual
FM	Functional Model
FSS	Financial Standard System

Acronym/ Abbreviation	Definition
G&A	General and Administrative
HMV	Heavy Maintenance Visit
IDEF	Integrated DEFinition
IETM	Interactive Electronic Technical Manuals
IICE	Information Integration for Concurrent Engineering
IMDS	Integrated Maintenance Data System
IMIS	Integrated Maintenance Information System
ITI-ALC	Integrated Technical Information for the Air Logistic Centers
IWSM	Integrated Weapon Systems Manager
JLC	Joint Logistics Commanders
JLSC	Joint Logistics Systems Center
JPCG	Joint Policy Coordinating Group
MDS	Mission, Design, and Series
MMD	Mobile Management Device
MMSS	Materiel Management Standard System
MSD	Maintenance Support Device
MSIP	Multi-Stage Improvement Program
NDI	Non-Destructive Inspection
O-level	Organizational level
OSD	Office of the Assistant Secretary of Defense
PAC	Production Acceptance Certification System
PDM	Programmed Depot Maintenance
PIP	Process Improvement Proposal
RGC	Repair Group Category
SM-ALC	Sacramento-Air Logistics Center
SPARES	Spare Parts Production and Reproduction
SRA	Systems Research and Applications
SSDD	System/Subsystem Design Description
SSS	System/Subsystem Specification
TAFIM	Technical Architecture Framework for Information Management
WPAFB	Wright-Patterson Air Force Base
WR-ALC	Warner Robins-Air Logistics Center