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Aviation Logistics Support in the United States Coast Guard

An Assessment of Management and Cost-Effectiveness

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Executive Summary

AVIATION LOGISTICS SUPPORT IN THE UNITED STATES COAST GUARD

An Assessment of Management and Cost-Effectiveness

The U.S. Coast Guard (USCG) has made a substantial investment in materiel, people, facilities, and equipment to develop an aviation logistics system that can support the 220 aircraft in its fleet. Operating from 27 air stations, those aircraft perform a variety of missions, including search and rescue, drug interdiction, and ice patrol.

The goal of the Coast Guard's aviation logistics system is to ensure that each air station has an average mission-capable rate of 71 percent, for each aircraft type, to support its readiness requirement. While all missions require a high level of readiness, the search-and-rescue mission imposes the most stringent requirement – the ability to put an aircraft in the air within 30 minutes. Other missions are performed as recurring patrols and are based on an annual flying-hour program.

In an earlier study, we found the structure of the aviation logistics system was based on a number of excellent concepts.[1] In this study, we review the management and cost-effectiveness of the support delivered by that structure, examine current modernization projects, and recommend improvements to the Coast Guard's short-term and strategic plans.

To evaluate management and cost-effectiveness, we analyzed, at a macro level, aviation logistics support functions, and we assessed the current approach and related costs of providing the 71 percent mission-capable rate. We examined the Coast Guard's approach to analyzing mission requirements, performing logistics support analysis, determining procurement and repair sources, organizing and staffing, determining requirements, managing supply and maintenance, managing financial resources, and controlling and measuring performance.

[1]LMI Report CG001R1, *Forecasting the Applicability of Aviation Integrated Logistics Support Concepts to the Fleet*, George L. Slyman and Bruce A. Pincus, February 1992.

Overall, we found that USCG aviation logistics organization's management is sound and oriented toward problem solving; its maintenance program produces quality aircraft; its supply system responds to the air stations' priority requests and strives to meet the same service level for all requests; and its information system ably supports the air stations' maintenance schedules and partially meets the Aircraft Repair and Supply Center (AR&SC) management needs. However, we also found that its management information system is almost completely unable to forecast requirements and measure and report performance.

An effective technical channel links the Aeronautical Engineering Division (G-EAE) – the program manager for aviation logistics – to the AR&SC, and either through AR&SC to the air stations, or quite often, directly to the air stations. The Division performs considerable "brokering" services – internally to other Headquarters offices and externally to the Department of Defense (DoD), industry, and other Government agencies – in providing support and resolving aviation logistics problems. Besides G-EAE's brokering effectiveness, we found other macro-level indicators of management effectiveness, including the following:

- At every level, an aviation logistics staff committed to ensuring maintenance programs meet mission requirements. (For FY91, mission-capable rates averaged 71 percent.)
- An aviation logistics system delivering properly configured aircraft able to meet the flying-hour program. (For FY91, 94 percent of the assigned hours were flown.)
- A logistics network responding to the continuing support challenges presented by non-DoD aircraft. (Those aircraft are the HH-65 Dolphin and the HU-25 Guardian.)
- A management information system plan and architecture, originally defined in 1986, progressing toward integrating aviation logistics functions and levels of support.

We had difficulty assessing cost-effectiveness at either a macro or micro level. Finance-related performance measures and a cost-recording and collection system and procedures for Allotment Fund Codes 30 and 41 are needed to measure the full cost of aviation logistics support.[2] However, those data do not exist or must be

[2]Allotment Fund Code 30 is for air station operating and maintenance costs; Allotment Fund Code 41 is for AR&SC operations, inventory, depot maintenance and related costs, and G-EAE-directed aviation logistics-related projects.

aggregated from too many sources for useful cost analysis. AR&SC reports imply cost-effective operation but do not necessarily affirm it:

- Its supply system fills customer requests for stocked items at a rate generally comparable to that of similar DoD systems.
- The cost of its depot repair program is comparable to that of DoD for similar work (AR&SC: $45.09 per labor hour; DoD facilities: $43.06 to $54.40 per labor hour).
- Only 19 percent of the Repair Division personnel are indirect labor, a relatively low proportion compared to DoD.

We also found other instances in which better management and control would have resulted in more cost-effective operations:

- A high percentage of reparables for retrograde to AR&SC are late or overdue by USCG standards [31 December 1991, $20.8 million worth (60 percent) of retrograde overdue to AR&SC].
- Depot repair cycle times for components are considerably longer than those of comparable non-USCG activities and are, in fact, well above AR&SC's in-house and commercial repair targets (FY92 average: 149 days; FY93 goal: 99 days).

We believe AR&SC's ability to perform cost analysis will be enhanced by changes in recording the resources spent on aircraft and component overhaul during FY92 and implementing the new financial module of AR&SC's management information system. Analyzing other cost-effectiveness indicators such as inventory investment and lead times with any degree of accuracy must await implementation of the supply management module in AR&SC's management information system. Analyzing the full cost of aviation logistics support requires changes to the Coast Guard's cost accounting and reporting system or to the Headquarters corporate data base.

Because our study examined aviation logistics at the macro level and delved into detailed areas to test and validate our findings and conclusions, the recommendations in the report address a wide range of actions that will improve support, establish the capability to assess system performance, and focus strategic planning on implementing management and cost-effectiveness processes. The most important of our recommendations are summarized here:

- The USCG should improve aviation logistics planning during acquisition of aircraft or aircraft systems and after fielding by examining effectiveness as an optimum mix of capability, durability, and availability; by developing availability goals linking reliability, maintainability, and supportability; by evaluating alternative (we present several in this report) relationships among aircraft mission-capable goals, the 3-of-each-type aircraft stationing concept, and the 97.5 percent probability of meeting the air stations' readiness requirements; and by realigning G-EAE's focus to policy, planning, and resourcing and delegating technical and procedural responsibilities to AR&SC.

- The USCG should take the following steps to improve aviation maintenance support: it should analyze alternative depot maintenance intervals and cycle times (in terms of capacity and costs at different levels of work) relative to the number of aircraft or aircraft systems to be acquired; it should provide incentives to AR&SC, DoD, and other repair sources, through the development and application of an aggressive competition strategy; and it should develop workload alternatives for AR&SC that consider economics-related tradeoffs between aircraft overhaul and component repair.

- The USCG should improve aviation supply support by establishing comprehensive goals tying together AR&SC and air stations' responsibilities; linking requirements determination at both levels, and focusing supportability measures and standards on the processes that affect aircraft availability; by developing an AR&SC staff dedicated to initial and post-fielding provisioning; and by expediting the development of process measures required as input to a comprehensive requirements determination model and conducting rigorous evaluation of candidate models before implementing one in AR&SC's management information system.

- The USCG should improve aviation logistics operations, requirements forecasting, and system oversight by continuing its strategic plans to integrate separate information systems; developing requirements and system capabilities for performance standards and performance and resource measures (we identify a number of key measures for AR&SC, the air stations, and system oversight in this report); and measuring the full cost of the program using both AR&SC's and the air stations' financial information recording and cost reporting systems.

The Coast Guard should integrate the recommendations presented in this report into its strategic plan and implement them through its continuous improvement process. By doing so, it can enhance the operation of its aviation logistics system and ensure well managed and cost-effective support to maintain the **readiness of its air stations.**

CONTENTS

CONTENTS (Continued)

TABLES

TABLES (Continued)

FIGURES

CHAPTER 1

INTRODUCTION

BACKGROUND

Aviation Logistics Infrastructure

The United States Coast Guard (USCG) operates a fleet of approximately 220 aircraft to accomplish a wide variety of assigned missions, including search and rescue (SAR), drug interdiction, and ice patrol. This aircraft fleet, which is composed of several different types of aircraft, is positioned primarily at 27 USCG air stations located around the country. On average, about 180 aircraft (82 percent) are actually in service at any point in time; about 32 aircraft (15 percent) are undergoing major scheduled overhaul/maintenance; and the remaining aircraft (3 percent) are in some other status, such as storage.

The USCG relies on an extensive logistics network, including Department of Defense (DoD), commercial, and organic facilities to provide critical materiel support to the aviation units. The USCG aviation logistics "infrastructure" is a multi-echelon system with USCG materiel, equipment, facilities, and personnel positioned at each of the air stations and at the Aviation Repair and Supply Center (AR&SC). The DoD and commercial repair and procurement sources are employed extensively to augment this USCG aviation logistics infrastructure.

Organizationally, USCG aviation logistics support involves Headquarters elements, AR&SC, air stations, and external DoD and commercial activities. As illustrated in Figure 1-1, effective control over aviation logistics is critical to the readiness and sustainability of USCG aviation units.[1]

The USCG has made a substantial investment in materiel, in people, in facilities, and in equipment. The total inventory investment is approximately $717 million. On-hand inventories of reparable components and maintenance-related spare

[1] Aviation logistics, broadly defined, consists of acquisition, transportation, supply, maintenance, financial and human resource management; technical data and information systems; and facilities and equipment used during the full life cycle of the aircraft.

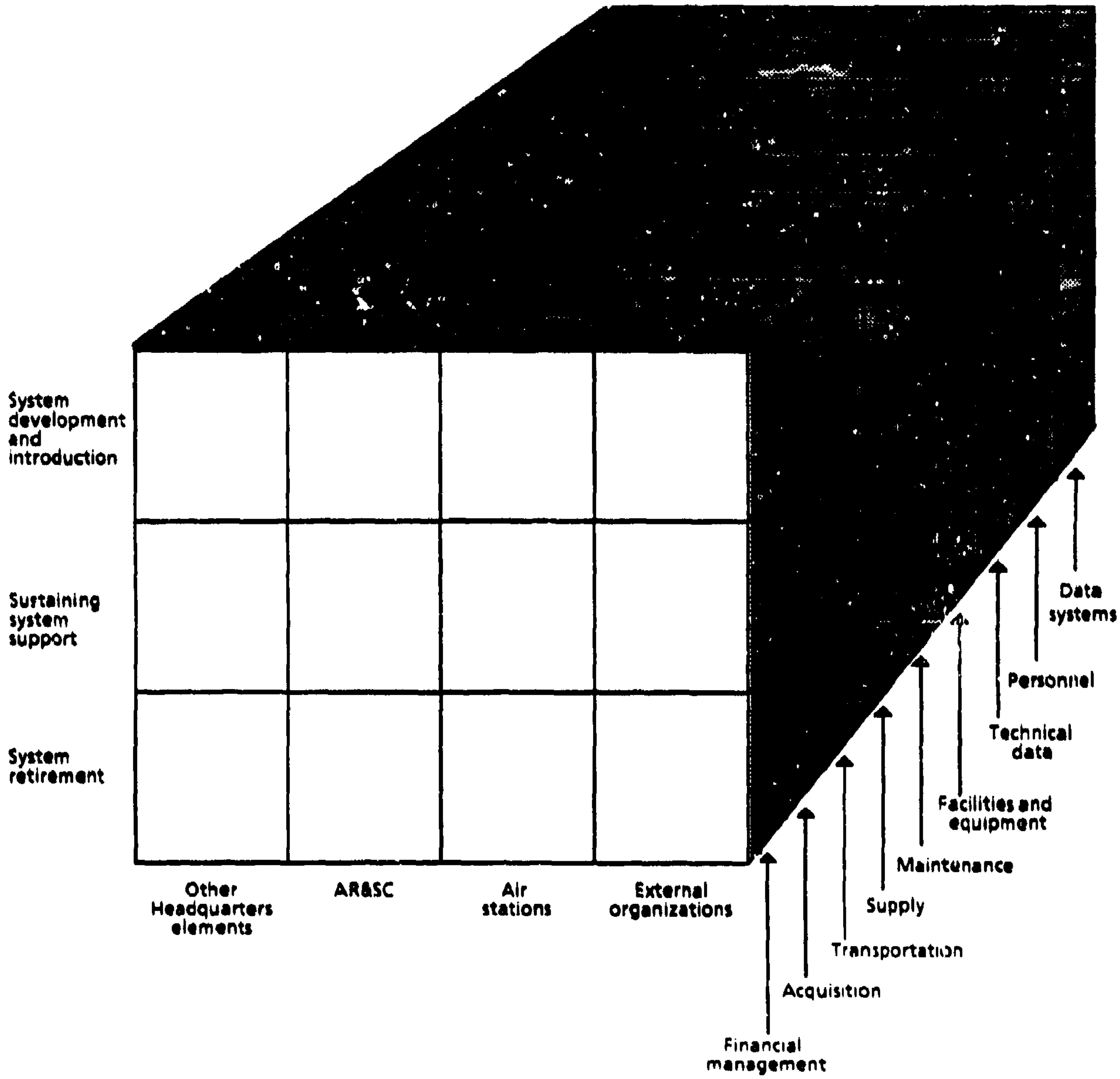

FIG. 1-1. COAST GUARD AVIATION LOGISTICS SUPPORT

parts are worth about $469 million (with an additional $248 million on order, due in from repair, or due in retrograde). Of the total inventory on hand, there is about $352 million worth in serviceable assets and approximately $117 million worth is on-hand unserviceable assets. About $54 million worth is on order, $160 million worth is currently in repair status, and about $34.5 million worth is due in as unserviceable retrograde assets. Most of the on-hand inventory (78 percent) is positioned at AR&SC or at DoD/commercial repair facilities; about 22 percent is on hand at air stations. Approximately $25 million worth of materiel is used per month. Thus, the total inventory value of $717 million represents almost 29 months worth of inventory on hand or on order. A combined military and civilian aviation logistics staff of almost 1,000 people (located at Headquarters, at AR&SC, and at air stations' maintenance and supply organizations) is another major element of the USCG aviation logistics infrastructure. Finally, while capital investment records were not accessed and evaluated, the total investment in facilities and equipment at AR&SC and at the air stations is very significant.

The Aeronautical Engineering Division (G-EAE) at USCG Headquarters is responsible for overall policy direction, planning, program management, and the performance assessment of USCG aviation logistics. Thus, G-EAE is charged with the overall management and oversight for the USCG logistics system outlined above. Clearly, G-EAE's management effectiveness is a major factor in the overall cost-effectiveness of the USCG aviation logistics program. The key management tasks are strategic planning; policy and procedural direction; technical direction; budgeting and financial support; data systems support; coordination, communication, and control; performance monitoring and analysis; and problem solving.

The G-EAE meets these responsibilities through direct line management (primarily of AR&SC), through formal staff channels within Headquarters and in the field (in budget development and budget defense, air station visits, and personnel assignment), and through active "brokering" (as a problem solver or facilitator) in a wide range of technical and management issues (both within the USCG and as an interface with DoD and industry) affecting both current and long-term USCG aviation logistics support. Therefore, G-EAE maintains active and pervasive communications with all elements of the USCG aviation logistics network. The G-EAE has achieved "connectivity" with air stations, with DoD support sources, with AR&SC, with other USCG Headquarters elements, with commercial vendors, and with research and development organizations in the public and private sectors.

In providing day-to-day logistics management and coordination to support the operational aviation units, the two key elements in the USCG's aviation logistics infrastructure are AR&SC and the aviation supply and maintenance organizations located at the air stations. AR&SC functions as the aviation inventory control point within the USCG. With an annual budget of $120 million for staffing, repair, procurement, and facility operations, AR&SC acts as the primary aviation logistics "manager" for USCG aviation materiel and has direct line responsibility for the supply and maintenance functions at the depot level. Approximately 80 percent of the AR&SC budget is used for materiel procurement and repair; about 16 percent is used for salaries and employee benefits. A total of approximately 37,000 line items are stocked at AR&SC to support air station operations. Of this total, about 42 percent are assigned to AR&SC for item management; the remaining 58 percent are managed by DoD or other Government inventory control points (ICPs). The AR&SC is directly responsible for overall aviation logistics support to the entire USCG system through centralized management and control of Type I (major principal items tracked by serial number), Type II (high-cost, nonavionic reparables and spare parts), Type IV (high-cost, avionic reparables and spare parts), and other designated materiel categories. The G-EAE has technical control over, and serves as, the Program Office for AR&SC.

At the "customer" (i.e., unit) level, some 27 air station supply and maintenance organizations provide direct logistics support to operating units. These organizations are staffed primarily by military personnel who have both functional responsibilities and duty/flying assignments. Air station maintenance personnel have both preventive/scheduled and corrective/unscheduled maintenance responsibilities. While the basic maintenance philosophy at the air station is "remove and replace," some component repair is done locally even in the absence of any local repair "pipeline." In addition to materiel positioned at the air station by AR&SC – managed under the Standardized Air Station Inventory (SASI) system and visible to the inventory managers at AR&SC – air stations also stock and replenish common use consumable items (Types III and V materiel) to support air station aviation maintenance. These items are currently maintained under a variety of local inventory management systems. The systems range from manual procedures, to locally developed personal computer (PC)-based systems, and to local application of SASI.

Type III and Type V materiel is not centrally visible. The dollar-value of inventory investment can only be estimated in the $3 million to $5 million range. Generally, Type III and V materiel is physically located in or near maintenance shops which the Aviation Materiel Officer organization is responsible for at the air station. The G-EAE is responsible for aviation logistics policy, for general oversight/performance assessment of logistics performance, and for providing functional guidance and assistance to air station maintenance and supply organizations.

Nevertheless, air stations report through District Commanders to USCG Headquarters for line management and direction.

Current Operating Requirements

Figure 1-2 shows that the current USCG aviation logistics system is grounded on a triad of operating requirements: mission-capable (MC) rate, programmed flying hours (PFH), and sortie-generation capability [Bravo Zero (B0) aircraft requirement]. Each of these three is described as follows:

- Based on the traditional USCG mission of life saving and emergency response, the ability to generate an emergency SAR sortie within a short window of time (generally specified as a B0 requirement of 30 minutes or a B2 requirement of 2 hours) is the initial driving operating requirement for aviation logistics support. Emergency sortie capability on an "as needed" basis is essentially the flight readiness (i.e., "alert") requirement on which the USCG logistics system is based. In the case of the B0 requirement, this means that most three-plane detachments must have at least one aircraft immediately available for emergency use at all times. For some larger aircraft detachments, the B0 requirement may call for two or more aircraft to be available immediately.

- With a readiness-based B0 requirement for one aircraft and an assumed aircraft inventory of three aircraft, an MC rate of 71 percent is required to ensure the compound probability that at least one aircraft is available at all times. This target MC rate (assuming the B0 requirement and an inventory of three aircraft), is uniform for all aircraft types and for all air stations regardless of their aircraft inventory or assigned operational missions. Moreover, the 71 percent MC rate has been a consistent operational standard within the USCG and has not changed for many years. Within the 29 percent downtime allowed under the MC rate standard, the supply downtime goal is 5 percent, allowing for up to 24 percent maintenance downtime. This mix does not vary with respect to aircraft type, air station, and over the course of time.

- Beyond the readiness-based B0 requirement, most USCG aircraft have assigned regular missions (such as training, patrol, drug interdiction, etc.) which mandate that specified flying hours be completed. An assigned PFH target, geared to mission/sortie requirements unique to a specific aircraft/air station, can be conceptually developed using an overall average MC rate of 71 percent, inherent aircraft capabilities, and the amount of available aircraft. Generally, the PFH goal for a particular aircraft does not vary from air station to air station; it is used to evaluate the success of the air station in meeting its mission responsibilities, including operational missions, training flights, etc. Moreover, PFH standards are used, in combination with historical operating and cost data, for budget development and funds allocation to the air stations.

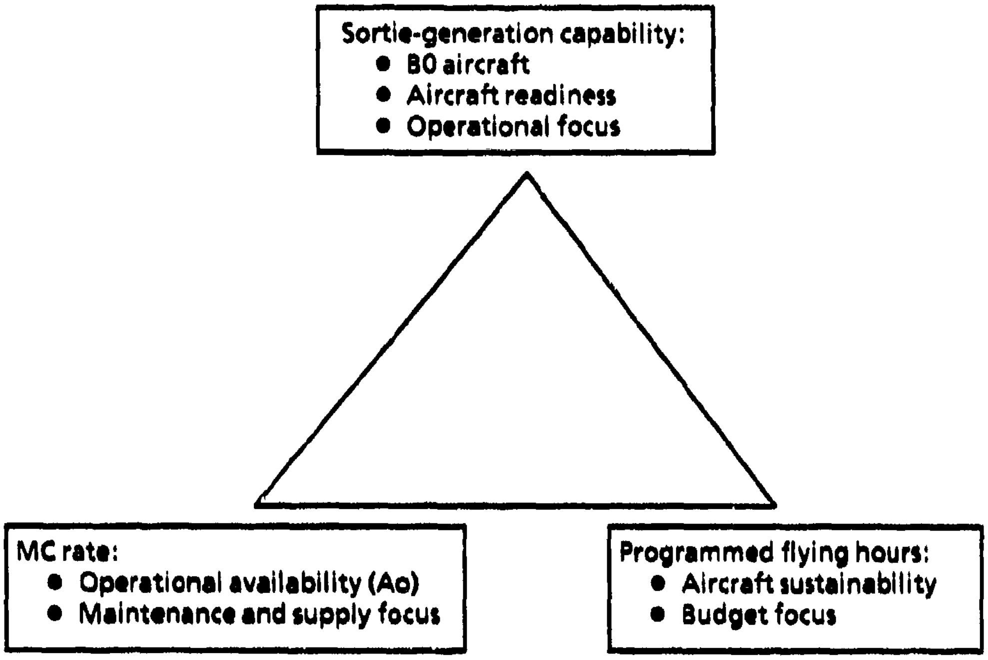

FIG. 1-2. COAST GUARD OPERATING REQUIREMENTS

In combination, the three operating requirements described above form the basis for new aircraft acquisition planning and procurement; they also serve as the underpinning for basic aviation maintenance and supply planning, policy development, and aviation logistics system operations. In essence, the management of the USCG's aviation logistics program is designed to support, and the required logistics infrastructure (of inventory, people, facilities, and equipment) is built to meet these requirements.

The mission requirement and the alert requirement are established as an initial step by the Office of Law Enforcement and Defense Operations (G-O). Mission requirements (by mission area) are established in appropriate aggregate terms (e.g., total PFH per time period for a specific mission area and not by PFH per aircraft). Alert requirements (e.g., B0 requirement) also are established for a specific operating unit. No direct analytical relationship exists between these two operational requirements since they essentially address two different operating needs. From the basic operational requirements, *conceptually*, a cost-effective mix of MC rates, aircraft type/number/siting, and PFH per aircraft can be derived. Current USCG operational requirements are internally consistent given the underlying assumptions on which they are based. The MC rate is consistent with the B0 requirement. Further, the MC rate is consistent with the PFH targets for a given aircraft type. However, while existing MC rates and PFHs per aircraft are internally consistent, our analysis does not lead us to conclude that the current mix of MC rate, PFH per aircraft, and the number/siting of aircraft are necessarily optimum in terms of meeting mission and alert requirements at lowest life-cycle cost. We address this issue in more detail in Chapter 2.

Aviation Infrastructure Performance

The USCG FY91 operating data indicate that the current aviation logistics infrastructure generally provides responsive and effective materiel support to aviation units.

As reflected in Table 1-1, MC rates have averaged slightly above 71 percent for FY91; the percentage of assigned flying hours that have been flown is generally above 90 percent. While B0 rates are not comprehensively measured and while there is some variation by aircraft type, the overall pattern of support reflected in these basic operating statistics indicates that, in the aggregate, the current USCG aviation logistics support system generally achieves assigned operational goals.

TABLE 1-1

USCG OPERATIONAL PERFORMANCE DATA

(FY91 average)

Aircraft	Mission capable rate (percent)	Programmed hours flown (percent)
HU-25	68	90
HC-130	77	98
HH-65	71	95
MRR	73	91

Source: *USCG Operating Status Report*, 1 October 1990 through 30 September 1991.

Note: Medium range and recovery (MRR) consolidates HH-3 and HH-60 data. In FY91, PFH were transferable between these aircraft.

Less evident, based on current data, are the linkages between those aggregate operational results and the underlying aviation maintenance and supply policies, aviation logistics funding levels and program execution, and maintenance and supply performance (as measured by unit level and AR&SC statistics). To assess the integrity and evaluate the effectiveness of these linkages, we analyze the actual relationships and basic system flows that form USCG aviation logistics support. That is the primary purpose of this study, as discussed below.

STUDY OBJECTIVES, SCOPE, AND APPROACH

Study Objective

This study examines USCG aviation logistics support, at a macro level with emphasis on the management and cost-effectiveness of the logistics support provided to the aviation operating unit. Rather than a detailed analysis of specific operating procedures and results, this study focuses on the overall integrity of USCG aviation logistics support that includes linkages among aviation logistics support objectives, plans, policies, organizations, systems, information flows, and personnel.

The central study objective is twofold:

- to assess the management effectiveness of USCG aviation logistics support to ensure that the program is complete and comprehensive and that results are cost-effective; and,
- to recommend alternative strategies for improving the USCG's management effectiveness and, in turn, the cost-effectiveness of aviation logistics support.

For purposes of our analysis, we define "cost-effectiveness" in its component parts as follows:

- Costs are defined as aircraft life-cycle costs, including system and logistics infrastructure acquisition costs, operating and support costs, and system phaseout/replacement costs.
- Effectiveness is defined as the operational availability (Ao) of USCG aircraft as measured by the MC rate for the aircraft.

Thus, in each section of our report, we assess the current capability, and related life-cycle costs, of USCG aviation logistics support to provide the established effectiveness measure (i.e., aircraft availability) required to meet operational requirements.

Study Scope

The scope of this study is intentionally broad. A long-term perspective is taken. We found that the scope of USCG aviation logistics support consists of the following nine major elements:

- *Operational Requirements Analysis.* This element requires the planning and analytical linkages among mission requirements and required aircraft/equipment system effectiveness, capability, availability, durability, and utility. This element forms the heart of the acquisition planning process in determining the optimum type/number of aircraft/equipment needed to meet a given operating mission.

- *Logistics Support Analysis.* This element requires the planning and analytical linkages among required system availability (see above) and the determination and positioning of the maintenance and supply infrastructure most appropriate for supporting the required level of operational availability. The Level of Repair Analysis, initial spares provisioning, and the specification of logistics support requirements for both maintenance and supply are a part of this element.

- *Procurement and Repair Sourcing and Acquisition.* This element requires the initial and ongoing determination of the appropriate repair sources [internal, other Government activities (OGAs), and/or commercial] and procurement sources (OGAs or commercial), and the acquisition of materiel/repair services from these sources to meet established logistics support requirements.

- *Requirements Determination.* This element requires the determination of ongoing inventory requirements (both for positioning at AR&SC and at air stations) given an established sourcing strategy and established logistics support requirements.

- *Organization and Staffing.* This element requires the planning, organizing, training, and positioning of human resources to meet established logistics support requirements.

- *Maintenance Management.* This element requires planning and managing the maintenance and repair infrastructure (i.e., policies, procedures, facilities, equipment, technical data, and systems) to meet established logistics support requirements.

- *Supply Management.* This element requires planning and managing the supply infrastructure (i.e., policies, procedures, processes, and systems) to meet established logistics support requirements.

- *Financial Management.* This element requires planning and managing the financial resources [specifically Allotment Fund Code (AFC) 30 and 41 funds] to meet established logistics support requirements.[2]

- *Performance Measurement and Control.* This element requires planning and managing the information resources and related systems used to monitor and control the performance of the aviation logistics program in meeting established logistics support requirements.

Based on this broad study scope, we then examined each of these major elements of USCG aviation logistics support.

Study Approach

In completing this study, a five-phase analytical approach was used. The major phases of the study were as follows:

- Initial USCG Headquarters and field interviews were completed. Analyses of basic USCG aviation logistics operating policies and performance were completed. The goal of this effort was to define and assess the integrity of G-EAE management interfaces both internally (within G-E and within G-EAE) and externally (with other Headquarters organizations, with AR&SC, with air stations, and with commercial and OGAs). (January and February 1992)

- Selected aviation logistics focus areas with significant potential for cost-effectiveness improvement were identified and evaluated. (March 1992)

- Data collection and analysis of those key cost and performance measures considered relevant to each focus area was completed. (April and May 1992)

- Functional benchmarking of USCG aviation logistics support costs and performance against non-USCG organizations with comparable logistics support missions in selected aviation logistics focus areas was completed. (June and July 1992)

- Study conclusions and strategic recommendations were developed and presented for G-EAE consideration. (August through October 1992)

Based on our examination of USCG aviation logistics policies, processes, aggregate costs, and performance, we identified twelve key focus areas for further analysis and discussion. As outlined in Table 1-2, these focus areas form the framework for the analyses developed and presented in this report.

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[2]Allotment Fund Code 30 is for air station operating and maintenance costs; Allotment Fund Code 41 is for AR&SC operations, inventory, depot maintenance and related costs, and G-EAE-directed aviation logistics-related projects.

TABLE 1-2

MAJOR FOCUS AREAS

Focus area	Issues
Logistics Support Goals	• Aircraft number versus Ao goals • Mean time between failure (MTBF), mean time to repair (MTTR), and mean logistics delay time (MLDT) goals
Supply Network Integration	• Materiel availability goals • Processing times • Site/system tradeoffs
Initial Provisioning	• Delay-time sparing • Multi-echelon positioning
Maintenance Production Planning, Capacity, and Competition Management	• Programed depot maintenance (PDM) planning • Repair sourcing and competition • Maintenance scheduling and control
Maintenance Management Information Systems	• Limitations of current systems • Future development of aviation systems • Assessing maintenance effectiveness
Maintenance Policies and Procedures	• Maintenance manual • Organic versus commercial options • Communication channels
Reliability and Quality Management	• Monitoring/reacting to reliability-centered maintenance (RCM) improvements • RCM program integration • Unsatisfactory reports management
Reparables Management	• Depot cycle time • Retrograde management • Induction management • Commercial repair
Air Stations' Supply Management	• Range/demand match • Allowance list validity • Turn-in control • Management of Types III and V materiel
Financial Management	• AFC 30 and AFC 41 budgeting • AFC 30 execution
Organization and Staffing	• Supply expertise • Strategic direction • Planning capabilities
Performance Measurement and Management Control	• Management indicators • Monitoring performance • Decision-making tools

STRATEGY FOR THE FUTURE

Based on our research, knowledge of other aviation logistics support programs, and analysis of the USCG's program, we believe that a more management and cost-effective aviation logistics support program can be achieved if the USCG's strategy for the future focuses on the following issues and capabilities:

- *Logistics Support Goals.* The aviation logistics support program should be targeted on an optimum support goal(s). The aircraft availability standard or standards on which all logistics support is based should be the result of an explicit tradeoff analysis that recognizes new systems capabilities and mission needs in selecting the most appropriate mix of aircraft and logistics support.

- *Supply Network Integration.* Given an optimum support goal, the future aviation supply network (including the mix of air station and AR&SC supply capabilities) should be designed, as an integrated system, to provide the level of supportability (as measured by logistics system delay times) consistent with the given aircraft availability standard at lowest life-cycle cost. The appropriate mix of air station and AR&SC supply strategies and capabilities should be jointly determined and flexible enough to accommodate an environment in which both technology and support costs are likely to be continuously changing.

- *Initial Provisioning.* The initial sparing (range, depth, and positioning of materiel assets) should be directly related to aircraft Ao goals, to the aviation supply network structure, and to the logistics system delays associated with meeting critical maintenance-related parts requirements. Initial provisioning computations should move from sparing methods based on traditional materiel availability (or fill rate) objectives to those sparing models that include a time-based objective.

- *Maintenance Production Planning, Capacity, and Competition Management.* Aggregate production planning and capacity management during acquisition should be based on specified aircraft/equipment system maintainability parameters and operational requirements. The appropriate programmed depot maintenance (PDM) interval and PDM cycle time should be analyzed jointly to determine the optimal number of aircraft to be procured. Depot repair cycle time (DRCT) tradeoffs should be examined to determine the optimal mean logistics delay time (MLDT) for a given Ao requirement.

- *Maintenance Management Information Systems.* Comprehensive, accurate, responsive, and well-integrated management information systems should be developed for use by aviation maintenance managers at the air stations, at AR&SC, and at USCG Headquarters. The maintenance management information systems should address the planning and operational requirements of the maintenance community. They also should collect, process, and communicate a wide range of item-specific maintenance data (failure rates, maintenance actions, etc.) needed by other USCG aviation logistics managers (engineering, acquisition, supply, and transportation) to make critical strategic and tactical decisions. It will be the *basic functionality* of maintenance management information systems and the *degree of integration* of these systems with other aviation logistics systems and processes that will ultimately determine the ability of the USCG to meet future logistics demands and challenges.

- *Maintenance Policies and Procedures.* Clear and focused policies and procedures should be developed and communicated throughout the USCG aviation logistics support infrastructure. To ensure that aviation maintenance policies and procedures are effectively communicated, more formal communication channels, methods, and directives should be established. Rather than as it is now in USCG Commandant Instruction (COMDTINST M13020.1c, *Aeronautical Engineering Maintenance Management Manual,* policy should be in a separate instruction from the one conveying specific procedural/technical guidance and methods.

- *Reliability and Quality Management.* Reliability and quality management responsibilities and organizations should be well integrated within the USCG maintenance management program to achieve the highest level of program effectiveness and to maximize the results of the reliability-centered maintenance (RCM) program. The ability of maintenance managers to identify the impact of better aircraft/ equipment system reliability in aviation logistics planning (e.g., in requirements determination and aviation logistics budgets) is essential to the long-run success of reliability improvement efforts.

- *Reparables Management.* Management of critical reparable components should be targeted for continuous improvement in transitioning from existing processes to those crucial to cost-effective support in a time-sensitive supply network. Increased attention should be directed to determination of induction quantities and induction scheduling controls, management of the DRCT, management of unserviceable returns, and efficiency of commercial repair.

- *Air Station Supply Management.* The capabilities and expertise of the supply management resources positioned at the air stations should be enhanced to improve their contribution to aircraft availability. Air station materiel allowances should be established to effectively accommodate the actual maintenance demand experienced.

- *Financial Management.* Financial management should shift to readiness-based budgeting and execution to reflect the shifts in policies and processes envisioned in aviation maintenance and supply. The AFC 41 budgeting process and the linkages to AFC 30 budgeting should be refined and strengthened as materiel budgeting moves to a requirements-oriented methodology. Further, AFC 30 financial management should reflect a more visible linkage from budget to execution.

- *Organization and Staffing.* Organizationally, the USCG aviation logistics program is exceptionally effective in dealing with emerging issues and problems that impact maintenance and engineering capabilities and support; however, in the future, as aviation logistics support becomes more integrated (from system introduction to retirement, across both maintenance and supply functions, and from the air station level to AR&SC), there should be more emphasis on strategic planning to ensure future cost-effective logistics support to the operating units. This requires an expanded role and enhanced organizational capabilities for strategic planning both in G-EAE and at AR&SC and supply management expertise in both organizations.

- *Performance Measurement and Management Control.* The aviation logistics support program should have the capability to measure and monitor system performance and to provide decision-makers at all levels with the requisite information necessary to continuously evaluate and improve system performance. The overall performance of the USCG aviation logistics support program should be related to "success measures" that are directly linked to the triad of accepted operational standards.

MAJOR CONCLUSIONS AND RECOMMENDATIONS

The USCG aviation logistics system, while currently providing responsive support to the operating units, can be substantially improved by taking management action to strengthen key elements of the USCG aviation logistics support system. We conclude that management initiatives are warranted in the following areas:

- Aviation logistics planning
- Performance measurement
- Maintenance production planning, capacity, and competition management
- Maintenance policies and procedures
- Maintenance management information systems
- Reliability and quality management
- Supply system focus
- Initial provisioning

- Reparables management
- Air station supply management
- Financial management.

Aviation Logistics Planning

To facilitate future aviation logistics policy direction and systems development, an increased emphasis on aviation logistics planning is mandatory. To provide this planning capability, we recommend the USCG

- Emphasize strategic aviation logistics policy development, planning, and programming responsibilities; realign the G-EAE focus to that purpose; and delegate the preponderance of technical and procedural responsibilities to AR&SC.
- Establish a long-term planning capability to
  - Examine aircraft effectiveness as an optimum mix among the goals of equipment capability, equipment availability, and equipment durability, and to
  - Consider logistics factors when aircraft acquisition decisions are made in order to select the least-cost alternative satisfying the USCG's operating requirements.
- Evaluate the potential alternatives that we present (in Chapter 2) on the relationships among Ao, the concept of stationing three aircraft of a given type at an air station to meet the B0 requirement, and the requirement to achieve a 97.5 percent probability of always having one aircraft ready to meet mission requirements.
- Implement the capability to incorporate scheduled maintenance requirements in setting performance standards and in acquisition planning and develop a system to measure the number of hours spent doing scheduled maintenance.

Performance Measurement

To provide fundamental management direction and to determine the actual effectiveness of the aviation logistics support system in meeting operational standards, we recommend the USCG

- Develop and implement performance standards and measures, data-collection methods and analysis requirements that directly support decisions affecting the cost of aviation logistics support.
- Establish the specific performance indicators needed to measure the effectiveness of logistics support.

Maintenance Production Planning, Capacity, and Competition Management

To ensure the optimum mix of aircraft and aircraft systems in acquisition and sustainment planning, a more discrete and direct analysis of tradeoffs between maintenance production and capacity planning (including PDM intervals, PDM cycle times, and DRCT) is essential. Depot maintenance management of component overhaul and repair (whether done at AR&SC, at a DoD depot, or at a commercial repair source) is a critical element of the aviation logistics program and a major maintenance management responsibility. Timely and cost-effective repair of essential reparable components impacts inventory investment and operational support. To enhance current production planning, capacity, and component management, we recommend the USCG

- Analyze alternative PDM intervals and cycle times (both in terms of PDM capacity requirements and costs) relative to the number of aircraft and aircraft systems to be acquired during initial aircraft acquisition planning.
- Analyze alternative DRCT options (both in terms of organic repair capacity required and costs) relative to projected Ao during the integrated logistics support planning (ILSP) process and in steady-state operations once the aircraft is introduced.
- Evaluate the cost structure of AR&SC as it affects burdened PDM and component overhaul costs to ensure accurate costing of labor hours and units produced.
- Develop cost comparability with DoD, OGAs, and commercial sources to determine cost-efficient sources of repair.
- Analyze cost-allocation schemes to determine the accuracy and validity of products produced.

- Incentivize AR&SC, and DoD and OGA repair sources, through the development of a competition strategy. Such a strategy could include direct competitions or rigorous cost comparisons. Putting workload at risk is a strong incentive to achieving reduced repair costs and improved support.

- Develop, substantiate, and promulgate policy for workloading AR&SC that considers economical as well as programmatic and technical support requirements.

- Assess current repair set-up times and costs in the component repair process to ensure that these costs are realistic and that they are minimized.

- Examine current component induction batch sizes to ensure that repair lot sizes reflect not only the tradeoff between set-up costs and inventory holding cost but that these induction quantities are properly matched to the ability of the repair process to efficiently execute the repair process.

- Review component repair scheduling and control policies, systems, and procedures at AR&SC and at commercial repair sources in order to identify processing backlogs or delays within the component repair process that may be negatively impacting DRCT.

Maintenance Policies and Procedures

Maintaining and improving communication flows to convey basic maintenance policies and procedures within the aviation logistics community is vital to the effectiveness of aviation maintenance at both the air station and depot level. To facilitate these essential communication flows, we recommend the USCG

- Develop and use additional formal communication methods and directives to promulgate policy, procedures, and decisions to AR&SC and to field units. Formal taskings to both entities should be accomplished in a consistent, structured manner that considers resource and technical effects. In structuring these processes, consideration should be given to eliminating imprecise or overlapping guidance. Further, responsibility for issuing direction and guidance should be clearly spelled out to prevent conflicting guidance from being promulgated.

- Evaluate the *Aeronautical Engineering Maintenance Management Manual* and restructure it to separate high-level policy statements from lower level procedural and technical guidance. This would be consistent with relocation of the latter responsibilities away from the Headquarters level.

Maintenance Management Information Systems

The functionality of aviation-related management information systems (MISs) and the ability of these systems to allow maintenance and supply managers to implement strategic policy initiatives to improve support to the operating customer must be a top priority for future aviation logistics management. To improve current aviation-related MIS and to ensure that future systems development efforts are most beneficial, we recommend the USCG

- Provide strategic direction for MIS development that defines the breadth and depth of maintenance data required to effectively support all aspects of maintenance management.
- Refine current strategic planning to address the specifics of MIS integration and evolution. Planning should ensure that systems are capable of developing performance standards and measuring performance and resource (time, dollars, and personnel) expenditures at the fleet, aircraft, and component level with the ultimate goal of evaluating maintenance program effectiveness and efficiency.

Reliability and Quality Management

The USCG RCM program and related quality management initiatives in aviation maintenance clearly have the potential to improve aircraft and system reliability, to reduce future logistics budget requirements, and to improve the quality of aircraft maintenance and component repair. To enhance these all-important reliability and quality management programs and initiatives, we recommend the USCG

- Integrate complimentary elements of the RCM program with AR&SC product improvement efforts.
- Centralize responsibility for product/system reliability evaluation and provide the tools and resources necessary to carry out the program.
- Rely on the AR&SC Engineering Division to lead the RCM program and ensure its implementation (in an integrated way) with maintenance and supply programs.

Supply System Focus

The current aviation supply system lacks comprehensive goals for tying together the air station and AR&SC roles and responsibilities and for linking requirements determination processes at both levels. To establish aviation supply system focus and to integrate the structural and policy decisions within the system to meet established supply support standards at lowest life-cycle cost, we recommend the USCG take the following actions

- Develop – as a joint effort of the Aviation Operations Division (G-OAV) and G-EAE – and promulgate a MLDT standard for each current and future aircraft or system to be supported.
- Use the MLDT for each given aircraft to develop the mix of air station and AR&SC gross effectiveness and processing times that will meet the MLDT requirements at lowest total life-cycle cost.
- Include specific consideration of Types III and V aviation maintenance-related consumables in the basic requirements determination process and include quantities for the minimum mandatory air station range and depth levels of those items on the 298 Allowance List.

Initial Provisioning

More active and comprehensive involvement by the aviation logistics community in the initial provisioning of new aircraft and aircraft systems is essential for ensuring cost-effective spares requirements at the air stations and AR&SC. To improve integrated logistics support planning process, to develop optimum initial spares requirements, and to strengthen the organizational capabilities for initial provisioning, we recommend the USCG

- Actively involve G-EAE, G-ELM (Chief, Logistics Management Division), and AR&SC in the early stages of aircraft and systems acquisition with the assigned program manager in directing the integrated logistics support planning process to ensure that the mix of maintainability [i.e., mean time to repair (MTTR)] and supportability (i.e., MLDT) is the optimum life-cycle cost (given Ao goals established by the USCG for the aircraft).
- Develop and implement an MLDT initial provisioning methodology as an integrated process that determines both site and system spares requirements (range and depth). Further, this initial sparing methodology should be compatible with steady-state replenishment methods (including the use of both procurement and repair batching rules); it should also recognize the materiel positioning strategies and physical distribution network structure unique to the USCG.
- Direct management attention to developing and refining the factors (the Ao requirement, MLDT, logistics costs, and lead times) that are critical to a requirements determination model's output validity before selecting a new model for the future aviation logistics MISs.

- Develop, staff, and train an organization at AR&SC devoted to initial provisioning of new aircraft and major systems. Ideally, such an organization's structure would be developed on a "matrix" basis within AR&SC; it would include designated individuals from the Repair Division, the Inventory Management Division, and the Engineering Division. These same individuals would, in turn, also be responsible for the ongoing steady-state logistics support of the aircraft.

Reparables Management

More effective management of reparable components is essential to the future support of emerging aircraft systems in the USCG. To strengthen overall reparables management and to improve retrograde processing, requirements determination for reparables, and DRCT management, we recommend the USCG

- Direct top management attention toward improving so-called "265 processing" in order to eliminate the lengthy delays currently experienced in retrograde flows from the field to AR&SC. This effort should begin with a validation of the data actually being used for monitoring purposes to ensure that it provides a realistic picture of current performance. Once the data has been validated, specific goals, monitoring, and report/feedback procedures should be initiated at the G-EAE level to highlight for Headquarters action problem items or problem air stations.

- Develop an item-specific mandatory remain-in-place (RIP) list for each aircraft type that indicates the line items that may be retained in the aircraft while supply action is underway. Once the appropriate RIP list is developed, specific policies and procedures should be put in place to ensure the removal and return of all other items at the time a requisition is placed on the supply system.

- Expedite the development and implementation of a comprehensive requirements determination process for reparable items at AR&SC. Such a reparables requirements determination process should be based on support goals, should be able to specify when repair action is required, and should be integrated with an automated capability to determine the appropriate economic repair quantity (ERQ) or economic repair batch size for a given reparable line item, considering set-up cost versus inventory holding cost tradeoffs.

In general, repair lot sizes should be minimized and tailored to the repair capability of the repair activity so that delays (scheduling queues) within the repair facility are minimized. Inductions should be scheduled so that repair action on a given batch can begin within a reasonable period of time, e.g., 1 or 2 days following receipt in the repair facility.

- Reverse current AR&SC repair scheduling and induction processing procedures to place responsibility for initiating the repair action (the timing, the quantity, and the required completion date) on the cognizant inventory manager for the item. Once the item manager has determined that an item should be repaired, the induction quantity required should be passed directly to the warehouse, and unserviceable assets should be pulled and moved to the Repair Division for repair scheduling and actual repair.

- Base measured DRCT (and DRCT requirements) on the "first unit" completion time for an individual reparable line item to focus attention on control and scheduling discipline in the repair process and to minimize the inventory investment impacts of extended repair delays for the large batches that are completed sporadically once inducted.

- Develop internal AR&SC and commercial repair vendor data management systems and interfaces to increase the visibility of reparable assets undergoing repair. This enhanced management visibility should include, at minimum, an estimate of the "next unit" completion (availability) date and "days to complete the lot" information that is updated during the actual repair process. Further, as asset needs change, the system should allow the item manager (in conjunction with the repair facility) to re-prioritize repair scheduling to ensure that the repair source is focused on the most critical materiel requirements at any given point in time.

- Incentivize commercial repair vendors to reduce commercial DRCT in order to recognize the USCG inventory investment in pipeline spares by including the DRCT in addition to repair cost as a competitive factor in evaluating and awarding commercial repair contracts.

- Evaluate the benefits of expanding the use of long-term (multiyear), requirements-type contracts for commercial component repair. Those contracts should include the provision that unserviceable units are to be returned by air stations directly to the designated repair vendor and held pending a specific induction request from AR&SC.

This change in the processing flow would require data system changes to separately reflect the quantity of unserviceable items on hand and in work at commercial repair sources.

Air Station Supply Management

Improving the general level of supply support at the air station level is considered fundamental to meeting the potential operational standards that may be established by the USCG. To upgrade air station supply management and to enhance 298 Allowance List integrity, demand recording and analysis, and supply management capabilities and expertise at the air station, we recommend the USCG

- Establish clear gross requisition effectiveness and net requisition effectiveness performance standards for the air station and use these standards directly in 298 Allowance List development and evaluation through the use of variable-level inventory models.
- Establish AR&SC procedures that update all air station 298 Allowance Lists on a cyclic (perhaps annual) basis using the most recent air station demand and maintenance data.
- Include the 298 Allowance List requirements in AFC 41 budget formulation and in execution at AR&SC by making 298 Allowance List requirements an explicit part of procurement and repair computations.
- Develop and implement a policy and standard work station capabilities (together with related procedures and SASI system applications) to record and analyze demand for "not-stocked" items at the air station.
- Evaluate current air station aviation supply responsibilities, organization, and management expertise. Implement alternative organizational responsibilities and structures to improve the management of all aviation materiel at the air station.
- Establish a uniform system capability for inventory management by the air station of Types III and V materiel.

Financial Management

Current USCG financial management policies and data systems neither provide a comprehensive profile of the true costs of aviation support nor the management capabilities needed to effectively execute a financial plan to maximize aviation logistics support. To facilitate improved financial management, we recommend the USCG

- Upgrade the Headquarters corporate data base and improve the integrity of the data maintained. Additionally, G-EAE in coordination with Chief, Financial Management Division (G-CFM), develop a set of financial reports to measure aviation logistics support costs and to review the execution of those cost. against the budget.
- Measure and evaluate the cost effectiveness of the USCG aviation logistics support program using reports produced from the Headquarters corporate data base to ensure that AFC 30 and AFC 41 funding for aviation logistics

support is adequate to meet established operational goals and that financial execution is consistent with the funding requested.

REPORT FORMAT

The remaining chapters of this report provide the underlying empirical foundation and supporting analyses on which our major conclusions are based.

In Chapter 2, we discuss the basic planning and control concepts and policies that currently guide the USCG aviation logistics, and in large part, determine the overall logistics infrastructure used to deliver materiel support. Chapter 2 also addresses basic operational requirements and key logistics relationships and linkages, organizational responsibilities and capabilities, and the effectiveness of critical performance measures currently used to evaluate system performance.

In Chapter 3, we assess the overall effectiveness of the Coast Guard aviation maintenance system. We analyze aggregate production planning, capacity management, scheduling and control, the introduction of emerging maintenance MISs, depot capacity and competition issues, and reliability and quality management efforts. Comparative or benchmark data is introduced in the analysis for perspective.

Chapter 4 examines aviation supply management. Aviation supply management extends from the initial provisioning of new aircraft and aircraft systems, to the continuing determination of materiel requirements at both AR&SC and the air station level, to budgeting and execution of required repair and procurement activities, to materiel storage and transportation, and to system retirement. We also focus directly on the structural integrity of the USCG aviation supply network, initial provisioning policies and techniques, the management of critical reparable components, and the effectiveness of air station supply support.

Lastly, in Chapter 5, we analyze the basic financial management process used to budget, fund, and execute the aviation logistics program. The focus of this chapter is on the budget integrity and financial execution for AFC 30 and AFC 41 funds, those financial resources for which G-EAE is either directly or indirectly responsible.

CHAPTER 2

AVIATION LOGISTICS PLANNING AND CONTROL

INTRODUCTION

In the course of our analysis, we examined several logistics issues that significantly influence the Coast Guard's overall investment in aviation logistics and the capability of G-EAE to execute high-quality aviation logistics program management. This chapter presents our analysis and recommendations in the following areas:

- Alternative approaches to interrelating the mix of readiness (B0 requirement), Ao, required aircraft inventory, programmed flying hours, and aircraft support infrastructure
- The G-EAE's ability to measure the performance of the aviation logistics support program
- The G-EAE's staffing required to successfully manage the full range of aviation logistics responsibilities.

LOGISTICS SUPPORT ALTERNATIVES FOR ACHIEVING AVIATION OPERATIONAL GOALS

Current Logic for Aircraft Readiness Goals

Development and promulgation of the USCG's aircraft readiness goals (including the current MC rate of 71 percent, the current PFH targets, and the B0 requirement) are the responsibility of the Aviation Operations Division (G-OAV), Office of Law Enforcement and Defense Operations (G-O). The G-OAV also is responsible for monitoring and reviewing aviation unit performance relative to these established operational goals through the collection and analysis of actual operating data.

From the perspective of the aviation logistics system (and G-EAE as the program manager of the USCG's aviation logistics system), those aircraft readiness goals establish the customer's requirement for basic aviation logistics policy. While G-EAE is not responsible for establishing the goals, it routinely uses them as an input to aviation logistics planning and structures aviation logistics policies and systems to meet the goals at the lowest overall life-cycle cost to the USCG.

Chapter 1 explains the relationship between establishing an aircraft Ao goal and meeting a given air station's B0 requirement. The relationship between Ao, stationing three aircraft of a given type at each air station, and achieving a 97.5 percent probability of always having one aircraft ready to meet mission requirements is addressed in this section.

The USCG target for Ao is 71 percent[1] and, historically, the USCG has used a 71 percent Ao goal. This Ao goal was established and is maintained because the USCG believes it accurately reflects the availability of aircraft based on inherent design and logistics support capability. Given that the USCG has positioned three aircraft[2] at each air station assigned a single B0 alert requirement, the existing 71 percent aircraft Ao goal allows the USCG to achieve a 97.5 percent probability that at least one out of three aircraft will be ready for flight at any given time.[3] Table 2-1 shows the current air station readiness requirements and the total number of aircraft of each type stationed at each air station. Table 2-2 shows the total number of days each air station has HH-65A aircraft deployed aboard ship[4] (the deployment requirements are in addition to the B0 readiness requirement). Those air stations with no HH-65A aircraft assigned scheduled missions (S.M.) use SAR aircraft for deployment aboard ship.

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[1]COMDTINST M13020.1C, *Aeronautical Engineering Maintenance Management Manual.*

[2]Except Air Station Chicago, which has two aircraft assigned.

[3]To determine the Ao that will provide for a 97.5 percent probability that one out of three aircraft will be ready for flight at any given time, the USCG would make the following calculations:

a. Determine that the 97.5 percent goal is equal to one minus the probability that all three aircraft are down. That is,

   .975 = 1 − probability of all three down; or probability of all three down = 1 − .975 = .025.

b. Determine that the probability that one aircraft is down is one minus the probability that it is up (which is its Ao). That is,

   probability of one down = 1 − Ao.

   The probability of all three aircraft being down is the probability of one down cubed. That is,

   probability of all three down = $(1 - Ao)^3$; or

   Ao = 1 − cube root of probability of all three down.

c. Solve for the desired Ao as one minus the cube root of .025 = .708 or 71 percent.

[4]A comparison of the assignment of HH-65A aircraft and the number of days deployed aboard ship indicates that those air stations assigned three HH-65A aircraft performed 146 out of the total 2,525 deployment days in 1991.

TABLE 2-1

AIR STATION READINESS REQUIREMENTS

Air stations	Aircraft	Program requirement	Number of aircraft authorized	Comments
Astoria, Oreg.	HU-25A	S.M.	2	
	HH-65A	1-B0	3	
Barbers Point, Hawaii	HC-130H	1-B0[a]	3	
	HH-65A	1-B0	3	
Borinquen, P.R.	HC-130H	S.M.	3	
	HH-65A	1-B0	3	
		S.M.	1	
Brooklyn, N.Y.	HH-65A	2-B0	5	15 May – 1 October
		1-B0	3	1 October – 15 May
		S.M.	2	1 October – 15 May
Cape Cod, Mass.	HU-25A	1-B0	3	
	HU-25B	1-B18	3	
	HH-60J	1-B0	3	
	HH-60J	S.M.	1	
Cape May, N.J.	HH-65A	1-B0	3	
Chicago, Ill.	HH-65A	1-B0	2	
Clearwater, Fla.	HC-130H	1-B0 (0800 – 1600)	5	
		1-B2 (1600 – 0800)		
	EC-130V	N/A	1	
	HH-3F	1-B0	3	
		S.M.	9	
Corpus Christi, Tex.	HU-25A	1-B0	3	
	HH-65A	1-B0	3	
Detroit, Mich.	HH-65A	1-B0	3	
Elizabeth City, N.C.	HC-130H	1-B2	3	
		S.M.	1	
	HH-60J	1-B0	3	
Houston, Tex.	HH-65A	1-B0	4	
Humboldt Bay, Cal.	HH-65A	1-B0	3	

Program requirement notes: A = law enforcement requirement to proceed in 15 minutes; B0 = able to proceed in 30 minutes; B2 = able to proceed in 2 hours; S.M. = scheduled mission, scheduled operations, no readiness requirements; ALPAT = Alaska Patrol. Note: B-18 = able to proceed in 18 hours; N/A = not applicable.

[a] Long Range Intercept Guard crew on call when B0 HC-130H is on SAR.

TABLE 2-1

AIR STATION READINESS REQUIREMENTS (Continued)

Air stations	Aircraft	Program requirement	Number of aircraft authorized	Comments
Kodiak, Alaska	HC-130H	1-B0	3	
		S.M.	3	
	HH-3F	1-B0 Kodiak	4	
		1-B0 Cordova		1 May – 1 October
	HH-65A	S.M. ALPAT	4	
Los Angeles, Calif.	HH-65A	1-B0	3	
Miami, Fla.	HU-25A/B	1-B0	3	
		S.M.	2	
	HU-25C	1-A	5	
		2-Deployed		
	HH-65A	1-B0	3	
		S.M.	6	
	RG-8A	S.M.	2	
Mobile, Ala.	HU-25A	1-B0	3	
		S.M.	2	Training
	HU-25C	1-Deployed	3	
	HH-65A	S.M.	4	Polar Operations
		S.M.	4	Training
	HH-3F	S.M.	3	
	HH-60J	S.M.	4	
New Orleans, La.	HH-65A	1-B0	5	
		1-B2		
North Bend[b], Oreg.	HH-65A	2-B0	5	
Port Angeles, Wash.	HH-65A	1-B0	3	
Sacramento, Calif.	HC-130H	1-B0	3	
		S.M.	1	
San Diego, Calif.	HU-25A	1-B0	3	
	HH-65A	1-B0	3	
		S.M.	1	
San Francisco, Calif.	HH-60J	1-B0	3	
Savannah[c], Ga.	HH-65A	2-B0	5	
		S.M.	1	
Sitka	HH-3F	1-B0	3	
Traverse City	HH-60J	1-B0	3	
Washington	VC-4	S.M.	1	
	VC-11	S.M.	1	

Program requirement notes: A = law enforcement requirement to proceed in 15 minutes; B0 = able to proceed in 30 minutes; B2 = able to proceed in 2 hours; S.M. = scheduled mission, scheduled operations, no readiness requirements; ALPAT = Alaska Patrol

[b] North Bend has a dual B0 requirement (one aircraft at North Bend and one aircraft at the Newport Air Facility).

[c] Savannah has a dual B0 requirement (one aircraft at Savannah and one aircraft at Charleston Air Facility).

TABLE 2-2

HH-65A AIRCRAFT – DAYS DEPLOYED ABOARD SHIP

Unit	DDAS (1989 – 1991)				Total number HH-65A aircraft assigned S.M.
	1991	1990	1989	Average	
Astoria, Oreg.	34	0	15	16	0
Barbers point, Hawaii	0	0	2	1	0
Borinquen, P.R.	133	146	104	128	1
Brooklyn, N.Y.	206	168	99	158	2
Cape May, N.J.	0	0	1	1	0
Corpus Christi, Tex.	27	48	69	48	0
Detroit. Mich.	0	17	0	6	0
Houston, Tex.	165	146	65	125	1
Humboldt Bay, Calif.	48	9	56	38	0
Kodiak (ALPAT), Alaska	343	221	358	307	4
Los Angeles, Calif.	18	84	66	56	0
Miami, Fla.	535	496	625	552	6
Mobile, Ala.	432	319	376	376	4
New Orleans, La.	150	146	184	160	0
North Bend, Oreg.	50	28	0	26	0
Port Angeles, Wash.	19	9	18	15	0
San Diego, Calif,	170	33	99	101	1
Savannah, Ga.	195	152	171	173	1
Totals	2,525	2,022	2,308	2,287	20

Note: Average days deployed aboard ship (DDAS) rounded to whole number.

Findings and Conclusions Concerning the Approach to Linking Logistics Factors to the Acquisition of Aircraft

As new aircraft are introduced into the USCG, long-range planning should be based upon the need to support operating requirements at the overall minimum life-cycle cost. This requires a long-range planning capability to evaluate both acquisition and support costs against various Ao levels that fulfill operational requirements.

Figure 2-1 shows that aircraft effectiveness is really a combination of aircraft capability, aircraft availability[5], and aircraft durability.[6,7] By focusing on the tradeoffs that may exist between those three factors, the USCG could select the alternative that meets operating requirements at the lowest overall life-cycle costs. Each of these factors must be evaluated to select the most cost-effective alternative. Both aircraft capability and aircraft durability are usually design-driven and specific to the given aircraft. Aircraft availability, on the other hand, is largely a function of the aviation logistics support decisions made. Availability varies for a given alternative based on the reliability, maintainability, and supportability of the equipment.[8] Figure 2-1 also shows the relationship between these factors and aircraft availability.

We saw no indication that the USCG examines aircraft effectiveness based on the tradeoffs between aircraft capability, availability, and durability. Additionally, there is no evidence that the USCG actually links all logistics factors to the aircraft acquisition decision in order to select the least-cost alternative available to satisfy its operating requirements. We also found that the USCG has not varied the aircraft Ao goal for any fixed wing or rotary aircraft regardless of the differences in aircraft capability, aircraft durability, aircraft inventory or their assigned operating missions.

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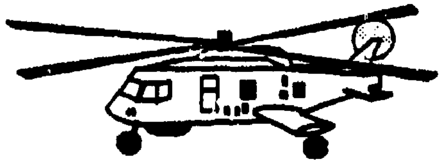
[5]Throughout our discussion we use the terms "aircraft operational availability" and "aircraft availability" interchangeably. This is represented by the acronym "Ao."

[6]*Aircraft effectiveness* measures whether the aircraft successfully does what it is intended to do. *Aircraft capability* measures the inherent operating capability of the aircraft. *Aircraft availability* measures the probability that the aircraft is "up" and ready to perform as intended at a random point in time that begins with the operating cycle. *Aircraft durability* measures the probability that the equipment, which is "up" at the beginning of an operating cycle, can perform during its intended operating cycle.

[7]We have tailored our definition of aircraft availability to the USCG by introducing a new factor that we believe will take advantage of the USCG's aviation engineering management capability. The new factor, not included in the traditional definitions of availability, is "mean time between maintenance $_{uncontrollable}$ ($MTBM_u$)." $MTBM_u$ includes uncontrollable maintenance actions, i.e., all corrective maintenance and all scheduled maintenance actions that are not controllable by the air station engineering officer. This definition actually equates to "managed operational availability."

[8]*Reliability* is the duration or probability of failure-free performance under stated conditions. *Maintainability* is the extent to which the aircraft can be restored to an operating condition in its intended operating environment, given the availability of necessary resources such as skilled personnel, spare parts, and maintenance manuals. *Supportability* is the degree to which the aircraft can be supported by the necessary combination of logistics resources, measured by the delay experienced when the USCG's logistics system is called on to perform.



Aircraft effectiveness = Aircraft capability × Aircraft availability × Aircraft durability

513 flying hours per year = 600 flying hours per year × .90 × .95

$$\text{Aircraft availability} = \frac{\text{Mean time between maintenance}_u}{\text{Mean time between maintenance}_u \text{ (reliability)} + \text{Mean time to repair (maintainability)} + \text{Mean logistics delay time (supportability)}}$$

$$.89 = \frac{1{,}000}{1{,}000 \text{ hours} + 3 \text{ hours} + 125 \text{ hours}}$$

Note: In Figure 2-1, we have selected PFH as the unit of measure for evaluating aircraft effectiveness and aircraft capability. We use PFH to illustrate our overall concept that aircraft effectiveness should be examined as a combination of the tradeoffs that exist between aircraft capability, aircraft availability, and aircraft durability. We recognize that there are alternative combinations of MC rate, PFH, and aircraft (number, siting, and performance capabilities) that conceptually could meet assigned mission and alert standards. Assessing alternative combinations of MC rate/PFH/aircraft population for each aircraft in the USCG inventory ensures that the type, number, and siting of aircraft meets operational requirements at lowest life-cycle cost.

FIG. 2-1. LINKING LOGISTICS FACTORS TO AIRCRAFT ACQUISITION DECISIONS

We conclude that the USCG does not separately consider each Ao factor – $MTBM_u$[9], MTTR, and MLDT – or the overall aircraft effectiveness factors when acquiring new aircraft. The discussions of maintenance and supply in Chapters 3 and 4 further address logistics planning and the tradeoff analysis needed to achieve the optimum mix between Ao and the quantity of a given aircraft required.

[9]$MTBM_u$ includes uncontrollable maintenance actions (i.e., all corrective maintenance and all scheduled maintenance actions that are not controllable by the maintenance officer).

Findings and Conclusions Concerning the Approach to Linking Logistics Factors to the Stationing of Aircraft

The above findings discussed lead us to conclude that the USCG has not necessarily optimized the trade-offs between Ao and aircraft quantity given the B0 requirements, nor is the Ao/aircraft quantity relationship necessarily optimum from a cost standpoint.

Table 2-3 displays some of the possible alternatives for stationing aircraft and satisfying the B0 mission readiness requirements. For example, Table 2-3 shows the various combinations of aircraft stationed and Ao targets that will provide a 97.5 percent probability that at least one aircraft will be ready for flight at any given point in time. The desired 97.5 percent probability could be achieved by two stationed aircraft and 84.2 percent Ao, three stationed aircraft and 70.8 percent Ao, four stationed aircraft and 60.2 percent Ao, etc. (This analysis assumes that the chance of any given aircraft being "down" is statistically independent from the other aircraft stationed at the given air station.) Table 2-3 also shows other probabilities (levels of confidence) that the Coast Guard might choose and the corresponding combinations of Ao and aircraft required to achieve them.

We also conclude that the reasoning behind adopting the standard of a 97.5 percent probability of having at least one aircraft ready for flight, as opposed to some other probability, is questionable. That number (i.e., 97.5) does not appear to have any particular statistical significance other than that it is derived when one assumes a 71 percent aircraft availability. Additionally, the many alternatives presented in Table 2-3 and the many other sets of alternatives that exist (but are not shown) highlight the fact that the current relationship linking logistics factors and the stationing of aircraft may not be optimal.

Findings and Conclusions Concerning the Programmed Flying Hour Target and Achieving Operational Availability

In Chapter 1, we indicated that the assigned PFH target for a given aircraft/mission is, conceptually and analytically, a derivative of the assumed 71 percent Ao rate. We found the USCG has established several different PFH standards for a given aircraft to account for the varying missions a type of aircraft may be assigned; however, we found no analytical or statistical evidence to support

TABLE 2-3

ALTERNATIVE APPROACHES TO STATIONING AIRCRAFT TO SATISFY BRAVO ZERO FLIGHT MISSION READINESS REQUIREMENTS

Aircraft flight readiness probabilities (%)	Aircraft stationed					
	Number	Ao (%)	Number	Ao (%)	Number	Ao (%)
Probability of one aircraft ready for flight						
99.5	2	92.9	3	82.9	4	73.4
99.0	2	90.0	3	78.5	4	68.4
98.5	2	87.8	3	75.3	4	65.0
98.0	2	85.9	3	72.9	4	62.4
97.5	2	84.2	3	70.8	4	60.2
97.0	2	82.7	3	68.9	4	58.4
96.5	2	81.3	3	67.3	4	56.7
96.0	2	80.0	3	65.8	4	55.3
95.5	2	78.8	3	64.4	4	53.9
95.0	2	77.6	3	63.2	4	52.7
94.5	2	76.5	3	62.0	4	51.6
94.0	2	75.5	3	60.9	4	50.5
Probability of one aircraft ready for flight						
99.5	5	65.3	6	58.6	7	53.1
99.0	5	60.2	6	53.6	7	48.2
98.5	5	56.8	6	50.3	7	45.1
98.0	5	54.3	6	47.9	7	42.8
97.5	5	52.2	6	45.9	7	41.0
97.0	5	50.4	6	44.3	7	39.4
96.5	5	48.9	6	42.8	7	38.1
96.0	5	47.5	6	41.5	7	36.9
95.5	5	46.2	6	40.4	7	35.8
95.0	5	45.1	6	39.3	7	34.8
94.5	5	44.0	6	38.3	7	33.9
94.0	5	43.0	6	37.4	7	33.1
Probability of two aircraft ready for flight						
99.5	4	88.9	5	81.5	6	74.6
99.0	4	85.9	5	77.8	6	70.6
98.5	4	83.8	5	75.5	6	67.9
98.0	4	82.1	5	73.3	6	65.8
97.5	4	80.6	5	71.6	6	64.1
97.0	4	79.3	5	70.2	6	62.7
96.5	4	78.1	5	68.9	6	61.4
96.0	4	77.1	5	67.8	6	60.2
95.5	4	76.1	5	66.7	6	59.2
95.0	4	75.1	5	65.7	6	58.2
94.5	4	74.3	5	64.8	6	57.3
94.0	4	73.4	5	64.0	6	56.4

an actual relationship between the PFH mission standards and the 71 percent Ao goal.

A logical supposition is that not-mission-capable (NMC) rates would affect the availability of the Coast Guard aircraft to perform their PFH, that is, the higher the NMC rates, the lower the percent of hours flown, especially for NMC rates below 71 percent.

Table 2-4 identifies the specific accomplishment ranges of established flying-hour programs (FHP). Of the total 62 observations supporting Table 2-4, NMC rates range from 10 percent to 45 percent, and percents of unit FHP accomplished range from 68.4 percent to 137.2 percent. Inspection of the data shows that high NMC rates relate to both low and high percentages of FHP accomplishment, although the lowest FHP percentage (68.4 percent) has the highest NMC rate of 45 percent. To test the hypothesis that percent of FHP accomplishment is related to NMC rates, we performed a correlation analysis [a statistical test to determine if a negative (or positive) linear relationship exists between two variables]. The resulting coefficients of correlation determination were an extremely low .08 between NMC rates and FHP accomplishment. Based on this statistical test of a fairly large sample of data, we conclude that percent of FHP accomplishment is not related to NMC rate.

Based on this, we also conclude that the ability of USCG aircraft to perform their PFH is a function of several factors. Some of these factors can, to a large extent, compensate for low NMC levels when they occur. This could be an indicator of the overall resiliency of the entire aviation logistics resourcing structure or an indicator of the actual relationship between logistics resources and current FHP. In either case, the absence of a determinable relationship between NMC rates and FHP further aggravates measuring the effectiveness, in terms of resource investments and expenditures, of functional support areas such as maintenance and supply.

Findings and Conclusions Concerning Established Operational Availability Goal

We do not believe that the traditional/historical 71 percent Ao goal accurately reflects the inherent design/logistics-driven capability of aircraft. Our review of OGA data highlights the fact that it is feasible to achieve and sustain higher aircraft availability rates than the USCG's established standard. Figure 2-2 displays the different Ao levels achieved by DoD. Civilian airline aircraft continually achieve Ao

TABLE 2-4

AIRCRAFT AVAILABILITY EFFECTIVENESS DATA

Aircraft fleet type	Number of units in the field	Year	Fleet Ao rate (%)	Unit NMCM range (%)	Fleet FHP execution rate (%)	Unit FHP execution range (%)
HH-65A	19	FY91	71	14 – 42	95.5	77.3 – 101.7
		FY92	75	15 – 42	97.9	89.8 – 106.6
HC-130	6	FY91	77	10 – 41	113.6	92.0 – 137.2
		FY92	75	18 – 33	103.0	76.9 – 114.1
HU-25A	6	FY91	69	25 – 44	86.4	68.5 – 103.9
		FY92	68	20 – 45	83.8	68.4 – 102.3

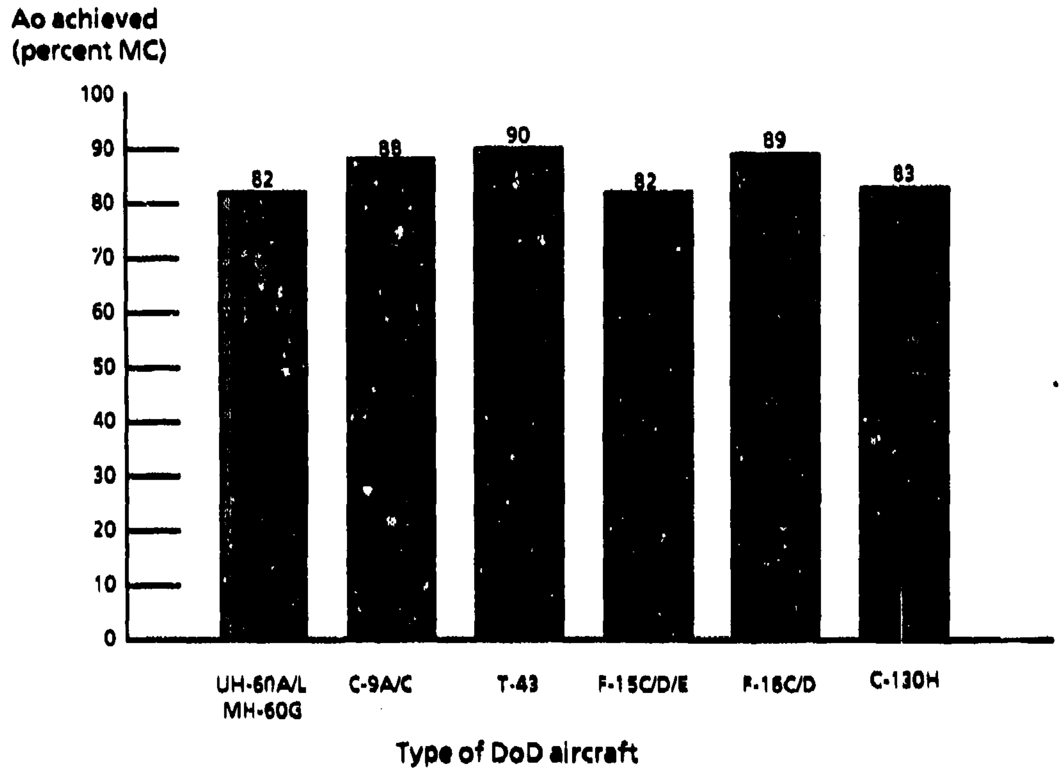
Source: USCG ACMS Operating Statistics Report; FY92 data through April 1992.

levels well in excess of 90 percent. While operating conditions (e.g., utilization rates, environmental severity, and resource levels) can cause variances in Ao, we conclude – and the data clearly shows – that higher availability rates are achievable with modern aircraft of all types.

Findings and Conclusions Concerning an Alternative Approach for Achieving Aircraft Operational Goals

Our previous report[10] says that "the air station maintenance program and all personnel resources required for aircraft maintenance are centrally managed and controlled. The engineering officer is held accountable for the availability of all air station aircraft. Organizing aircraft maintenance under the authority of a single department head allows that department head to set priorities for the most critical tasks."

[10]LMI Report CG001R1, *Forecasting the Applicability of Aviation Integrated Logistics Support Concepts to the Fleet*, George L. Slyman and Bruce A. Pincus, February 1992.



Note: DoD/U.S. Air Force. Period covered: May 1990 – April 1992.

FIG. 2-2. SAMPLE DoD ACHIEVED AIRCRAFT AVAILABILITIES

Alternative Approach

Two types of maintenance events can down an aircraft. One is the result of random failure and is referred to as "corrective" or "unscheduled" maintenance. The other is "preventive" or "scheduled" maintenance. The aviation maintenance program provides air station engineering officers with the flexibility necessary to execute scheduled maintenance since it is under his/her control. That flexibility allows managing scheduled maintenance in light of operational requirements. For example, assume a scenario in which three aircraft of a given type are stationed at an air station assigned a single B0 flight readiness requirement. If two of those aircraft are NMC (for scheduled or unscheduled maintenance or for supply reasons), the engineer would make a management decision to perform scheduled maintenance on the third aircraft only when failure to perform that maintenance causes that third aircraft to be grounded. Thus, in many instances, the engineering officer would control scheduled maintenance being done to ensure that the third aircraft remains ready for the B0 mission. Without managing maintenance in light of operational requirements, the third aircraft could have been downed independent of the mission capability of the other two aircraft.

Based on the logic above it is not necessarily correct that the chance of any given aircraft being down is statistically independent from the other aircraft stationed at the given air station. Since scheduled maintenance is controllable, it affects the probability analysis shown in Table 2-3. Some portion of the NMC time attributable to scheduled maintenance can be made dependent upon the mission capability of the other aircraft of that type assigned to the given air station. Specifically, the probability of the third aircraft being down becomes a conditional probability when scheduled maintenance is concerned.

To incorporate this added dimension in our analysis, we now explore the differences between the USCG's current approach and our alternative that assumes some portion of scheduled maintenance is controllable. First, we need to define the following terms:

U = probability the aircraft is up

D = probability the aircraft is down

Using these terms, we have the following relationships:

$$Ao = U = 1 - D \quad \text{and} \quad D = 1 - U = 1 - Ao$$

We add the following terms to differentiate between being down for scheduled versus unscheduled maintenance:

D_u = probability aircraft is down for unscheduled maintenance

D_s = probability aircraft is down for scheduled maintenance

$$D = D_u + D_s$$

To compare the current and the alternative approaches, we start by listing the possible readiness states of the three aircraft as if they were independent probabilities. Under the current approach, only the last readiness state (i.e., DDD) is used in the computation of desired Ao. As Table 2-5 shows, the same state breaks down to four states under the proposed approach.

TABLE 2-5

AIRCRAFT READINESS STATE – INDEPENDENT SCHEDULED MAINTENANCE

Current Approach				Alternative Approach			
No.	Description	State	Prob.	No.	Description	State	Prob.
1	All aircraft up	UUU	.355	1	All up	UUU	.355
3	One aircraft down	UUD	.439	3	One unscheduled down	UUD_u	.289
				3	One scheduled down	UUD_s	.150
3	Two aircraft down	UDD	.181	3	Two unscheduled down	UD_uD_u	.078
				3	Two scheduled down	UD_sD_s	.021
				6	Unscheduled/scheduled	UD_uD_s	.082
1	Three aircraft down	DDD	.025	1	Three unscheduled down	$D_uD_uD_u$	.007
				1	Three scheduled down	$D_sD_sD_s$	.001
				3	Two unscheduled/scheduled	$D_uD_uD_s$	.011
				3	Unscheduled/two scheduled	$D_uD_sD_s$	.006
	Total		1.000		Total		1.000

Note: In the table, number refers to the number of occurrences possible for a state. To compute the probability (Prob.) of a state, we use .708 for U (probability aircraft is up) and .292 for D_u (probability the aircraft is down for unscheduled maintenance).

In our alternative approach, the engineering officer would not down an aircraft for scheduled maintenance if the other two were already down.[11] This means that the last three readiness states under the proposed approach would not occur. The effect in these three readiness states would be to replace the scheduled maintenance probability of being down (D_s) with an equal controlled probability of being up (U_c); that is,

$$U_c = D_s$$

[11]We believe it is also possible that the engineering officer may exercise similar discretion with regard to even a second aircraft given certain scenarios.

Table 2-6 would then evolve as follows:

TABLE 2-6

AIRCRAFT READINESS STATE – CONTROLLABLE SCHEDULED MAINTENANCE

Current Approach				Alternative Approach			
No.	Description	State	Prob.	No.	Description	State	Prob.
1	All aircraft up	UUU	.355	1	All up	UUU	.355
3	One aircraft down	UUD	.439	3	One scheduled down	UUD_u	.289
				3	One scheduled down	UUD_s	.150
3	Two aircraft down	UDD	.181	3	Two unscheduled down	UD_uD_u	.078
				3	Two unscheduled down	$U_cD_uD_u$	.011
				3	Two scheduled down	UD_sD_s	.021
				1	Two scheduled down	$U_cD_sD_s$	.001
				6	Unscheduled/scheduled	UD_uD_s	.082
				3	Unscheduled/scheduled	$U_cD_uD_s$	.006
1	Three aircraft down	DDD	.025	1	Three unscheduled down	$D_uD_uD_u$	.007
	Total		1.000		Total		1.000

Note: In the table, number refers to the number of occurrences possible for a state. To compute the probability (Prob.) of a state, we use .708 for U (probability aircraft is up) and .292 for D_u (probability the aircraft is down for unscheduled maintenance).

Again, only the last readiness state under each approach is used in computing the desired probability.

To see how this change affects the final Ao result, consider the three aircraft scenario. However, this time, also assume that an aircraft is down for scheduled maintenance for a total of 3 days (72 hours) in the month (10 percent of the time).

Using the USCG's current approach, we computed (footnote 3, on page 2-2 of this chapter) the target Ao as 71 percent for a desired probability goal that one out of three aircraft would be ready 97.5 percent of the time. The corresponding probability of being down (D) would be 29 percent. Thus, with the same 97.5 confidence goal, the alternative approach would yield the equivalent of the 29 percent down but with only the .007 probability of three aircraft being down for unscheduled maintenance (i.e., the last readiness state in Table 2-6). Using the alternative approach, an Ao target of 61 percent achieves the desired goal that one of three aircraft would be ready 97.5 percent of the time. The lower Ao target derives from the 29 percent equivalent probability plus the assumed 10 percent down for scheduled maintenance.

Similar results follow for other cases. That is, our alternative approach determines the target Ao for any case by completing the following steps:

(1) Follow the current approach to determine the Ao percentage based only on unscheduled maintenance (Table 2-3).

(2) Determine the percentage of time an aircraft is down for scheduled maintenance.

(3) Subtract that percentage found in Step (2) from the Ao percentage found in Step (1) to arrive at the target Ao.

In short, the target Ao is the probability derived under the current approach less the percent of scheduled maintenance. Tables 2-7 and 2-8 show the results of the proposed approach with controllable scheduled maintenance percentages (i.e., the scheduled maintenance that can be deferred by the engineering officer without downing the aircraft) of 8 percent and 10 percent (respectively) of the 24 percent total NMC due to maintenance (NMCM) time.

Findings and Conclusions

We were unable to ascertain the amount of scheduled maintenance in relation to total maintenance performed because most corrective maintenance actions are not recorded in the Aviation Computerized Maintenance System (ACMS) nor is NMCM time reported as scheduled or unscheduled.[12] We also recognize that (1) some scheduled maintenance actions require extensive time to complete and may be ongoing when a second aircraft is downed, and (2) the order of scheduled versus

[12]COMDTINST M13090.1, *Aviation Computerized Maintenance System (ACMS) User's Manual* states that: "the ACMS software is used to schedule and report maintenance activities for all Coast Guard fixed and rotary wing aircraft, engines, propellers, selected assemblies, components, and life support equipment. The software is also used to record and report aircraft data and maintain significant historical records (Air Force Technical Order-95 format) on airframes and selected components. The significant historical records are maintained on all components designated as Serial Number Tracked. These include all airframes and all components which have a life limit, required overhaul time, specified maintenance interval, or are for any reason designated by the Coast Guard as a Serial Number Tracked Component."

unscheduled maintenance events is important to our analysis. Given these factors we have conservatively estimated controllable scheduled maintenance percentages of 8 percent and 10 percent and used them in Tables 2-7 and 2-8.

These tables suggest that our alternative approach would allow the Coast Guard to achieve a 97.5 percent probability of meeting its readiness commitment (B0) with two aircraft assigned to an air station if the Ao can be increased from 71 percent to 76 percent (8 percent controllable scheduled maintenance) or 74 percent (10 percent controllable scheduled maintenance). It should be possible to achieve the necessary increase in Ao by reducing the number of aircraft at an air station because the existing logistics support structure could provide more intensive support and management to the overall fewer number of aircraft.

Recommendations

Based on our analysis of logistics support alternatives for achieving aviation operational goals, we recommend the USCG

- Establish a long-range planning capability to (1) examine aircraft effectiveness as an optimum mix among the goals of aircraft capability, aircraft availability, and aircraft durability; and (2) consider logistics factors when aircraft acquisition decisions are made in order to select the least-cost available alternative satisfying the USCG's operating requirements.
- Evaluate our proposed alternatives related to the relationships among Ao, the concept of stationing three aircraft of a given type at an air station to meet the B0 requirement, and achieving a 97.5 percent probability of always having at least one aircraft ready to meet mission requirements.
- Implement a capability for measuring the amount of scheduled maintenance in relation to the total maintenance performed at each air station.

Note that Chapter 3 discusses alternative maintenance practices that will, when implemented, achieve long-term improvements in aircraft maintenance capabilities. Chapter 4 proposes alternative strategies for achieving improved Ao levels through supply-related management improvements.

TAPLE 2-7

PROPOSED APPROACH – 8 PERCENT CONTROLLABLE SCHEDULED MAINTENANCE

Aircraft flight readiness probabilities (%)	Aircraft stationed					
	Number	Ao (%)	Number	Ao (%)	Number	Ao (%)
Probability of one aircraft ready for flight						
99.5	2	84.9	3	74.9	4	65.4
99.0	2	82.0	3	70.5	4	60.4
98.5	2	79.8	3	67.3	4	57.0
98.0	2	77.9	3	64.9	4	54.4
97.5	2	76.2	3	62.8	4	52.2
97.0	2	74.7	3	60.9	4	50.4
96.5	2	73.3	3	59.3	4	48.7
96.0	2	72.0	3	57.8	4	47.3
95.5	2	70.8	3	56.4	4	45.9
95.0	2	69.6	3	55.2	4	44.7
94.5	2	68.5	3	54.0	4	43.6
94.0	2	67.5	3	52.9	4	42.5
Probability of one aircraft ready for flight						
99.5	5	57.3	6	50.6	7	45.1
99.0	5	52.2	6	45.6	7	40.2
98.5	5	48.8	6	42.3	7	37.1
98.0	5	46.3	6	39.9	7	34.8
97.5	5	44.2	6	37.9	7	33.0
97.0	5	42.4	6	36.3	7	31.4
96.5	5	40.9	6	34.8	7	30.1
96.0	5	39.5	6	33.5	7	28.9
95.5	5	38.2	6	32.4	7	27.8
95.0	5	37.1	6	31.3	7	26.8
94.5	5	36.0	6	30.3	7	25.9
94.0	5	35.0	6	29.4	7	25.1
Probability of two aircraft ready for flight						
99.5	4	80.9	5	73.5	6	66.6
99.0	4	77.9	5	69.8	6	62.6
98.5	4	75.8	5	67.3	6	59.9
98.0	4	74.1	5	65.3	6	57.8
97.5	4	72.6	5	63.6	6	56.1
97.0	4	71.3	5	62.2	6	54.7
96.5	4	70.1	5	60.9	6	53.4
96.0	4	69.1	5	59.8	6	52.2
95.5	4	68.1	5	58.7	6	51.2
95.0	4	67.1	5	57.7	6	50.2
94.5	4	66.3	5	56.8	6	49.3
94.0	4	65.4	5	56.0	6	48.4

TABLE 2-8

PROPOSED APPROACH – 10 PERCENT CONTROLLABLE SCHEDULED MAINTENANCE

Aircraft flight readiness probabilities (%)	Aircraft stationed					
	Number	Ao (%)	Number	Ao (%)	Number	Ao (%)
Probability of one aircraft ready for flight						
99.5	2	82.9	3	72.9	4	63.4
99.0	2	80.0	3	68.5	4	58.4
98.5	2	77.8	3	65.3	4	55.0
98.0	2	75.9	3	62.9	4	52.4
97.5	2	74.2	3	60.8	4	50.2
97.0	2	72.7	3	58.9	4	48.4
96.5	2	71.3	3	57.3	4	46.7
96.0	2	70.0	3	55.8	4	45.3
95.5	2	68.8	3	54.4	4	43.9
95.0	2	67.6	3	53.2	4	42.7
94.5	2	66.5	3	52.0	4	41.6
94.0	2	65.5	3	50.9	4	40.5
Probability of one aircraft ready for flight						
99.5	5	55.3	6	48.6	7	43.1
99.0	5	50.2	6	43.6	7	38.2
98.5	5	46.8	6	40.3	7	35.1
98.0	5	44.3	6	37.9	7	32.8
97.5	5	42.2	6	35.9	7	31.0
97.0	5	40.4	6	34.3	7	29.4
96.5	5	38.9	6	32.8	7	28.1
96.0	5	37.5	6	31.5	7	26.9
95.5	5	36.2	6	30.4	7	25.8
95.0	5	35.1	6	29.3	7	24.8
94.5	5	34.0	6	28.3	7	23.9
94.0	5	33.0	6	27.4	7	23.1
Probability of two aircraft ready for flight						
99.5	4	78.9	5	71.5	6	64.6
99.0	4	75.9	5	67.8	6	60.6
98.5	4	73.8	5	65.3	6	57.9
98.0	4	72.1	5	63.3	6	55.8
97.5	4	70.6	5	61.6	6	54.1
97.0	4	69.3	5	60.2	6	52.7
96.5	4	68.1	5	58.9	6	51.4
96.0	4	67.1	5	57.8	6	50.2
95.5	4	66.1	5	56.7	6	49.2
95.0	4	65.1	5	55.7	6	48.2
94.5	4	64.3	5	54.8	6	47.3
94.0	4	63.4	5	54.0	6	46.4

Two of the many responsibilities assigned to G-EAE are[13]

- Manage the Coast Guard aeronautical engineering maintenance programs.
- Serve as the program manager for AR&SC.

The successful execution of these responsibilities requires that G-EAE exercise oversight and review of the aviation logistics support program's performance. Measuring performance is integral to determining the degree to which the aviation logistics program is meeting aviation program objectives. Our previous studies indicate that measurement of current performance is essential to the development of rational policy and to the decisions on allocation of resources. Program oversight and review requires (1) the availability of a reporting system to convey performance data, (2) a procedure for establishing standards representing the desired level of performance, and (3) a staff to analyze and convert the data into information for management decision making.[14]

The aviation community determines "maintenance effectiveness... by the ability of the unit to provide operable aircraft to meet mission requirements at minimum cost to the aviation maintenance system. A measure of efficiency is the amount of manpower, money, and materiel required to meet unit readiness and mission requirements. Although meeting unit requirements is the prime consideration, maintenance effectiveness is derived from the entire maintenance effort. Maintenance effectiveness measures the Engineering Officer's ability to safely deliver serviceable equipment in good repair and correct configuration within specified time frames and at the minimum cost to the overall system. Engineering Officers must develop means of monitoring the effectiveness of their maintenance program in supporting the mission."[15]

Measuring the total cost of aviation logistics support is important and integral to G-EAE's successful performance of its aviation logistics program management responsibilities. The aviation community can only successfully optimize logistics

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[13]COMDTINST M13020.1C, op. cit.

[14] LMI Report CG701R1 Supplement, *Focusing Planning for Supply Management: Objectives, Policies, Oversight, and Review*, George L. Slyman, et al. April 1988.

[15]COMDTINST M13020.1C, op. cit.

support costs when total cost data related to logistics support is in the hands of the decision makers responsible for achieving the minimum cost alternative.

Findings and Conclusions

We found the Coast Guard currently does not have the capability to (1) analyze what represents the minimum cost of satisfying mission requirements and (2) measure the effectiveness of the aviation logistics support program. The financial-related performance measures and data collection requirements necessary to measure the full costs of aviation logistics support are absent at the air station level and at G-EAE.[16]

The only performance measures consistently used by air station Engineering Officers to measure supply and maintenance efficiency are NMC rates, PFH completion, and completion of scheduled maintenance.[17] These rates do measure whether the nonavailability of an aircraft is the result of maintenance or supply requirements; however, they do not explain the underlying causes for maintenance or supply requirements and deficiencies. Additionally, performance measures have not been developed to evaluate if NMC status results from nonsupply or maintenance deficiencies.

The G-EAE uses NMC rates and accomplishment of PFH by aircraft fleet or type to measure the overall performance of aviation logistics. Additionally, G-EAE conducts annual visits to each air station and evaluates each against a standard checklist, and obtains, on request, reports from the ACMS.

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[16]Chapter 5 of this report provides a more complete discussion of Headquarters capability to measure the full cost of the aviation logistics support program.

[17]COMDTINST M13020.1C, op. cit., states "availability of aircraft to perform operational missions is dependent on a wide range of variables. These include availability of flight and maintenance crews, special tools, ground support and launching equipment, spare parts, fueling apparatus, and numerous other factors. Non-availability is accounted for as follows:

1. NMC (Not Mission Capable): Assuming that adequate flight crew personnel, ground support equipment, fuel and other requirements have been provided, the non-availability of an aircraft can be described as the result of maintenance or supply requirements, or both.
2. NMC = Not Mission Capable due to Maintenance (NMCM) + Not Mission Capable due to Supply (NMCS) + Not Mission Capable due to Both Maintenance and Supply (NMCB)."

The air station visit checklist evaluates the following:

- Aircraft maintenance
- Aircraft/avionics maintenance management
- Maintenance support programs
- Records and reports
- Supply support
- Personnel and training
- Directives and publications
- Plant equipment and facilities
- Projects
- Maintenance safety.

The air station visit findings, both qualitative and quantitative, are documented and reported. Though performance standards have not been established per se, G-EAE has sufficient experience to identify and follow-up on actual and potential problem areas.

Other than the NMC due to Supply (NMCS) rates discussed above, G-EAE does not regularly use supply-related performance measures to exercise oversight and review of AR&SC performance.

We believe G-EAE should continue to measure Ao by aircraft type since equipment availability is largely a function of the aviation logistics support decisions made and varies for a given alternative based on the reliability, maintainability, and supportability of the equipment. Additionally, G-EAE should establish aggregate performance measures of each Ao factor ($MTBM_u$, MTTR, and MLDT). Finally, G-EAE should establish detailed supply, maintenance, and financial indicators to allow detailed analysis of the Ao factors.

Recommendations

To successfully exercise oversight and review of the aviation logistics program, the USCG should take the following actions:

- Develop and implement performance measures, data-collection methods, and analysis requirements that directly support decisions about the minimum cost of aviation logistics support.
- Establish performance areas to measure the effectiveness of logistics support.

The performance areas for which we recommend measures are operational availability and maintenance, supply, and finance. The following subsections list the factors we recommend be measured in the various performance areas. Those listed with an asterisk (*) are not routinely performed or reported under current Coast Guard policies and systems. The factors we recommend for measurement under operational availability are based on the Ao established for each aircraft type (the MC rate is an acceptable approximation of this indicator).

- Mean time between maintenance uncontrollable ($MTBM_u$) (in hours) by aircraft type (reliability).
- Mean time to repair (MTTR) (in hours) by aircraft type (maintainability).
- Mean logistics delay time (MLDT) (in hours) by aircraft type (supportability).

Maintenance

- Unscheduled versus scheduled NMCM percent*
- NMC percentage by aircraft system*
- Cannibalization rates per 100 or 1,000 flight hours*
- Resource intensive operations*
- Mission abort rates per mission/sortie/flight hour (or multiple thereof)*
- Visibility of corrosion problems in terms of NMC time or resource intensity*
- Bench check actions (e.g., cannot duplicate malfunctions)*
- Unscheduled maintenance actions and corrective action data*

- Scheduled maintenance effectiveness (percentage of actions completed on time)*.

Supply

- Air station accommodation rate (percentage of requisitions for stocked items)*
- Air station gross effectiveners (percentage of total requisitions filled)*
- Air station net effectiveness (percentage of requisitions for stocked items filled)*
- Air station issue processing time in hours*
- Air station back orders to maintenance (by materiel type)*
- Air station monthly demand in dollars*
- Air station monthly issues in dollars
- Air station inventory requirements (by materiel type) in dollars*
- Air station on-hand inventory (by materiel type) in dollars
- Air station on-order inventory (by materiel type) in dollars
- Retrograde pipeline time in hours*
- AR&SC accommodation rate (percentage of requisitions for stocked items)*
- AR&SC gross effectiveness (percentage of total requisitions filled)*
- AR&SC net effectiveness (percentage of requisitions for stocked items filled)
- AR&SC back orders to air stations (by materiel type)*
- AR&SC issue processing time in hours*
- AR&SC shipping/transportation time to the air station in days*
- Depot repair cycle time in days*
- Carcass return rate (percentage of failed components received at AR&SC)*
- AR&SC monthly demand in dollars*
- AR&SC monthly issues in dollars
- AR&SC on-hand serviceable inventory (by materiel type) in dollars
- AR&SC on-hand unserviceable inventory (by materiel type) in dollars

- AR&SC on-order inventory (by materiel type) in dollars
- AR&SC in-repair inventory (by materiel type) in dollars
- AR&SC procurement cycle time in dollars*
- AR&SC safety-level requirements in dollars*
- AR&SC procurement lead-time requirements in dollars*
- AR&SC non-demand-based/insurance requirements in dollars*.

Financial

- AFC 30 actual funding provided and actual expenditures incurred at all levels and for all areas of aviation logistics support*
- AFC 41 actual funding provided and actual expenditures incurred at all levels and for all areas of aviation logistics support*
- AFC 56 (personnel training and education) actual funding provided and actual expenditures incurred at all levels and for all areas of aviation logistics support*.

STAFF CAPABILITY AND FOCUS NEEDED TO ADDRESS AVIATION LOGISTICS SUPPORT RESPONSIBILITIES

The G-EAE staff is made up of individuals highly trained and capable in the technical aspects of aeronautical engineering. We believe that their technical orientation is well suited to G-EAE serving "as a focal point for technical and engineering support for systems and equipment in the operational inventory."[18] Combined with G-EAE's active "brokering" of solutions to problems impacting maintenance and engineering, we found G-EAE extremely effective in executing its technical maintenance and engineering responsibilities. Additionally, as stated in Chapter 4, although the G-ELM has responsibility for developing and promulgating supply policy, aviation supply policy development actually occurs at AR&SC.

Effective management of the full scope of aviation logistics responsibilities requires G-EAE to develop a much broader view of both its responsibilities and

[18]COMDTINST M13020.1C, op. cit.

capabilities. To provide for enhanced policy development planning, and program guidance capabilities, we recommend the USCG

- Develop aviation supply policy – as a coordinated effort between G-EAE and G-ELM – to ensure the supply policy reflects integrated logistics management concepts. While it is appropriate to delegate specific supply requirements and source of supply concerns to AR&SC, aviation supply policy should be promulgated in COMDTINST M4400.19, *Supply Planning and Procedures Manual.*
- Direct G-EAE to place greater strategic emphasis on long-range planning, policy development, and program guidance.
- Delegate specific technical responsibilities to AR&SC that are now performed by G-EAE.

Given the current G-EAE staffing levels, delegation of technical responsibilities to AR&SC permits G-EAE to implement strategic planning, policy development, and program guidance capabilities for the full range of aviation logistics support responsibilities. As examples of the technical responsibilities to delegate, management of the RCM program should come under the oversight of the AR&SC Engineering Division; the evolving "product-line manager" concept at AR&SC should be expanded over time to include many of the detailed procedural and operations-related direction currently performed by G-EAE. However, G-EAE should continue to use its brokering capability to assist AR&SC in resolving technical engineering or maintenance support concerns.

CHAPTER 3

AVIATION MAINTENANCE MANAGEMENT EFFECTIVENESS

INTRODUCTION

In Chapter 2, our discussion includes (1) the interrelationship between aircraft availability and aircraft equipment effectiveness and (2) the importance of maintainability and reliability in establishing an Ao goal. Maintainability and reliability are design characteristics. The aviation maintenance program, resulting from this design, performs maintenance[1] to "ensure, in the most cost-effective manner, that assigned materiel is serviceable (safe and operable) and properly configured to meet mission requirements."[2]

As defined and used in the development and analysis of Ao requirements, maintainability is specifically measured by the MTTR of the aircraft or aircraft system. The MTTR represents the expected delay or downtime associated with the repair (i.e., all corrective maintenance times plus all scheduled maintenance times that are not controllable by the maintenance officer) of the aircraft or aircraft system at the operating level; for the USCG, the operating level is the field unit/air station. Further, MTTR assumes that the necessary resources (e.g., people, parts, technical information, and tools) are available for repair or maintenance.

In this chapter, we discuss the effectiveness of the aeronautical engineering maintenance program. We evaluate maintenance program management and oversight, maintenance MISs, maintenance operations and planning, depot maintenance workload management and competition, and product improvement. We identify specific USCG-desired operating results, highlight ongoing USCG maintenance

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[1]COMDTINST M13020.1C, *Aeronautical Engineering Maintenance Management Manual* states that maintenance includes "inspection, repair, overhaul, modification, preservation, testing, and condition or performance analysis. Emphasis is placed on planning and scheduling these tasks to allow timely accomplishment through the efficient use of personnel, facilities, and equipment by supervisors." The USCG aviation maintenance program also requires management of the technical information in order to perform such tasks and the data generated by these actions.

[2]COMDTINST M13020.1C, *Aeronautical Engineering Maintenance Management Manual*.

management initiatives, contrast USCG experience with DoD benchmarks, and describe current DoD initiatives for accomplishing depot maintenance.

Aviation Maintenance System Overview

The USCG aviation maintenance management system is a composite of U.S. Air Force and Navy systems, commercial procedures, and USCG developed procedures.[3] The three basic elements of the aviation maintenance system are management, technical, and production.[4] The G-EAE provides the overall management of the maintenance system and further serves as a focal point for technical and engineering support for systems and equipment in the operational inventory. The technical element is provided by AR&SC (primarily from the Aviation Engineering Division) and by field units designated as "Prime Units" under the direction of G-EAE. Because of its brokering activities and current focus, G-EAE is also directly involved in facilitating or solving technical problems. Operating activities at air stations (unit-level maintenance) and at AR&SC (depot-level maintenance), including AR&SC-managed depot-level contract and OGA sources, perform as the maintenance production elements. Maintenance production includes functions such as service, repair, test, overhaul, modification, calibration, conversion and inspection. This two-level maintenance production concept relies heavily on the capabilities of AR&SC (i.e., organic, contract, and OGA) to provide timely, high-quality maintenance of airframes and components.

The AR&SC maintenance production is oriented to two primary maintenance programs. First, the programmed depot maintenance (PDM) addresses the cyclical overhaul and refurbishment of aircraft. At AR&SC, PDM requirements are extensive and are currently viewed as the top priority maintenance effort. The PDM intervals (i.e., how frequently aircraft are scheduled for PDM) and PDM cycle time (i.e., how long it takes to complete an average PDM) are major factors that can (1) affect the daily readiness (i.e., BO) capability at each air station and (2) influence, if properly considered, the acquisition planning decision regarding the total number of aircraft required. The second major program at AR&SC is the repair or overhaul of aircraft components. The effect of maintenance management effectiveness in component repair/overhaul at AR&SC (and in commercial/DoD depots) affects Ao;

[3]COMDTINST M13020. 1C, op. cit.
[4]COMDTINST M13020. 1C, op. cit.

however, that effect is not related to MTTR but rather to the MLDT[5] associated with the *supportability* of the aircraft system. Component repair/overhaul performance at (and managed by) AR&SC is a major element of supply availability at the air station and at AR&SC and, therefore, maintenance effectiveness directly influences investment in materiel inventories and also indirectly influences Ao.

Program Capability to Accomplish Required Maintenance Support

As expected, at every level of the aviation community (i.e., G-EAE, AR&SC, and USCG air stations) we found complete commitment and dedication to ensuring that maintenance programs are accomplished to achieve mission success. Overall, the USCG aviation engineering community contains individuals whose orientation, formal training, and career involvement is principally directed toward solving engineering-related problems and accomplishing required maintenance actions to meet mission needs. Additionally, maintenance performed at AR&SC and USCG air stations is producing quality aircraft for operational missions.

Staffing and Focus on Maintenance Management

The USCG has established a high level of redundancy and an intense focus on the technical and engineering aspects of maintenance management. From G-EAE through AR&SC to air station maintenance operations there is a strong propensity to view requirements for technical solutions to problems and issues as the most appropriate venue for action. We found a strong commitment (and concomitant assignment of resources) within G-EAE to operate in this venue. While we do not question the importance of this commitment, G-EAE should place greater emphasis on strategic issues, long-range planning, policy development, and program oversight and measurement. In essence, the current technical perspective should be refocused to improve the overall support provided to the USCG aviation logistics program.

We believe that responsibility for development of strategic aviation logistics policy, resources, and management information requirements belongs at G-EAE. The preponderance of technical, engineering, and procedural responsibilities should be at AR&SC. Among those responsibilities that should be at AR&SC, in addition to solving routine technical problems, are programs such as RCM, ACMS, corrosion

[5]MLDT includes all logistics delays (for parts, technicians, technical publications, etc.) that influence aircraft or system downtime. Supply availability is a major factor in MLDT. MLDT is discussed in detail in Chapter 4.

control, and product improvement. Initiatives that are primarily technical may originate in G-EAE but AR&SC – specifically the product-line managers – should manage their analysis, implementation plan, and execution. AR&SC's Engineering Division is also a likely recipient of a portion of the technical responsibility currently resident in G-EAE.

Such delegation enables the G-EAE staff to focus on strategic policy, mid- and long-range plans, infrastructure, and programmatic issues that provide the foundation for a successful aviation logistics program. The realignment will better utilize the inherent strengths of the organizational structure and element relationships. In the absence of such a realignment of roles and responsibilities, the G-EAE staff is not likely to be sufficiently resourced (1) to address the large number of policy, resource, technical, and support issues that are surfacing as the USCG restructures for the future; or (2) to address those issues in sufficient depth to ensure proper consideration of aviation logistics support requirements. Also, overall use of highly and equally trained aeronautical engineers may be less effective if technical issues remain a primary focus of the G-EAE staff. It is possible that overall support to the system will not be as effective given redundant technical and engineering focus and effort. In positioning for future Headquarters restructuring, redistributing roles and responsibilities will lead to AR&SC's operations being of enhanced value and will contribute to AR&SC's continued evolution as a comprehensive aviation logistics support center for the USCG.

AVIATION MAINTENANCE PROGRAM MANAGEMENT AND OVERSIGHT

As outlined in Chapter 1, G-EAE is responsible for overall policy direction, planning, program management and performance assessment for USCG aviation logistics. For the maintenance element of logistics, this responsibility encompasses a wide spectrum of functions, including technical, programmatic, and policy development.

Field Maintenance Support Concepts

Our previous study[6] discussed a number of G-EAE-related logistics support concepts that we believe significantly enhance maintenance accomplishment in the field. These concepts include the following:

- *Streamlined Technical Channel.* Aviation's integrated technical support channel provides each air station with a single point of contact/clearinghouse for maintenance functions. Air station maintenance operates independent of district or Maintenance Logistics Command coordination or oversight. The quick-reaction technical support channel streamlines aviation's distribution of general information, decisions, and advice. It enables G-EAE to establish policy and plan for all maintenance issues.
- *Centrally Managed Maintenance.* G-EAE is organized in such a way that platform managers centrally plan and direct all Coast Guard aeronautical engineering maintenance programs for the aircraft structural, mechanical, and engine components as well as for avionics, ground support equipment, and rescue and survival equipment.
- *Centralized Maintenance Reporting.* Policies are established to report required and completed maintenance actions to a central maintenance collection point (while the current primary focus of such reporting is on scheduled maintenance action completion, a significant portion of the aircraft maintenance effort is so reported).
- *Brokering Solutions.* The quick-reaction technical channel described above is enhanced through an active G-EAE brokering role within and outside the USCG. G-EAE actively brokers solutions to a wide range of issues by focusing a broad array of resources to solve technical and maintenance support requirements.

Production Planning and Capacity Management Effects on Acquisition and Sustaining Support

The quality of production planning and capacity management influences maintenance costs and operational support in aircraft and systems acquisition and in steady state maintenance support. During aircraft or system acquisition, effective planning of PDM intervals and PDM cycle times directly influences the number of aircraft to be acquired. Table 3-1 shows that as PDM intervals increase (or as PDM

[6]LMI Report CG001LN1, *Forecasting the Applicability of Aviation Integrated Logistics Support Concepts to the Fleet*, George L. Slyman and Bruce A. Pincus, February 1992.

cycle time decreases), the mean number of aircraft hours per month allocated to PDM decreases. In turn, this reduces the aircraft requirement proportionally.

TABLE 3-1

DETERMINATION OF MEAN MONTHLY AIRCRAFT HOUR REQUIREMENTS PER AIRCRAFT UNDER VARYING PDM ASSUMPTIONS

Required in-service aircraft hours per month	PDM interval (months)	PDM cycle time	Average PDM hours per month	Average total required aircraft hours per month	Monthly PDM hours as a percentage of in-service hours
400	48	5,000	104.2	504.2	26.1
400	36	5,000	138.9	538.9	34.7
400	36	2,000	55.6	455.3	13.9
400	24	5,000	208.3	608.3	52.1
400	24	2,000	83.3	483.3	20.8

Note: Entries in the table are for illustrative purposes only and are not meant to reflect USCG or OGA actual experience.

There is a clear cost tradeoff among aircraft durability (longer PDM intervals), depot PDM capacity (shorter PDM cycle times), and aircraft acquisition requirements. For example, using the combination of 400 hours of in-service aircraft hours, a PDM interval of 36 months, and a PDM cycle time of 5,000 hours as a baseline situation (as reflected in Table 3-1), the ratio of monthly PDM hours to in-service hours is 34.7 percent. For purposes of illustration, if in a specific aircraft acquisition program we assume that this ratio requires that a total of 100 aircraft be acquired, we may then compare alternative PDM intervals/PDM cycle times in terms of their potential impact on aircraft acquisition requirements. By reducing the PDM interval to 24 months, we would need to acquire 113 aircraft. However, reducing PDM cycle time to 2,000 hours, we would need to acquire only 84 aircraft. During aircraft acquisition these tradeoffs must be analyzed to determine the appropriate (i.e., most cost-effective) mix of aircraft durability (which influences the acquisition cost of an aircraft), the PDM capacity required (which impacts PDM cycle time), and the number of aircraft to be acquired. Our analysis of the USCG's long-range production planning and capacity management during aircraft acquisition does not reveal an adequate consideration and application of these tradeoffs. Rather, for the acquisition programs examined, the total number of aircraft required was determined by using the current fleet size (the number of aircraft being replaced), the current AR&SC PDM capacity (existing PDM cycle times), and the expected PDM interval for the new aircraft.

We observed that sustaining planning and the current work loading policy for AR&SC is to provide first for planned aircraft PDM and overhaul workloads. This normally utilizes about 85 percent of available labor-hour resources. The remaining resources are utilized for component workloads. There are many reasons for this approach, including traditional practices, uniqueness of USCG aircraft (i.e., HH-65 and UH-25), aircraft condition, and perceived potential costs. It is interesting to note that AR&SC workload planning and labor availability are prime determinants of PDM cycle development. New aircraft (e.g., HH-60) PDM planning is strongly influenced by labor availability and by technical, programmatic, and economical considerations. In most cases, PDM cycle-time planning has followed aircraft fleet acquisition, rather than being a key determinant of fleet size. However, there is no evidence that depot maintenance capacity management was either influenced or specified by aircraft/system maintainability. Thus, we do not believe that there is an actual link between the design parameters of the aircraft (durability), the PDM interval, the PDM cycle time, the number of aircraft acquired, and the actual depot maintenance capacity required.

Once the optimal total number of aircraft has been determined during system acquisition and the out-of-service aircraft projected for the remaining in-service aircraft, an Ao-based analysis of reliability, maintainability, and supportability tradeoffs can be conducted to determine the most cost-effective mix of these factors to meet a given Ao requirement. Maintainability improvements (through lower MTTR) at the field unit level of maintenance can be addressed in terms of cost and Ao impact relative to reliability and supportability improvements and related costs. In assessing different levels of supportability (measured as MLDT), the impact of added AR&SC (and/or commercial) component overhaul/repair capacity can be analyzed. As component overhaul/repair capacity increases, depot repair cycle time (DRCT) should decrease and, in turn, MLDT will decline. All else remaining stable, Ao will increase and materiel inventory requirements will decrease. The inventory investment savings can be applied (in part or in total) to cover added costs for increasing or reallocating maintenance capacity to reduce DRCT.

Our review of production planning and capacity management of component overhaul/repair did not disclose that such tradeoff analysis is routinely conducted during aircraft/systems acquisition. Instead, it takes the form of a general analysis during annual workload planning. Typically, maintenance capacity management for component overhaul/repair is a byproduct of PDM workload planning and represents the plug to account for remaining work force labor hours. We believe there is an opportunity for cost savings (through reduced DRCT and MLDT) and related benefits from additional component overhaul/repair capacity at AR&SC. Tradeoff analysis in support of resource and workload priorities should be a required element of multi-year maintenance budgets and work forecasts.

Maintenance Policy Promulgation

The G-EAE intends the *Aeronautical Engineering Maintenance Management Manual* (the "*Manual*") to be a "summary of the objectives, policies, organizational structures, and responsibilities which form the foundation for the USCG aeronautical maintenance management system."[7] This purpose is consistent with other logistics and maintenance program directives with which we are familiar. However, our review of the *Manual* indicates that it goes well beyond its stated purpose. The *Manual* deals with the entire scope of aviation maintenance (from Headquarters USCG policy to specific aircraft maintenance operations). It also contains policy and procedures that address the full spectrum of logistics operations, a variety of specialized programs (e.g., Tempest certification), and certain technical procedures (e.g., aircraft handling and marshaling).

The *Manual* should be revised to conform to its stated purpose. Separating the *Manual's* discussion of aeronautical engineering objectives, policies, organizational structures, and high-level responsibilities from the detailed operating procedures and other technical direction would make it feasible for specific technical procedures (e.g., aircraft operations or RCM procedures) to be decentralized and promulgated by other organizations within the aviation logistics structure (e.g., AR&SC) while allowing G-EAE to concentrate its efforts on policy development and program guidance.

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[7]COMDTINST M13020.1C, op. cit.

Maintenance Communication Channels

Establishment of a broad network of communications channels has made it possible for aeronautical engineering to have a streamlined technical channel and for G-EAE to actively broker to get the appropriate resources for resolving problems. The G-EAE's direction was most effectively promulgated and executed when the communication channel network was formally established, consistently utilized, and understood by all participants as representing official direction. Communication with air stations [supported by programs like Maintenance Management Reviews (MMRs)] is facilitated best by follow through and fulfilled expectations. In the absence of follow through on action items, the MMRs can become a source of frustration and misunderstanding regarding the actions being taken to improve the support of specific aircraft fleets.

We also found examples of informal communication channels that were effective. System and program newsletters are an example of effective informal channels of communication; especially when they are published in a consistent and timely manner, and make clear what and when official action or advice will be promulgated.

We also found examples of communication channels that were relatively ineffective principally because the informality of certain communications introduced confusion as to the applicability of the information being communicated. Electronic mail (E-mail) is one communication method that when used informally can cause confusion about whether a given E-mail message actually constitutes "official" authority to carry out an action. The volume and tone of E-mail transmissions, possibly containing a mixture of official direction, technical advice, and general information can result in G-EAE direction not being effectively carried out by air station maintenance management personnel.

Communication between G-EAE and AR&SC is problematical. Because of the factors described above and the close working relationship between those two organizations, programmatic direction to AR&SC from G-EAE can be issued by many individuals through various channels ranging from telephone calls and letters to formal program documents. We believe these varied communication channels can cause the same sort of confusion as described in the paragraph above; and possibly result in untimely or ineffective actions, the lack of an audit trail for the expenditure of resources, or even the misapplication of resources.

MAINTENANCE MANAGEMENT INFORMATION SYSTEMS

Systems Evolution

The USCG aviation community is developing the Aviation Maintenance Management Information System (AMMIS) to modernize its MIS. The AMMIS, originally envisioned as a comprehensive program under which all aviation-related logistics support systems would be developed and integrated, was downsized in the system design phase to provide a level of supply management automation somewhat equivalent to the level already existing for maintenance management. The ACMS can already schedule and track maintenance actions, monitor aircraft configuration status, record aircraft and engine operating statistics, and provide assistance and information for use in troubleshooting and reliability analysis. Thus, the initial AMMIS deliverable, known as "AMMIS(a)" or "AMMIS Supply," while addressing modules with such diverse requirements as flight crew training and operations, air station supply, depot maintenance, fiscal accounting and engineering services, principally focused on depot and air station supply management requirements.

Current Systems Limitations

The G-EAE and AR&SC recognize that aviation-related MISs require incremental improvement to provide five principal capabilities:

- Integration of all aviation logistics-related MIS requirements, including those related to performance standards and measurements
- Expansion of AMMIS(a) and ACMS to include functional requirements not currently addressed
- Development and integration of air station supply and maintenance management models and management reports
- Inclusion of an Aircraft Technical Information Management System (ATIMS) to address acquisition, maintenance, management, and dissemination of aeronautical technical information[8]
- Utilization of the most modern MIS technologies.

[8]U.S. Coast Guard, Commandant (G-EAE), *ATIMS Strategic Plan, Volume III*, 17 July 1992.

Specific weaknesses of the ACMS to be addressed in future MIS development projects are the following:

- The current system tracks only selected components and maintenance actions and limited aircraft performance statistics. It should be expanded to routinely collect data for such areas as unscheduled maintenance actions, failure modes, labor hours, corrective actions, system downtimes, and repair time. Additionally, it should collect detailed PDM data, including total time (labor hours and flow times) to overhaul aircraft as well as key task and subtask actions by both planned and actual flow times and labor hours.

- The limited data base of maintenance-related information precludes extensive analysis at a fleet, system, and to some extent, component level.

- The current system provides some capability to support RCM; however, expansion of this capability is desirable to support complete application of the RCM concept and related analyses across the full array of aircraft systems.

Integration of aviation-related MISs combined with utilization of modern MIS technologies is required for the following reasons:

- Comprehensive analysis used for evaluating aviation logistics support issues is difficult, even when the required data exists, because the data is not accessible from a single MIS. For example, AR&SC's Engineering Division indicated that using current MISs takes a considerable amount of time to gather data necessary to support reliability improvement efforts.[9]

- Management or technical questions are difficult to find answers to because of the lack of an easily accessed, integrated, and comprehensive data base. Applied maintenance and engineering resources such as system and product line managers and Engineering Officers at air stations are not as effectively used as they could be because they cannot access the maintenance-related information available or needed in a timely manner.

Development of Future Aviation Logistics Management Information Systems

Having recognized many of the above deficiencies, the USCG recently undertook a project to ensure logical evolution and integration of its MIS support structure. As the information resource manager, G-EAE has developed an

[9]U.S. Coast Guard, Aircraft Repair and Supply Center, *AR&SC Quality Action Team Report*, undated.

Information Resource Management Strategic Plan[10] and is directing efforts to identify integration requirements and opportunities for current MISs. The G-EAE is also beginning to focus on providing systems that will facilitate improvements in areas such as air station maintenance management, RCM applications, maintenance cost and production visibility, and engineering support.

Additionally, a concept has been outlined that effectively integrates the three major aviation-related MISs – AMMIS(a), ACMS, and ATIMS[11] – that support the aviation engineering community. That concept continues to evolve these systems so as to support new logistics business practices and to take advantage of state-of-the-art MIS technology. Figure 3-1 outlines the process of moving from the current situation to a logically derived future AMMIS and ultimately to a future aviation logistics system concept that provides full integration and user support.

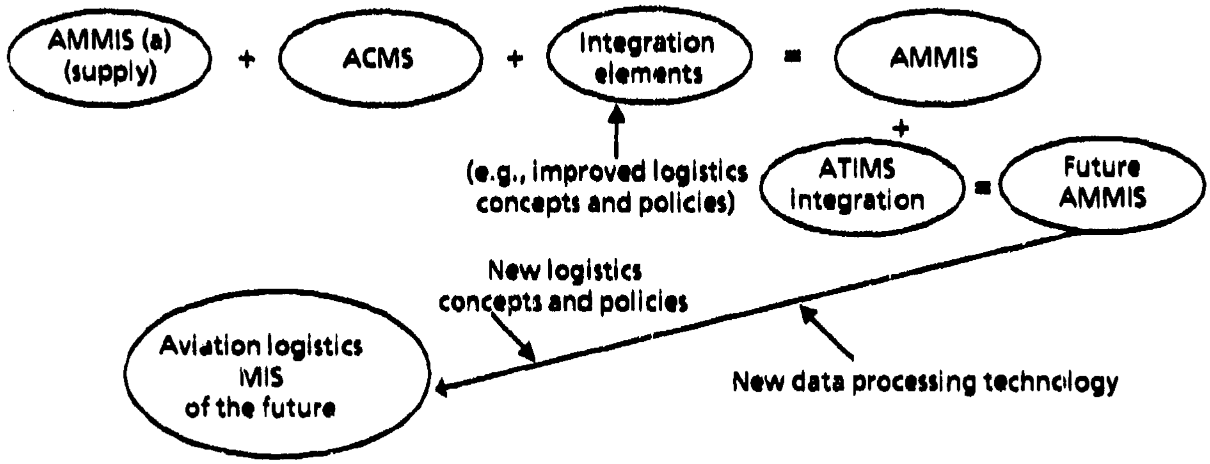

FIG. 3-1. AVIATION LOGISTICS MANAGEMENT INFORMATION SYSTEMS EVOLUTION

In moving toward this vision of the future structure of aviation logistics MISs, it is important to recognize the value of collecting additional maintenance-related information. Not only must current and emerging systems be effectively integrated, consideration also must be given to developing a comprehensive maintenance data base that satisfies maintenance managers, analysts, and field units – and contributes to overall improvement in the logistics support capabilities being

[10]U.S. Coast Guard, Commandant (G-EAE), *Aeronautical Engineering Information Resources Management Strategic Plan*, 20 February 1992.

[11]We recognize that ATIMS is largely a conceptual framework for technical information management functions with specific major systems applications yet to be developed.

provided for aircraft fleets. Additionally, consideration must be given to (1) developing the performance standards for specific maintenance tasks at a level where resources (i.e., dollars, time, and personnel) can be accurately assigned and (2) establishing the performance measurement procedures at the same level of the standards in order to identify opportunities for improvement in time and manpower utilization and reduction in costs for accomplishing the tasks.

MAINTENANCE OPERATION COSTS AND PLANNING

Capability to Evaluate Aviation Maintenance Cost-Effectiveness

As indicated earlier, the USCG believes that maintenance effectiveness at the field-unit level is determined by the ability of field-unit maintenance to provide operable aircraft to meet mission requirements at minimum cost to the aviation engineering and logistics system. We found that the system is certainly capable of delivering properly configured aircraft and flying hours as required.[12] Two key goals of the aviation maintenance program are to ensure cost-effectiveness and minimum cost operations. These two goals are not necessarily complementary. The aviation engineering and logistics system should focus primarily on the cost-effectiveness of overall resource use rather than on sub-optimization of parts of the system (to achieve minimum cost).

Relationship of Maintenance and Operational Requirements

Table 3-2 provides operating results for three principal USCG aircraft types over an 18-month period. As can be seen, the maintenance system is basically achieving the established goals with aircraft fleet availability approaching or exceeding 71 percent. However, the range of NMCM and NMCB rates at the individual field units is significant. For example, HH-65 NMCM and combined NMCM/NMCB rate ranges for FY91 were 7 percent to 22 percent, and 9 percent to 31 percent, respectively. Based on our experience with other maintenance systems, we did not expect this result because, over an extended period of time, we have found

[12]We could not measure the efficiency of the system in terms of resources such as labor, facilities, and materiel nor could we determine whether those resources were being used in the most cost-effective manner. This was primarily due to the lack of management information and data available at levels specific enough to evaluate actual resource expenditure and accomplishments and to support required management analysis. For example, the amount of maintenance effort expended(e.g., in labor hours or years) to achieve the varying results depicted in Table 3-2 could not be measured because military maintenance personnel do not record labor expenditures and spend a lot of the available time training for, and flying in, an operational status.

that unit rates are usually clustered closer to the normative NMCM rate. This is especially true for those maintenance systems that, like the USCG, place great emphasis on maintenance standardization. Additionally, because of the limited amount of maintenance-related data available, we were unable to determine analytically the significant factors that contributed to this variance.

TABLE 3-2

AIRCRAFT MAINTENANCE EFFECTIVENESS DATA

Aircraft fleet type	Number of units in the field	Year	Fleet Ao rate (%)	Unit NMCM range (%)	Unit NMCM + NMCB range (%)
HH-65A	19	FY91	71	7 – 22	9 - 31
		FY92	75	9 – 25	10 - 30
HC-130	6	FY91	77	8 – 21	9 - 30
		FY92	75	9 – 24	14 - 28
HU-25A	6	FY91	69	13 – 24	19 - 36
		FY92	68	15 – 23	16 - 31

Source: USCG ACMS Operating Statistics Report, FY92 data through April 1992.

It is not our contention that units reporting NMCM rates at the high end of the range are less effective than others; nor would we claim that achieving low NMCM rates is necessarily an indicator of an effective, efficient maintenance program. It is clear, however, from our knowledge of USCG aviation maintenance and visits to air stations, that the effective use of aircraft downtime is essential to sustain aircraft preparedness and availability. We observed the extensive corrosion control programs supported by some air station maintenance units. It is obvious that such programs often demand long periods of aircraft downtime, resulting in higher NMCM rates. Similarly, effective scheduled maintenance programs, even given the USCG's well structured ACMS concept, require substantial NMCM time to accomplish. Both of these efforts, however, ultimately contribute to improved aircraft reliability and higher levels of operational mission accomplishment (because fewer missions are aborted and the frequency of unscheduled maintenance decreases).

We believe that better understanding of the underlying causes of the current NMCM rates will assist USCG maintenance managers in identifying the elements of an optimum maintenance program. Further, understanding the component parts of aircraft and fleet NMCM times can lead to an improved ability to address systemic problems and to more effectively use resources to address requirements such as corrosion control and scheduled/unscheduled maintenance demands. A more standardized and uniformly performing maintenance system should result from such knowledge and effort.

As shown in Chapter 2, current DoD and commercial aircraft systems are capable of achieving MC rates well in excess of 71 percent and, conversely, NMCM rates substantially below 24 percent. While such systems may be resourced in ways that differ from the USCG approach (given the ranges of NMCM time depicted in Table 3-2), it is obvious that substantially varying results can be, and are, achieved with the resources currently provided to air station maintenance units. It may be possible to optimize and better standardize air station unit maintenance operations in such a way that less aircraft time is spent in a NMCM status. Alternatively, such efforts may lead to resource balancing and efficiencies.

Our inability to find an explanation for the variance does not in any way lessen our belief that the reasons for that variance are important for management and senior staff to pursue. We believe resolution of this issue could lead to programmatic changes that result in more efficient maintenance operations. This leads us to reiterate our conclusions from our earlier discussion of MISs where we said that the USCG should provide additional detail, definition, and integration to the maintenance management information that is collected on aircraft availability, aircraft systems performance, support of operational requirements, and maintenance labor-hour expenditures. Such information will provide a means for a more meaningful monitoring and analysis of the effectiveness of field units' maintenance programs. Further, it will contribute to improved indications of aircraft fleet condition and to identification of areas of interest to maintenance and logistics managers. Such information is essential to maintenance planning, policy development, and resource allocations.

Evaluation of Depot Maintenance Labor Effectiveness

Our evaluation technique for examining USCG depot effectiveness evolved throughout the course of this study. Our original approach was to evaluate the effectiveness of depot maintenance performed at AR&SC from a micro-level resource perspective. Most DoD depot data systems with which we are familiar provide detailed, comprehensive cost and production information through which resource cost-effectiveness is evaluated and managed. However, the absence of this type of information within the USCG precluded our using this approach. We eventually evolved to a more macro-level approach that compares AR&SC repair division costs to DoD.

At the macro level, AR&SC uses a labor planning factor yield of 1,744 direct labor hours of output annually, per work position. The DoD uses, for capacity planning, a planning factor of 1,615 direct labor hours of output annually, per work position. Given that AR&SC achieves labor yields close to the planning factor (indications are that current yield is about 1,750 direct labor hours of output per work position), it is clear that the USCG plans to operate at a higher level of personnel efficiency than does DoD. As a corollary of this higher personnel efficiency factor, indirect and overhead costs on a per-labor-hour basis should normally be lower for USCG work, since the base for overhead distribution is proportionally larger. In fact, we also observed that the relatively low level of indirect personnel work positions supporting the production element (Repair Division) of AR&SC amounted to only 19 percent of total division personnel.

It is appropriate, however, to compare current Repair Division operations to prior data in order to identify areas of potential savings (i.e., cost-effective processes and more efficient use of resources) and to include them in budget and work forecasts. In the application of total quality management (TQM), these are the bases for new methods and procedures that are the subjects of the continuous improvement (CI) program. In harmony with AR&SC's overall TQM effort, the Repair Division has made several CI initiatives to reduce labor hours expended on PDM and overhaul work and to improve aircraft flow (cycle) times. A modified flow network for PDM work has been developed. The PDM production line has been restructured. A new cellular-like maintenance concept has been initiated that includes such actions as locating primary off-equipment structural maintenance in close proximity to specific aircraft undergoing PDM. More flexibility to deal with variability (aircraft ahead of and behind schedule) has been introduced resulting in more uniform production of aircraft (closer adherence to schedule). As a result of these initiatives, it is anticipated that direct labor hours per aircraft PDM can be substantially reduced and that PDM intervals and input cycles can be modified to meet technical or managerial prerogatives. The current initiatives present opportunities for increased cost-effectiveness and efficient use of resources resulting in savings that can be applied to other unfunded or lower priority CI initiatives.

For purposes of this analysis, we did not attempt to develop detailed cost comparison or benchmark data. Given the variability and dissimilarity of aircraft types and PDM work content between the USCG and the DoD, establishing the validity of such comparisons would require exceptionally detailed analyses. However, we are able to make a general comparison and provide observations on the USCG as compared to DoD.

Both G-EAE and AR&SC believe that the AR&SC's Repair Division Costs for similar work are well below those of comparable DoD facilities. For example, a briefing presented to LMI during discussions at AR&SC identified the Repair Division's fully burdened labor hour costs as $45.09 per labor hour and DoD charges to USCG as $77.00 per labor hour.[13] We reviewed DoD depot maintenance costs for work similar to that performed on aircraft and components by AR&SC. We found that while it is true that AR&SC costs are currently below what DoD has established as stabilized billing prices for external customers (like the USCG), actual DoD costs (as shown in Table 3-3) are quite comparable to USCG costs. We also found that current DoD initiatives to streamline depot maintenance operations, reduce overhead costs, consolidate workloads, and eliminate excess capacity are all focused on driving down costs. In some cases, DoD has established target overhead rates at 50 percent of current levels, further reducing fully burdened direct labor hour costs. Some estimates of future burdened direct labor hour costs are in ranges well below $40.00 per labor hour.[14]

Table 3-3 identifies the relative comparability of AR&SC and DoD facilities. Recognizing that DoD pricing policy for depot maintenance is currently in a state of flux, we believe the USCG should evaluate (on an ongoing basis) the potential use of

[13]AR&SC Mission/Organization Briefing, 14 February 1992.

[14]For example, for consolidated tactical missile component depot-level maintenance.

DoD as a repair source, especially if aggressive negotiations result in DoD's prices being brought more in line with costs incurred by DoD.[15] This is discussed in detail in the section below on competition.

TABLE 3-3

FY90 COMPARABLE DEPOT MAINTENANCE COSTS FOR AIRFRAME WORKLOAD

Depot facility	Direct labor costs	Productive indirect costs	General and administrative costs	Total costs (per direct labor hour)
AR&SC	15.30	11.58	18.22	45.09
Corpus Christi Army Depot	18.14	23.62	1.29	43.06
Naval Aviation Depot Pensacola	18.64	27.62	8.14	54.40
Warner Robins Air Logistics Center	17.50	14.92	12.50	44.92
San Antonio Air Logistics Center	14.97	19.70	9.80	44.47

Source: AR&SC data sheet; DoD 7220.9-M depot maintenance cost data, Defense Manpower Data Center.

Depot-Level Production Overhead Costs

Our analysis of FY90 AR&SC cost information provided in Table 3-3 (FY91 data was not available) shows that AR&SC general and administrative (G&A) expense is dramatically higher than DoD G&A costs, even in the most costly DoD facility. While this may be driven by differing definitions of G&A costs, we believe it warrants further analysis and adjustment, especially in view of the higher labor-hour yield planning factor used by the USCG. To ensure comparability with external sources of repair, we believe that the USCG should ensure that the allocation scheme for overhead costs to maintenance production hours assigns costs for support services (i.e., engineering, supply, and management information) in a manner consistent with sound accounting practices that reflect AR&SC repair costs appropriately. Most

[15] Major initiatives are underway in DoD to establish depot maintenance on a sound business operation basis and to produce output at competitive prices.

recently, the DoD has established the *Cost Comparability Handbook*[16] to facilitate comparisons among its organic depots and with outside repair sources. We believe the *Handbook* would be of assistance to the USCG and recommend its use to evaluate AR&SC costs in relation to OGA and to commercial repair sources.

DEPOT MAINTENANCE WORKLOAD MANAGEMENT AND COMPETITION

Depot Maintenance Initiatives in DoD

In recent years, DoD has sought out and obtained Congressional approval to compete depot maintenance workloads among DoD owned and operated depots and commercial contractors. That competition is compelling the DoD organic structure to become more efficient, to produce savings and to provide the best value for the dollars spent.

The premises for this DoD competition-producing initiative include the following:

- Streamlining depot processes and organizations in preparation for competition ensures that no matter who wins the workload competition the most efficient, cost-effective organization performs the work.
- Lessons learned and savings achieved can be applied to the entire depot establishment and could occasion savings for all similar work performed, not just the workload competed. This is based on the belief that the winning bid will set the new price standard for similar work regardless of whether offered for bid or not.
- Putting workload at risk of being bid on and lost is an effective motivating factor. While the DoD depots have demonstrated that they are competitive, the competitions won by private industry are evidence that the Military Services award contracts based on best value to the Government. Depots winning workload contracts have developed innovative approaches to perform work that, in many cases, they had previously taken for granted. Not only were hourly rates lowered through reduction of overhead and other charges, but so were materiel costs and expended labor hours.

On average, DoD experience is that work offered to bidders is accomplished for 20 percent less than would have been the case if the workload was not competed. DoD plans to continue expansion of this competition-producing initiative. The DoD

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[16]AR&SC Mission/Organization Briefing, 14 February 1992.

forecasts that workload offered for bid among organic facilities and commercial firms will range as high as 40 percent of the total DoD depot maintenance workload.

In general, DoD depots and commercial firms each win about one-half of the workload contract competitions. In fact, in an Air Force, Army, and Marine Corps prototype competition program conducted for FY91 workloads, private firms won three of the five Air Force competitions, two of the Army's seven competitions, and one of the two Marine Corps competitions. Tooele Army Depot, Utah won one of the Marine Corps competitions. The workloads competed ranged from turbine engine rebuilds to avionics and component repairs.

Another initiative that the USCG must remain informed and concerned about is the major DoD depot consolidation effort. The Joint Chiefs of Staff (JCS), in conjunction with the Office of the Secretary of Defense, are studying major structural changes to DoD depot management. This effort may lead to commodity-oriented single managers or to a Defense depot maintenance agency structure. This initiative is certain to lead to significant changes in business practice at DoD. While the USCG has been participating in the JCS study effort, it is not clear what impact any resulting depot management changes may have on the USCG support structure.

Application of Competition Strategies

We believe G-EAE should evaluate the applicability of a DoD-like competition strategy for USCG depot maintenance workloads. Such a strategy can result in improved operating efficiencies, lower overall costs, and can provide more focus on those functions that can be performed in a more cost-effective manner. USCG implementation of this type of competitive strategy has two major implications. First, such an approach could ensure competitive costs for USCG repair work. Second, the USCG, in a customer role, may be able to secure more competitive prices from DoD depots or through DoD contracts. We believe that these implications should be considered by the USCG. In fact, several planned DoD competitions for FY93 have direct implications for the USCG (e.g., UH-60 helicopters at Naval Aviation Depot Pensacola; T56 engines at San Antonio Air Logistics Center; and Naval Aviation Depot Alameda, and T700 engines at Corpus Christi Army Depot).

Given the constraint of the personnel ceiling on the work force at AR&SC, competition with DoD or private sector commercial firms might not become the motivating factor that it has become in DoD. Cost competition in some form, however, may be achievable and effective. We found that the work-loading approach used by AR&SC establishes a priority for aircraft overhaul. The remaining level of effort (after all PDMs are planned for) is used for component repair. Once in a competitive mode, it may be found that AR&SC can perform component repair more cost-effectively and that some aircraft overhaul can be outsourced to DoD or commercial sources (as is currently done for the USCG's HC-130 aircraft). Obviously, if implemented, these scenarios would have to ensure acceptable work quality and scheduling.

Component Overhaul/Repair Scheduling and Control

As discussed in some detail in Chapter 4, current DRCTs for component overhaul/repair at AR&SC are considerably longer (four to five times) than comparable DoD and private sector DRCTs. Based on financial data provided by AR&SC, as of May 1992, the AR&SC internal DRCT investment approximated 200 days of demand. We believe that level of investment is too high by any generally accepted standard.

The size of the investment in components undergoing overhaul/repair is a function primarily of (1) induction quantities of unserviceable components put into the overhaul/repair process; and (2) overhaul/repair scheduling effectiveness, backlogs and delays, and AR&SC's effectiveness in managing the process. We believe that induction quantities may be oversized. We found that AR&SC does not use an economic repair quantity concept or computations to "build" the induction quantity lot size. Based on a limited sample of reparable line items reviewed, we found that when an item manager initiated a repair action the tendency was to induct all available unserviceable components.

To realize the benefits from computing an ERQ, once a batch of unserviceable components moves into the overhaul/repair process, it is important that the process proceed smoothly. Any delays should be controlled by the process manager. Scheduling and controlling delays are basic and vital to maintenance management. Inaccurate scheduling and uncontrolled delays directly increase DRCT and materiel inventories. Since AR&SC generally views component work as secondary to PDM requirements, maintenance management's focus is not on component overhaul/repair times either performed in house or by DoD or commercial contractors. As a result we found that AR&SC does not have performance standards or measures in place to assist in component overhaul/repair scheduling and control of delays. We believe those standards and measures are necessary and should be developed as a CI initiative.

RELIABILITY AND QUALITY – SUPPORT FOR PRODUCT IMPROVEMENT

Realization of Inherent Reliability

The goal of the USCG's RCM program is to realize the inherent reliability of the equipment being maintained.[17] We believe that goal must extend to improving reliability through better maintenance reporting and technical evaluations. The results of improved reliability should be applied to both maintenance and supply planning.

The G-EAE manages the RCM program. The program has been structured along traditional RCM lines and is supported with data from ACMS. The USCG RCM program is organized and designed to continuously monitor the performance and reliability of aircraft components by using historical maintenance data and statistical methods. The program also is designed to (1) bring problems and deteriorating trends to the attention of Coast Guard management, (2) to determine whether preventative action is needed when the inherent reliability of components is not realized, and (3) to assist in building an optimum maintenance program (by driving maintenance plans and schedules reflecting improved reliability data) and improving supply forecasting (by adjusting computational factors linked to failure or replacement estimates).[18]

The increased focus on component/system reliability may cause significant reductions in future aviation logistics costs. For example, the success achieved by the USCG in extending the overhaul period for the HH-65 gearbox from the manufacturer's recommended 1,300 hours to 2,300 hours (possibly up to 2,500 hours) from reliability data analysis[19] means that future work requirements for gearbox overhaul can be reduced and budget forecasts for gear box replacements can be revised downward. Those actions provide the USCG with the opportunity to recoup a

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[17]COMDTINST M13020.1C, op. cit.

[18]U.S. Coast Guard, Commandant (G-EAE), *Aeronautical Engineering Process Guide – Reliability-Centered Maintenance*, 16 January 1992.

[19]Technical and Management Services Corporation (TAMSCO) briefing, *Fleet Logistics System Concepts and Capabilities*, Volpe National Transportation Systems Center, 1 July 1992.

portion of overhaul and procurement budgets targeted for the HH-65 gearbox. The reduction in logistics costs – properly identified, monitored, and documented – is the savings directly associated with an aggressive RCM program and the ultimate justification for initial investment in RCM. However, to ensure that RCM-related savings are identified and recaptured, the appropriate information must be collected and made accessible to the maintenance and supply managers. Managers should use the information in their requirements determination processes and models to reflect the improved reliability in future materiel and maintenance budget requests.

Implementation of Reliability-Centered Maintenance

While the USCG RCM program has been established, its implementation throughout the aviation maintenance program is limited for the following reasons:

- The ACMS only tracks a limited number of aircraft components.
- The ACMS does not require consistent inputs to explain the "reason for component removal."
- The G-EAE sponsored RCM program is not integrated with similar programs within the AR&SC Engineering Division. The Engineering Division is, among other things, a repository of information that can enhance reliability improvement efforts. In fact, under a separate initiative the AR&SC Engineering Division established a goal of increasing the percentage of problem parts in reliability studies by 50 percent by July 1994.[20]
- Total personnel assigned to the RCM program are inadequate to fully implement and meet program goals and objectives. We believe this is true even though the USCG has contracted for RCM services to include information on revision of maintenance procedures, analyses of component reliability characteristics (e.g., age exploration), training to members of RCM working groups and reports concerning improved aircraft maintenance management.[21]
- The RCM program is not integrated with the aviation budget process. A methodology is not in place to forecast and report reliability program achievements and reflect those in budget forecasts for the aviation logistics program.

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[20]U.S. Coast Guard, Aircraft Repair and Supply Center, *AR&SC Quality Action Team Report on Reliability Improvement Efforts*, undated.

[21]*Aeronautical Engineering Process Guide – Reliability-Centered Maintenance*, 16 January 1992

We believe the following types of actions should be taken by the USCG to fully realize the RCM program's goals:

- An assessment should be made about the aircraft components that should be added for ACMS tracking to establish the most effective RCM program.
- The ACMS "reason for component removal" should require standardized coding wherever possible. This will help ensure that RCM age exploration programs are supported with the best possible data.
- The degree of integration of the RCM program with AR&SC Engineering Division operations should be clearly established in policy and procedures.
- The ACMS program should be able to routinely support the analysis of the savings created through extended component maintenance intervals, improved maintenance inspection procedures, etc.
- The USCG should evaluate the total personnel resources required to fully implement the goals and objectives of the RCM program and establish a plan and schedule to supplement personnel resources as required.

Quality Performance Information

In addition to the cornerstone RCM project, the USCG has a number of other programs in place to monitor and correct maintenance production quality [e.g., G-EAE visit program, unsatisfactory reports (URs), and product reliability tracking]. During our field visits we heard expressions of dissatisfaction with some of the current quality monitoring and action systems. In some cases, we heard that actions took too long or were not being taken to improve production quality and, thus, provide a more reliable product to the field. In other cases, there was a certain frustration with the lack of feedback on reports submitted and the perceived inability to influence product quality (and correspondingly, the availability and reliability of aircraft).

In the case of the UR system, we found that AR&SC identified a significant problem with the quality monitoring process that substantiated the field perceptions.[22] It is clear from the analysis available on URs that they can be a significant source of information for product improvement efforts. When combined with other reliability and performance information available, it should be possible to

[22]U.S. Coast Guard, Aircraft Repair and Supply Center, *AR&SC Quality Action Team Report on Reliability Improvement Efforts*, undated.

identify and influence deficient repair processes, less than satisfactory repair sources, and parts/system deficiencies.

RECOMMENDATIONS

Given our discussion of aviation maintenance management and the opportunities we identified for improvements, we recommend the USCG

- Develop and use additional formal communication methods and directives to promulgate policy, procedures, and decisions to AR&SC and to field units. Formal taskings to both entities should be accomplished in a consistent, structured manner that considers resource and technical effects. In structuring those processes, consideration should be given to eliminating imprecise or overlapping guidance. Responsibility for issuing direction and guidance should be clearly spelled out to prevent conflicting guidance from being promulgated. The *Aeronautical Engineering Maintenance Management Manual* should be evaluated and restructured to separate high-level policy statements from lower level procedural and technical guidance. This would be consistent with relocation of the latter responsibilities away from the Headquarters level and could improve system responsiveness to air station maintenance managers.

- Revise organizational structural support concepts to centralize maintenance policy, planning and programming responsibilities at Headquarters (G-EAE) while migrating technical and procedural responsibilities to AR&SC. This would be consistent with the evolution of AR&SC as a logistics support center capable of supporting a fuller range of maintenance services.

- Provide strategic direction to MIS development that defines the breadth and depth of maintenance data required to effectively support all aspects of maintenance management.

- Refine current strategic planning to address the specifics of system integration and evolution. Planning should ensure that systems have the capability for developing performance standards and measuring performance at the fleet, aircraft, and component level and measuring resource (e.g., time, dollars, and personnel) expenditures – with the ultimate goal of evaluating maintenance program effectiveness and efficiency.

- Evaluate the cost structure of AR&SC as it affects burdened PDM and component overhaul costs to ensure accurate costing of labor hours and units produced. Develop cost comparability with DoD, OGA, and commercial sources to determine cost-efficient sources of repair. Analyze cost allocation schemes for accuracy and validity as to product produced.

- Incentivize AR&SC, as well as DoD and OGA sources of repair, by developing a competition strategy. Such a strategy could include direct competitions or rigorous cost comparisons. Putting workload "at risk" of being bid on and contracted out creates a strong incentive to reduce repair costs and improve support.

- Integrate complementary elements of the RCM program with AR&SC product improvement efforts. Centralize responsibility for product/system reliability evaluation and provide the necessary tools and resources to carry out the program. Use the AR&SC Engineering Division to lead the RCM program and to ensure its integrated implementation with maintenance and supply programs.

- Integrate the Repair Division's CI initiatives into the AR&SC Five Year Plan as major elements of the TQM program.

- Analyze alternative PDM intervals and cycle times (both in terms of PDM capacity requirements and costs) relative to the number of aircraft and aircraft systems to be acquired during initial aircraft acquisition planning.

- Analyze alternative DRCT options (both in terms of organic repair capacity required and costs) relative to projected Ao during the integrated logistics support planning (ILSP) process and in steady state operations once the aircraft is introduced.

- Assess current repair set-up times and costs in the component repair process to ensure that these costs are realistic and that they are minimized.

- Examine current component induction batch sizes to ensure that repair lot sizes reflect the tradeoff between set-up costs and inventory holding cost and that the induction quantities are properly matched to the ability of the repair process to efficiently execute repairs.

- Review component repair scheduling and control policies, systems, and procedures both at AR&SC and at commercial repair sources in order to identify component repair processing backlogs and/or delays that may be impacting DRCT negatively.

CHAPTER 4

AVIATION SUPPLY MANAGEMENT

INTRODUCTION

This chapter discusses the cost-effectiveness of the USCG aviation supply system and identifies four major areas in which improvements in the aviation supply management process will yield greater cost-effective support to the operating customer. To provide perspective on the changes recommended, we initially provide an overview of the existing aviation supply support infrastructure and then examine the current investment in materiel inventories, highlight the level of operational support provided by the aviation supply system, and introduce selected benchmark indicators for comparison with other aviation supply management systems.

Aviation Supply Support Infrastructure

A number of organizations and facilities – within the USCG and from OGAs, DoD, and the private sector – provide aviation supply support to operating USCG units. Internally, however, the basic USCG aviation supply support infrastructure is composed of three primary levels:

- The G-EAE provides overall aviation maintenance, program direction, and system oversight. While G-ELM is responsible for developing and promulgating USCG supply policy, aviation supply policy is actually developed and implemented by AR&SC to support G-EAE's program direction.

- The AR&SC at Elizabeth City, N.C., acts as the aviation ICP within the USCG and is responsible for central inventory management of Types I, II, and IV materiel, for central repair, procurement, stockage, and technical support.

- The supply department (or the supply department and the aviation materiel office) at USCG air stations provides inventory management, fiscal, local purchase, warehousing, and requisition processing capabilities in support of a myriad of station functions, including station aircraft maintenance and repair.

Figure 4-1 provides an overview of the flow of funding, materiel, and orders throughout the USCG aviation supply support structure. The air stations stock materiel based on an approved allowance list (referred to as the 298 Allowance list) prepared at AR&SC. While that allowance list specifies authorized quantities for USCG-managed items (Types I, II, and IV) it includes only recommendations for Types III and V materiel. (Air stations resupply Types I, II, and IV inventories from AR&SC and Types III and V inventories from either local sources or the designated integrated manager.) All retrograde is processed through AR&SC to the designated repair source — either organic, OGA, or commercial.

Inventory Investment

Materiel inventories represent a major investment in the USCG aviation supply system. AR&SC stocks approximately 37,000 individual line items and, of those, it codes more than 31,000 items (including about 3,300 reparables) as "demand-based" and only about 6,000 items as "non demand-based." The annual dollar-value of orders is about $300 million. AR&SC acts as the primary inventory control activity (PICA) for about 12,000 items and as the secondary inventory control activity (SICA) for about 21,000 items. The on-hand portion of these assets, defined by materiel type, is located at the air stations and at AR&SC. Additional assets are on order by USCG air stations, are due in at AR&SC from both procurement and repair sources, and are due in at AR&SC from USCG air stations as retrograde. As seen in Table 4-1, the total inventory investment (excluding Types III and V assets, which are not visible centrally) is almost three-quarters of a billion dollars.

These aggregate inventory investment data provide several important indicators as to the philosophy and potential customer support effectiveness of current USCG aviation supply management policies. First, unlike the multiechelon inventories of most private-sector and public-sector supply management systems, the USCG inventory is heavily focused at one center, AR&SC. Almost 80 percent of all on-hand and on-order assets are at or due in to AR&SC, and only 20 percent of total on-hand or on-order assets are at or due in to air stations. While assets held higher in these multiechelon systems are generally easier to manage and control, they are typically less "effective" or "valuable" in meeting customer requirements since they are further away (in distance and in time) from the actual operational need. Second, the current USCG inventory investment is primarily in on-hand assets (65 percent) and in repair assets (22 percent) and the level of procurement/on-order investment

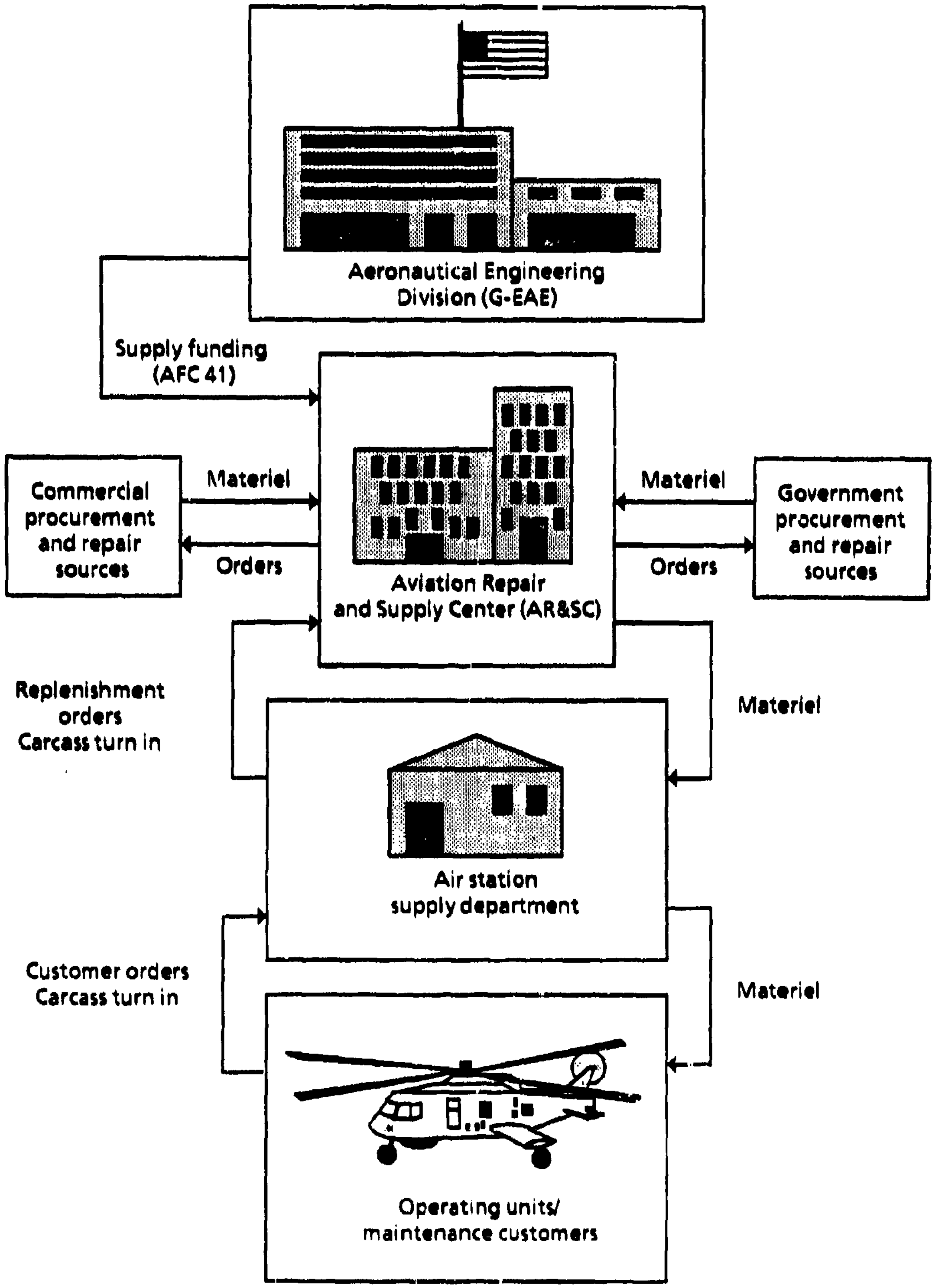


FIG. 4-1. USCG AVIATION SUPPLY SUPPORT INFRASTRUCTURE

TABLE 4-1

TOTAL USCG INVENTORY INVESTMENT

($ millions)

Location	On-hand inventory	Due in from procurement	Due in from repair	On order from AR&SC	Due-in retrograde	Total
AR&SC	332.6	42.4	160.0	-	34.5	569.5
Air station	136.3	-	-	11.3	-	147.6
Total (percentage of total)	468.9 (65%)	42.4 (6%)	160.0 (22%)	11.3 (2%)	34.5 (5%)	717.1 (100%)
Monthly dollar issues	24.0	-	-	-	-	-
Months	19.5	1.8	6.7	.5	1.4	29.9

Source: Compiled from AR&SC PGM SM 105 Report dated 22 May 1992 and from related supporting AR&SC data.

Note: Excludes Types III and V materiel inventories at USCG air stations.

(7 percent) is relatively small. In large part, this reflects USCG's continued reliance on other Government sources, including DoD, for replenishment of inventories and its relatively low reliance (at this time) on commercial procurement sources with the associated longer procurement lead times. Third, the key reparables pipelines (the depot cycle time and the retrograde pipeline) are relatively long based on aggregate financial data, and it normally takes about 42 days (1.4 months) to get a failed unit from the field to AR&SC and over 200 days (6.7 months) to repair an asset once it is inducted for repair.

In Table 4-2, USCG air station inventory data are presented in greater detail by aircraft type. In the aggregate, air stations carry 5.7 months of serviceable on-hand inventory with another 15 days (0.5 months) of serviceable assets due in from AR&SC. Based on the number of aircraft supported, a high percentage of this inventory is positioned to support the HH-65 (38 percent), the HC-130 (19 percent), and the HU-25 (17 percent) aircraft.

In addition to inventories at the USCG air stations, on-hand inventory investment at AR&SC may be further analyzed by condition (serviceable or unserviceable) and by aircraft type as is done in Table 4-3.

From Table 4-3, we see that the investment in on-hand inventory at AR&SC is focused in selected aircraft. The older aircraft in the USCG inventory (the HC-130

TABLE 4-2

USCG AIR STATION INVENTORY DATA

($ thousands)

Aircraft type	Serviceable inventory on hand	Serviceable inventory due in	Total inventory investment
HC-130	28,159	535	28,694 (19%)
HH-3	10,138	2,983	13,121 (9%)
HH-60	11,733	2,160	13,893 (9%)
HH-25	23,074	1,634	24,708 (17%)
HH-65	53,959	2,396	56,355 (38%)
Miscellaneous	9,195	1,565	10,760 (8%)
Total[a] (percentage of total)	136,258 (92%)	11,273 (8%)	147,531 (100%)
Average monthly issues	24,000	–	–
Months of inventory	5.7	0.5	6.2

Source: AR&SC Report PGM SM 105 dated 22 May 1992.

Note: Excludes Types III and V materiel inventories.

[a] AR&SC replenishes air stations inventories as Types I, II, and /IV materiel is used on a one-for-one basis. These replenishment actions by AR&SC typically result in issues of materiel by AR&SC.

and the HH-3) account for only 29 percent of the investment in on-hand inventory, while the newer, non-DoD aircraft (the HH-25 and the HH-65) account for almost 60 percent of the on-hand inventory investment. Thus, a current reality of USCG aviation supply management is the requirement to effectively support a large population of relatively new, non-DoD platforms. Any substantial improvements in the productivity of the USCG inventory investment must occur for these aircraft types, which are perhaps the most difficult support challenges faced by AR&SC. The data in Table 4-3 also show that the level of reparable components actually being repaired ($160 million as seen in Table 4-1) exceeds the unserviceable inventory on-hand ($117 million) by almost 37 percent, an unusually high ratio in comparison to other similar supply management systems. In other comparable systems, the value of assets in work is generally lower than that of unserviceable assets being held for future repair.

TABLE 4-3

USCG AR&SC INVENTORY DATA

($ thousands)

Aircraft type	Serviceable inventory on hand	Unserviceable inventory on hand	Total inventory investment
HC-130	22,444	21,471	43,915 (13%)
HH-3	24,618	27,478	52,096 (16%)
HH-60	22,697	2,258	24,955 (8%)
HH-25	67,332	32,112	99,444 (30%)
HH-65	68,702	27,104	95,806 (29%)
Miscellaneous	10,051	6,399	16,450 (4%)
Total (percentage of total)	215,844 (65 %)	116,822 (35 %)	332,666 (100%)
Average monthly issues	24,000	–	–
Months of inventory	9.0	4.9	13.9

Source: AR&SC Report PGM SM 105 dated 22 May 1992.

Yet another way to view the current USCG investment in materiel inventories is to compare inventory requirements to actual inventory on hand and on order. In Table 4-4, we present an analysis of current USCG inventory requirements as determined from our survey at AR&SC and our visits to air stations.

An examination of the requirements data indicates that AR&SC inventory requirements (requisitioning objective) of about $255 million represent about 318 days of supply. Procurement cycle requirements (order quantity) ($22 million or about 30 days of demand) reflect a very low cost to order ($103) used in current computational models. The total reorder point requirement ($233 million) of about 291 days includes retrograde pipeline requirements ($24 million), DRCT requirements ($72 million), procurement lead time requirements ($65 million), and safety level requirements ($72 million). At the air station level, reorders are almost exclusively on a one-for-one basis. We estimate that the current air station order quantity requirement is about $10 million (12 days) and that the reorder point requirement is about $186 million (233 days). The USCG plans to reduce air station

TABLE 4-4

MATERIEL REQUIREMENTS

($ millions)

Location	Order quantity	Reorder point	Requisitioning objective	Actual on-hand/ on-order assets	Difference
AR&SC	22	233	255	569	(314)
Air station (current)	10	186	196	148	48
Air station (planned)	4	68	72	—	—
Total (current) (percentage)	32 7%	419 93%	451 100%	717 159%	(266) 59%
Days of supply at full demand	40	523	563	896	333

Source: Computed from AR&SC's response to LMI's Survey Questionnaire using an assumed attrition rate for reparables of 30 percent.

requirements over time to about 90 days, and those revised requirements are also indicated in Table 4-4. The estimated impact of the change in air station requirements is a reduction of about $124 million. In total, the current USCG materiel investment ($717 million) exceeds existing materiel requirements ($451 million) by some $266 million, or roughly 59 percent.

Operating Results

We now turn to the materiel support provided by the substantial inventory investment discussed above viewed from the operating customer's perspective. In Table 4-5, we show supply support performance in terms of requisition effectiveness (the percentage of customer requests satisfied from stock), in terms of processing times (the time required to repair or to issue and ship materiel if it is available in stock), and in terms of the delays experienced when materiel is not immediately available (the backorder delay).

The information in Table 4-5 indicates that at the air station level, relatively little performance data are routinely available for evaluating supply performance. For example, neither gross requisition effectiveness (the percentage of customer orders filled from air station supply inventories) nor net requisition effectiveness (for stocked items, the percentage of customer orders that are filled from air station supply inventories) are measured routinely. Indeed, the primary focus is on the

TABLE 4-5

AVIATION SUPPLY SUPPORT PARAMETERS

(FY91 mean data)

Location	Gross requisition effectiveness	Net requisition effectiveness	Depot repair cycle time	Customer order and shipping time	Backorder age	Average customer waiting time[a]
Air station	NM	NM	NA	1 day	NA	NM
AR&SC	NM	79%	202 days	14 days	37 days	NM

Source: AR&SC Inventory Management Division Management Statistics and air station survey results.

Notes: NA = not applicable; NM = not measured.

[a] Using a combination of requisition effectiveness and processing time data, we estimate that the average customer waiting time for the current USCG aviation supply management system is about 421 hours, or roughly 17.5 days.

timely processing of customer orders, and air station supply departments are effective in doing so. At AR&SC, more comprehensive performance statistics are routinely captured; those statistics include AR&SC net requisition effectiveness, order and shipping time to the air station, and backorder delays. Approximately 80 percent of customer orders for materiel stocked at AR&SC are filled from inventory, and delivery times to the air station are responsive, averaging about 2 weeks for all materiel. While the average age of a backordered requirement at AR&SC is 37 days, Issue Priority Designator 02 and 05 backorder delays are likely to be less than 37 days. Finally, the DRCT pipeline exceeds 200 days of assets.

Comparative Benchmark Analysis

In addition to internal comparisons, "functional benchmarking" can provide added insights on the cost-effectiveness of the USCG aviation supply management process. While we recognize that other organizations differ from the USCG in specific operating environments, the specific aircraft supported, and specific structural and policy characteristics, we nevertheless believe that a number of DoD aviation support systems and processes provide reasonable points of comparison. Among them are the Army Aviation Systems Command (AVSCOM), the Air Force Logistics Command (AFLC), and the Navy Aviation Supply Office (ASO) and their related retail/operating sites.

In Table 4-6, we compare selected management indicators for the USCG and each of those comparable DoD aviation supply management systems to provide a benchmark for assessing USCG cost-effectiveness. Because reporting systems vary, total system effectiveness data are provided even though most DoD components measure both retail and wholesale materiel availability performance.

TABLE 4-6

FUNCTIONAL BENCHMARK DATA

Performance area	USCG	Army AVSCOM	AFLC	Navy ASO
System gross requisition effectiveness	Not measured	74%	84%	74%
System net requisition effectiveness	79%	79%	77%	76%
On-order investment (days)	54	319	645	501
Depot repair cycle time investment (days)	202	75	61	55
Months of inventory	19.7	22.8	31.2	30.6
Months of requirements	18.8	35.8	42.0	36.7
Inventory/requirements ratio	1.0	.6	.7	.8

Source: For DoD components, *FY91 Military Supply and Transportation Evaluation Procedures* (MILSTEP) reports and Assistant Secretary of Defense (Logistics) *FY91 Budget and Execution Data System*. For USCG, selected financial and operating statistics provided by AR&SC and used for computation.

In face of the operational and structural differences, any comprehensive assessment of USCG aviation supply support relative to comparable organizations must be qualified. However, with limited exceptions, the data in Table 4-6 indicates that the current USCG aviation supply system is generally comparable with DoD benchmark results in terms of the net requisition effectiveness provided. Further, actual on-hand inventory in the system (measured in months of demand) is also comparable. However, one key difference in the benchmark data is that the USCG has substantially lower total months of requirements (18.8 versus roughly 36 to 42 months) primarily because its shorter production lead times and smaller safety levels are partially the result of its being supported by DoD on many items. Thus, the "inventory intensity" of the USCG system (actual inventory relative to requirements) is appreciably higher than AVSCOM (40 percent more), AFLC

(30 percent more) and ASO (20 percent more). The second major difference that is evident in the benchmark data is the DRCT pipeline. In that area, the USCG is not competitive with DoD Components. The DRCT pipeline for the USCG is in excess of 200 days of demand, while that for similar DoD Components ranges between 55 and 75 days of assets. Private sector DRCTs (for commercial airlines, for example) average roughly 75 percent of DoD cycle times. Thus, DRCT is an area for potential improvement in component rework processes within the USCG.

Overall, our review of the current USCG aviation supply management process points to the following four elements of the current USCG system as major potential contributing factors to the apparent comparative disparities in supply system costs:

- Supply system focus and integration
- Initial provisioning
- Reparables management
- Air station supply management.

SUPPLY SYSTEM FOCUS AND INTEGRATION

Any cost-effective aviation supply system must have an overall system focus that is directly tied to operational requirements and must be internally integrated to meet the assigned logistics performance requirements at the lowest life-cycle cost. Without a meaningful supply system target on which to focus and an integrated internal supply management structure to reach that target, more specific supply management policies and procedures (for requirements determination, inventory management, warehousing, etc.) are without any conceptual foundation.

Our analysis of aviation items and systems being supported by the USCG aviation supply system does not show a consistent system focus on those key operational goals that are relevant to operational support. Furthermore, it does not show any clear linkage between the operational requirements of the items and systems, the related logistics system performance goals, and the integrated management of inventories at both the air station and AR&SC levels within the USCG supply system.

Supply Support Standards

Conceptually, the development of a meaningful MLDT standard drives supply support structure and policy. In Figure 4-2, aircraft system effectiveness (ASE) is seen to be a function of three factors:

- System availability
- System durability
- System capability.

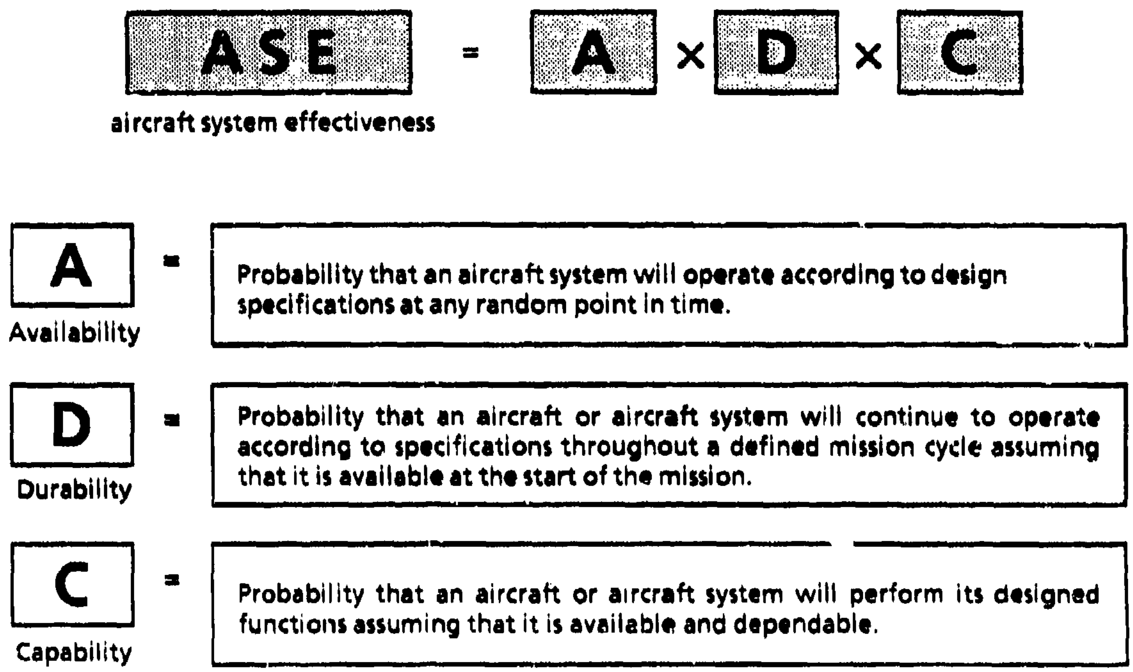


FIG. 4-2. USCG AIRCRAFT READINESS RELATIONSHIPS

If we assume that the USCG has a process to evaluate the systems acquisition tradeoffs between the expected system effectiveness of a given aircraft and the required number of aircraft, and if we further assume that an optimum mix of system capability, availability, and durability has been determined during this process (as discussed in detail in Chapter 2), then the resulting aircraft Ao becomes the primary factor on which reliability, maintainability, and supportability tradeoffs are based. Given an Ao target and the integrated logistics support planning needed to define the appropriate mix for corrective maintenance support and related materiel requirements of reliability (MTBF), maintainability (MTTR), and supportability (MLDT) – a process discussed subsequently under the section on provisioning – the performance standard on which the aviation supply support system is based becomes MLDT or, more specifically, the portion of MLDT that excludes delays associated with unavailable technical publications and maintenance personnel and focuses on supply delays, often called average supply response time or average customer waiting time. In our discussion in this chapter, we use the term MLDT to refer to what are essentially supply-related delays for corrective maintenance materiel requirements. Preventive maintenance requirements would conceptually be supported using deterministic inventory planning techniques such as time-phased program requirements or materiel requirements planning models.

Current supply support standards used at the air station level and at AR&SC are oriented exclusively to net requisition effectiveness. The target level of performance is 95 percent net requisition effectiveness at the air station and 95 percent net requisition effectiveness at AR&SC. This set of supply support standards, while demanding, may provide a false sense of security in that they do not ensure that the NMCS Rate will be 5 percent because

- No analytical or conceptual relationship exists between requisition effectiveness, MLDT, and Ao. Thus, the ability to fill 95 percent of customer orders at the air station and at AR&SC for stocked materiel does not imply that the NMCS rate for the air station is 5 percent. This is the case because MLDT, the linkage to Ao, is a time-based linkage that takes into account both materiel availability and materiel positioning (see Figure 4-3).
- Exclusive emphasis on net requisition effectiveness totally ignores how well the *range* of materiel stocked accommodates the demand experience and the related time delays (MLDT impact) associated with those items that are not stocked either at the air station, at AR&SC, or at both levels.

Our analysis indicates that to establish the integrity of the aviation supply system, the USCG should move beyond its current emphasis on net requisition effectiveness and adopt MLDT, the time-based performance standard as the appropriate supply system linkage to operational requirements.

Integration of Multiple Echelons

Given a valid MLDT standard for corrective maintenance requirements – one that is analytically grounded on an Ao that is itself a function of an optimum mix of

$$A_o = \frac{\text{Uptime}}{\text{Total time}}$$

$$A_o = \frac{\text{MTBF} \times K}{(\text{MTBF} \times K) + \text{MTTR} + \text{MLDT}}$$

where K = ratio: calendar time to equipment operating time (duty factor)

FIG. 4-3. THE OPERATIONAL AVAILABILITY EQUATION

system availability, system durability, and system capability – the USCG aviation supply system must be structurally integrated to ensure that as an integrated process it meets the required MLDT at the lowest life-cycle cost. The need for such structural integration is not widely recognized in today's aviation supply management process.

Air station and AR&SC supply goals are viewed separately and inventory requirements are computed separately. Consider the example portrayed in Figure 4-4.

Under a two-echelon system similar to the current USCG system, the combination of gross requisition effectiveness and processing/delay times at each echelon determines the MLDT of the system. In the example shown in Figure 4-4, this combined effect results in an MLDT of 52 hours. Moreover, alternative combinations of gross requisition effectiveness and processing times at each echelon will meet a given MLDT requirement, and conceptually, each of those alternative supply system structures has a different life-cycle cost. For example, a mix of air station gross requisition effectiveness of 90 percent and an average air station delay of 4 hours in combination with an AR&SC gross requisition effectiveness of 80 percent and an average AR&SC delay of 245 hours will provide the same MLDT (52 hours) as the combination portrayed in Figure 4-4. Thus, one can argue that the basic integrity of the USCG aviation supply system can be further improved if, given adoption of an MLDT standard, an integrated approach to the aviation supply infrastructure and related management policies and processes is adopted to minimize life-cycle costs. That essentially means that both gross requisition effectiveness goals

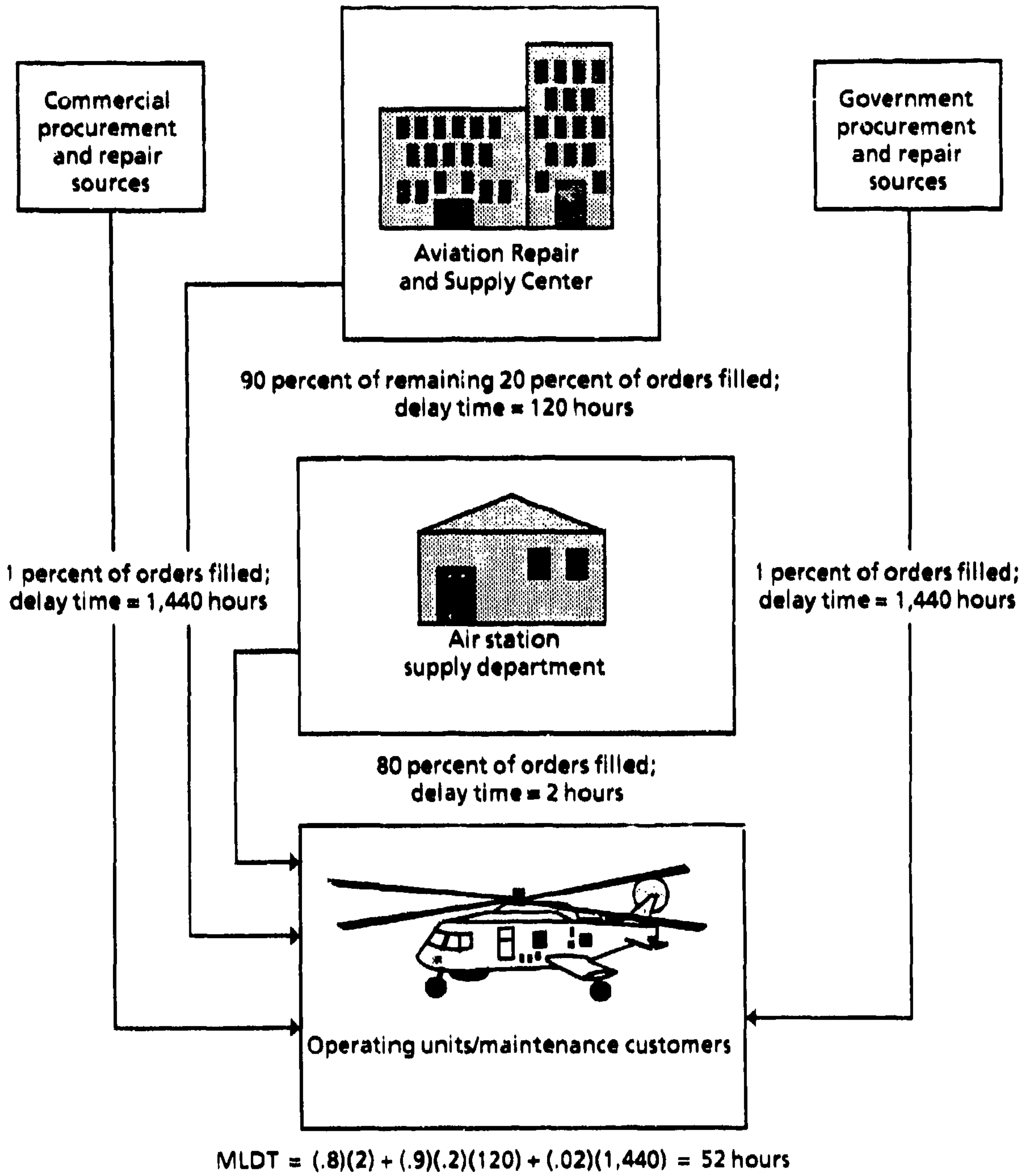


FIG. 4-4. INTEGRATION OF AVIATION SUPPLY SUPPORT GOALS

and processing time goals must be jointly developed and that combinations of those goals must be analyzed to determine the lowest life-cycle cost combination.

Role of Type III and Type V Materiel in Aircraft Support

Recognizing that the ultimate goal of the USCG aviation supply system is to achieve an MLDT that will meet the required Ao goals for operating aircraft leads to concurrent recognition that the absence of a comprehensive approach to the positioning and management of Types III and V maintenance-related spare parts and consumables limits the USCG's ability to meet MLDT standards. At air stations, we observed the use of a wide range of management approaches and systems for managing these common-use consumables. These procedures ranged from totally manual (visual replenishment) methods, to the use of locally developed PC-based systems to provide some limited item visibility. The total dollar value invested in Types III and V materiel is estimated to be between $50,000 and $100,000 at air stations we visited. Although that materiel is generally inexpensive, specific items are often critical to aircraft maintenance. Current USCG aviation supply management processes largely ignore this category of materiel both in the preparation of the 298 Allowance Lists and in the ongoing management control and oversight at the air station itself where Types III and V materiel is generally not a part of the SASI system data base and may not be the responsibility of the air station supply department. Nevertheless, maintenance-related requirements for Types III and V materiel conceptually affect Ao. As a result, range and depth decisions for Types III and V materiel and the related effect of these decisions on MLDT should be incorporated into overall supply management processes and systems.

Recommendations

In light of our discussion of aviation supply system focus and the need to integrate the structural and policy decisions within the system to meet established supply support standards at lowest life cycle cost, we recommend the USCG

- Develop – as a joint G-EAE and G-OAV effort – and promulgate an MLDT standard for each current and future aircraft or system to be supported.
- Use the MLDT for each given aircraft to develop the mix of air station and AR&SC gross effectiveness and processing times that will meet the MLDT requirements at lowest total life-cycle cost.
- Include specific consideration of Types III and V aviation maintenance-related consumables in the basic requirements determination process and make 298 Allowance list quantities for minimum mandatory levels of those items in terms of air station range and depth. The 298 Allowance list

quantity would serve as the reorder point. Based on local air station demand, additional depth above the Allowance 298 Allowance List quantity could be stocked under procedures developed by AR&SC.

PROVISIONING POLICIES AND PROCEDURES

With the changes in aviation supply system performance standards and a more integrated approach to the supply infrastructure to meet these standards, the next major area of current aviation supply management that warrants improvement is the provisioning process.

As a key part of integrated logistics support planning, initial provisioning involves the determination of the range and depth of air station and AR&SC spares to support a new aircraft or major aircraft system. In conjunction with analysis of tradeoffs between aircraft reliability, aircraft maintainability (including Level Of Repair Analysis), and aircraft supportability, initial provisioning is designed to develop those materiel inventories required to meet the Ao established for the aircraft and to allow the USCG logistics system to respond to maintenance orders within the required MLDT.

In the past, when aircraft were introduced into the Fleet, initial provisioning was conducted under varying policies and procedures. Before the HH-60 aircraft was introduced, G-EAE was largely responsible for initial provisioning. Computations for site spares were typically based on a fixed stockage objective for each line item. Using projected demand, a depth of 90 days was computed for each line item for both site and system stockage or vendor-recommended site and system sparing quantities were used.

When the HH-60 aircraft was introduced, the initial provisioning procedures were revised to shift the emphasis to meeting a site net requisition effectiveness goal of 95 percent and an AR&SC net requisition effectiveness goal of 95 percent. Responsibility for the initial provisioning model was shifted to the Office of Acquisition program manager responsible for the aircraft. An improved initial provisioning model (the CASA model[1]) was selected and AR&SC performed the provisioning analysis.

[1]The CASA model was developed for the USCG under contract by TAMSCO (a commercial system development and operations firm currently managing the USCG's ACMS and computer site).

The revised and improved initial provisioning process, however, is not related to MLDT and Ao as we have discussed them in this report. The USCG has recognized this shortcoming and is planning to adopt a multiechelon, readiness-based initial provisioning model that is designed to address the shortcoming. As plans are implemented to move to such an upgraded initial provisioning process, we believe that it is important to place additional management emphasis on three critical elements of the process:

- The use of Ao targets and MLDT
- The use of a structured approach for the computation of initial provisioning quantities
- The involvement of G-ELM, G-EAE, and AR&SC in policy and procedures for the initial provisioning process for future USCG aircraft, and in the cyclic process that updates allowances for existing aircraft.

Use of Operational Availability Targets and Mean Logistics Delay Time

In the future, the USCG AR&SC plans to move to a readiness-based, multiechelon approach to determining initial provisioning requirements to meet corrective maintenance demands. This improved methodology is based on the concept of aircraft availability and is consistent with the use of Ao as we have used it in this analysis. However, the initial provisioning process must recognize the inherent tradeoffs that exist between corrective maintenance planning and supply planning, tradeoffs typically addressed during the ILSP process. As shown in Figure 4-5, in combination with the anticipated mission profile and aircraft or equipment technical parameters (including MTBF), a mix of site and system supply and maintenance policies that will determine the resultant aircraft and equipment operational indices that can be anticipated in actual operations.

During the ILSP process, the USCG must develop the appropriate mix of supply policy and maintenance policy. For corrective maintenance materiel requirements, these policies, broadly defined, will essentially determine the combination of maintainability (MTTR) and supportability (MLDT) used to meet aircraft and equipment Ao. As we have seen, the MLDT results will dictate initial provisioning requirements. As discussed in Chapter 2, the USCG has routinely used a combination of 24 percent NMCM (related to MTTR) and 5 percent NMCS (related to MLDT) in logistics planning and execution for all previous aircraft introduced into the USCG inventory. We did not find a clear analytical foundation for the current

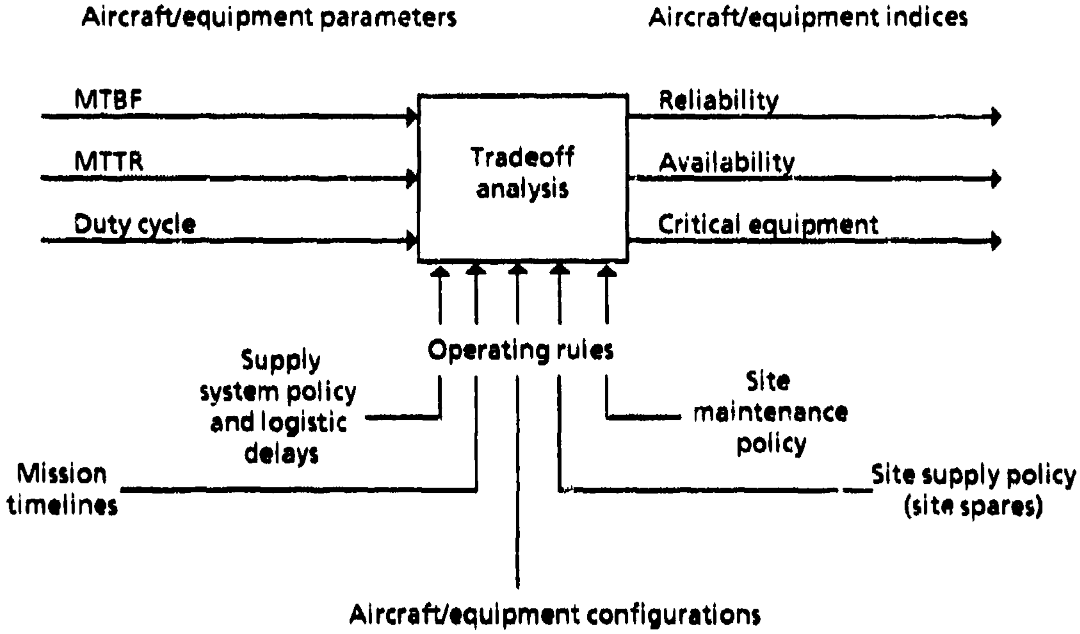


FIG. 4-5. INITIAL PROVISIONING TRADEOFFS

mix of maintenance and supply downtime (and related MTTR/MLDT standards); intuitively, one would believe that the MTTR, given all necessary resources, should be appreciably shorter than the MLDT (which is the composite of all "system" delays, including those for spare parts and components). Further, we believe this routine and consistent approach to NMCM and NMCS is suspect in that it fails to recognize potential changes in maintenance and supply technology, productivity, and costs that may have emerged over time or may be appropriate to a specific new aircraft introduced in the future.

The implications of the current division between MTTR and MLDT on aviation supply support requirements are striking as reflected in Table 4-7. Our baseline analysis indicates that the current Ao achieved by the existing USCG logistics system is approximately 67 percent and that current MLDT is roughly 421 hours, almost six times the MTTR. We have developed various MTBF/MTTR/MLDT combinations in Table 4-7 under the assumption that the required Ao is about 71 percent (the current MC rate) and that the ratio of MTTR/MLDT is about 5:1 (the current USCG NMCM:NMCS ratio). In all cases, the MLDT required of the USCG aviation supply system is much shorter than the current MLDT. Even when aircraft reliability is assumed to double (to 2,000 MTBF hours), the required target MLDT (assuming it will be one-fifth as long as MTTR) would require a 28 percent reduction from its current estimated value of 421 hours.

TABLE 4-7

MTTR VERSUS MLDT TRADEOFFS

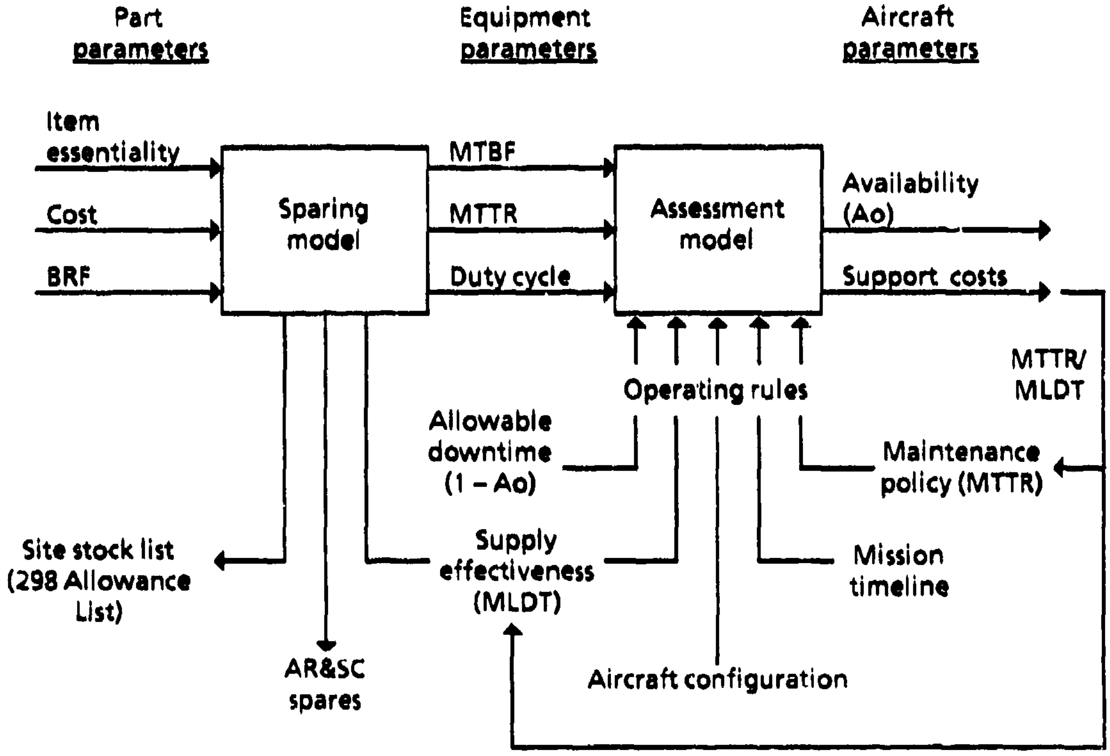
Ao %	MTBF (hours)	MTTR (hours)	MLDT (hours)
67 (baseline)	1,000	72	421
71	500	170	34
71	1,000	340	68
71	1,500	927	185
71	2,000	1,513	303

Note: Baseline data were estimated using current MC rates and assuming an average MTBF of 1,000 hours for all aircraft types supported. Current MLDT was then estimated on the basis of available supply system performance data, and MTTR was extrapolated from these results.

We did not collect information on the actual tradeoffs that exist between the maintainability and supportability of USCG aircraft nor did we analyze those tradeoffs. However, if we accept that an Ao target of 71 percent is appropriate, a major ILSP effort (and, later, an initial provisioning effort) is warranted to ensure that aviation supply planning is based on a realistic and defensible MLDT standard and that an analytical audit trail exists to support the MLDT.

Rather than simply accepting the ratio of MTTR to MLDT that has been traditional in previous USCG logistics support planning, we should consider alternative combinations of aviation maintenance and supply policies (MTTR/MLDT) for meeting established Ao goals. As seen in Figure 4-6, this tradeoff analysis is an essential part of the initial provisioning process and will result in determining an optimum MLDT goal, which will then become an input (constraint) to the new initial provisioning model being developed by the USCG. The conceptual flows of information and analyses portrayed in Figure 4-6 are based initially on item or part parameters (such as unit cost, item essentiality, etc.) and aircraft and equipment parameters (such as MTBF and duty cycle). Using this information, the USCG can develop alternative air station 298 Allowance List spares and AR&SC system spares.

In combination, this sparing option yields a projected MLDT for the USCG aviation supply system. The projected MLDT, in turn, would be an input to an Ao assessment model (along with aircraft configuration data, mission and downtime allowed data, and maintenance data on MTTR), and the assessment model would project Ao and costs. This output from the assessment process would, in turn, be used to adjust MLDT/MTTR, as needed, to reach the required aircraft Ao at lowest life-cycle cost.



Note: BRF = best replacement factor.

FIG. 4-6. INITIAL PROVISIONING DATA FLOWS

Site and System Spares Computations

Initial provisioning results in the computation of line item requirements for initial stockage at air stations and at AR&SC. The data needed to drive this initial provisioning computation are quite specific to the individual line items that are candidates for sparing and are typically acquired as a part of the technical data package from aircraft vendors during the acquisition process. To ensure consistency in the ability to meet MLDT support goals at minimum cost over time, a structured approach is then needed for the computation of initial provisioning quantities. While in the past, the USCG has relied either on vendor recommendations or on the CASA model for this initial sparing computation, none of the past approaches used to compute initial provisioning quantities is consistent with the support standards prescribed for USCG aircraft. Thus, the USCG needs a new sparing approach. This sparing approach should have the following eight major characteristics, or capabilities:

- It should address both range and depth issues.
- It should recognize the unique materiel positioning strategy and structure of the USCG distribution system.
- It should meet the aircraft MLDT standard at lowest life-cycle cost.
- It should not be unduly data dependent either in initial acquisition of technical data or in management of configuration data over the life cycle of the aircraft.
- It should serve both in initial provisioning and in steady-state replenishment.
- It should incorporate specific performance standards and allow performance to be measured at the separate levels (air stations and AR&SC) and in the separate functions (inventory management, procurement, component repair, and warehousing and distribution) that constitute aviation supply management.
- It should recognize the likely need to batch (i.e., order and repair in economic lots) in the procurement and repair process at both the air station and at the AR&SC level to accommodate staffing and processing/workload costs.
- It should be understandable to the item managers at AR&SC and the inventory managers at the air stations who must ultimately make the system work.

Several requirements determination models with many of the desirable characteristics outlined above are available to the USCG. All those models represent a much greater level of sophistication, are far more data-sensitive than current inventory management approaches, and, with some modification, could be used in this USCG application.

Evaluating and selecting an appropriate requirements determination model should occur as the aviation logistics MISs evolve (as discussed in Chapter 3). As that evolution progresses, adopting an interim methodology that uses current USCG capabilities (essentially a continuous review/EOQ/reorder point model geared to a fill-rate objective) has some advantages. Figure 4-7 is a conceptual overview of the requirements determination process envisioned.

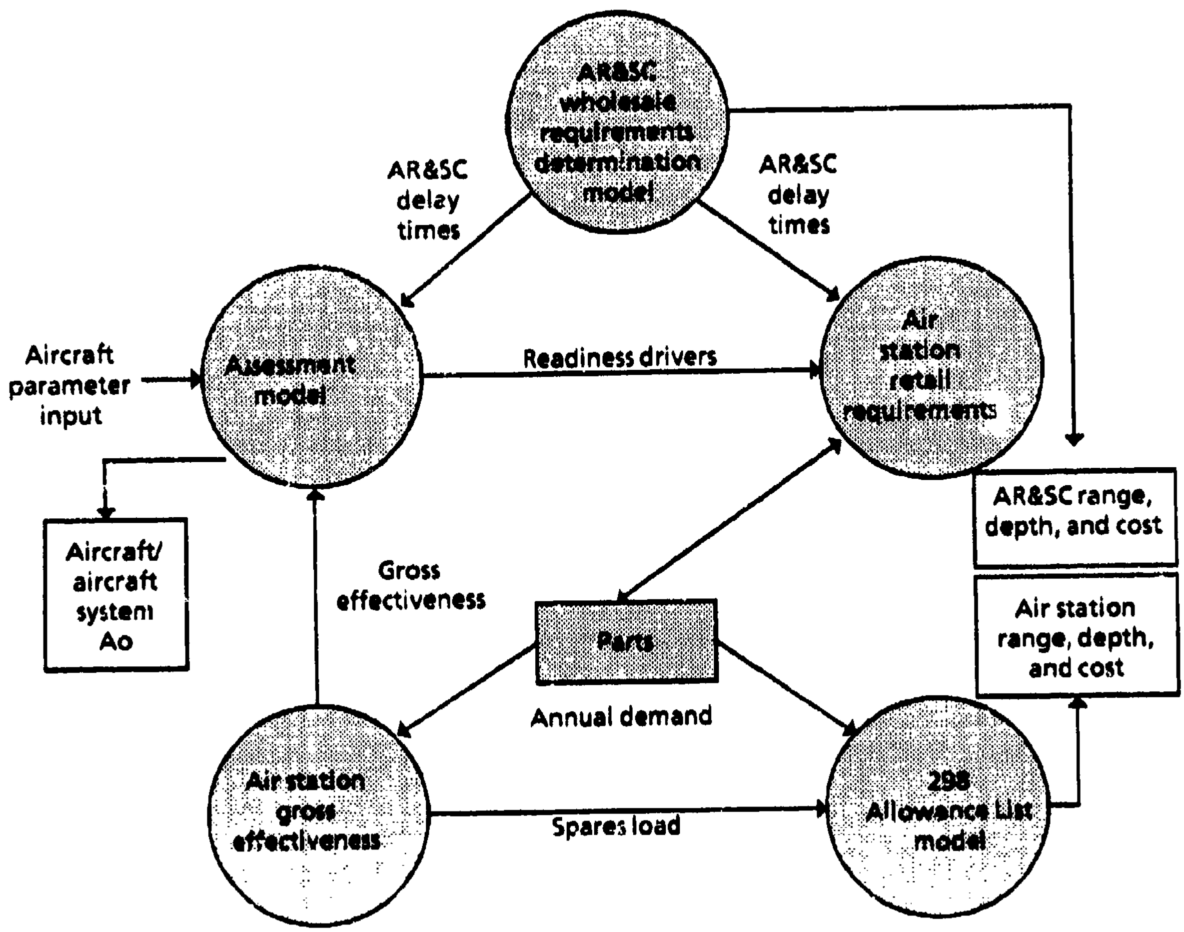


FIG. 4-7. REQUIREMENTS DETERMINATION PROCESS

Figure 4-7 presents a macro-level, general description of the basic requirements determination process. It includes the major data flows (inputs and outputs), an assessment model for developing delay time and air station gross requisition effectiveness standards, the requirements computations model for AR&SC and air station inventory/298 Allowance List requirements, and the key process outputs (AR&SC and air station item range, depth, and cost information). As a generalized process, Figure 4-7 incorporates many of the primary concepts and strategic issues discussed throughout this report.

First, as we illustrated earlier in our discussion of system integration, gross requisition objectives and delay time standards that meet required aircraft MLDT should be established for the air station and AR&SC. Second, these fill-rate objectives should be used to project the required air station investment and the anticipated AR&SC inventory investment to support the aircraft being acquired. Through a process of tradeoff analysis at the macro-, or aggregate-, dollar-value level, one can determine the most cost-effective combination of air station and AR&SC fill rates. Third, once that optimum fill-rate combination is determined, these gross requisition effectiveness goals may be used in combination with line item data to develop the actual air station 298 Allowance List and AR&SC stockage levels. In so doing, the capability for air station replenishment (using economic lots instead of one-for-one replacement, if desired) and AR&SC repair and procurement (with appropriate batching as desired) is also provided. Further, the initial provisioning approach is entirely consistent with replenishment procedures.

For inventory managers at both the air station and AR&SC this approach is basically a refinement and an extension of current processes, not an entirely new approach to requirements determination. It is also compatible with budget development and execution. Finally, use of this approach allows the USCG to measure performance (gross effectiveness and delay times) at both the air station and AR&SC and to relate that supply performance directly to meeting the assigned MLDT goal for the aircraft. Thus, it provides managers at all levels in the USCG aviation supply management system a clear sense of how their efforts relate to meeting system MLDT and, in turn, aircraft Ao (as discussed, in greater detail in Chapter 2).

Many computational models for determining inventory requirements are used today in both the private and Government sectors. Some existing models offer capabilities (e.g., initial provisioning, spares requirements and distribution, budget forecasting, and spending-to-readiness priorities) essential to improving the USCG's aviation logistics management in the future. The USCG has VMetric™, a commercial version of an availability model, currently being evaluated at AR&SC.[2] VMetric™

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[2]VMetric™ is a product of Systems Exchange, 5504 Garth Avenue, Los Angeles, CA 90056.

has many capabilities found in the Aircraft Availability Model developed for the Air Force by LMI.

It is not our intent to recommend a specific computational model nor do we consider it inappropriate for the USCG to be evaluating VMetric™. We believe adoption and implementation of a model requires that decision to be preceded by a concerted effort to develop and refine the maintenance and supply data the model uses. That effort should include determining the basic Ao requirement and the MLDT standards that "drive" the computational model. Additionally, to initialize the computational model requires the USCG to (1) analyze and determine the most cost-effective mix of logistics resources (e.g., procurement, repair, transportation, warehousing, receiving, and issuing costs); (2) identify processing times and set standards for procurement, repair, ordering, and shipping lead times; and (3) determine the fill-rate objectives for spares, components, and parts not indentured to an aircraft's Ao requirement for computing inventory quantities and distribution.

Because the requirements determination model is important to future improvements in the USCG's aviation logistics support, we believe management attention should focus on developing the factors that drive the model – the Ao requirement, MLDT, logistics costs, and leadtimes – to ensure sound maintenance and supply data are used in the model(s) evaluated. We believe this effort should have top management priority as the evaluation of VMetric™ occurs and should precede a final decision on the requirements determination model most suitable for the USCG's future goals. To do less is to risk using incomplete or incorrect data that distort the model's output products and result in rejection or acceptance of a model for erroneous reasons.

Responsibilities for Requirements Determination

Our analysis of provisioning policies and procedures highlights the need for increased involvement by G-ELM, G-EAE, and AR&SC in the G-A program manager's ILSP process, in initial provisioning computations for future USCG aircraft acquisition programs, and in the validation/recomputation of air station 298 Allowance Lists and AR&SC system inventory requirements for existing air-craft. Such an involvement by both maintenance and supply personnel is considered vital given the inherent tradeoffs that exist. That involvement means greater participation in ILSP activities as members of the acquisition program manager's staff and direct responsibility for computing initial provisioning requirements. Continued reliance on external sources, either the aircraft vendor or an organization that is removed from the AR&SC replenishment support environment, is shortsighted in our view, and action to significantly upgrade and improve the internal USCG organization for initial provisioning is necessary. For existing aircraft and aircraft systems, greater involvement by G-ELM, G-EAE, and AR&SC in cyclic updates of air station 298 Allowance List requirements is also vital.

Recommendations

In view of our discussion of provisioning and the need to improve the ILSP process, to develop spares and parts requirements, and to strengthen the organizational capabilities for initial provisioning, we recommend the USCG

- Direct G-EAE, G-ELM, and AR&SC to actively participate in the early stages of the aircraft and systems acquisition with the assigned program manager's ILSP process to ensure that the mix of maintainability (MTTR) and supportability (MLDT) is the minimum life-cycle cost needed to meet Ao goals established by the USCG for the aircraft.

- Develop and implement an MLDT-based initial provisioning methodology that determines both site and system spares requirements (range and depth) as an integrated process. Further, make this initial sparing methodology compatible with steady-state replenishment methods (including the use of both procurement and repair batching rules) and ensure that it reflects the materiel positioning strategies and physical distribution network structure unique to the USCG.

- Direct management attention to developing and refining the factors (the Ao requirement, MLDT, logistics costs, and lead times) that are critical to a requirements determination model's output validity before selecting a new model for the future aviation logistics MIS.

- Develop, staff, and train an AR&SC organization devoted to initial provisioning of new aircraft and major systems. Ideally, such an organization, would be developed on a "matrix" basis within AR&SC and would include designated individuals from the Repair Division, Inventory Management Division, and Engineering Division. Those individuals would, in turn, also be responsible for the ongoing steady-state logistics support of the aircraft including postfielding provisioning analysis and cyclic update of air station 298 Allowance Lists.

REPARABLES MANAGEMENT

The prevailing USCG maintenance philosophy explicitly limits air station component repair responsibilities and capabilities. Under that philosophy, the management of expensive and essential reparables, including the requirements determination process and the related support processes, should be as cost-effective as possible.

In our analysis of USCG reparables management operations, we could not find any clear relationship among the basic requirements determination process for reparables at AR&SC, the determination of appropriate repair batch quantities and induction schedules, and the overall target level of reparables support required from the composite aviation logistics system. Moreover, the key processing times (pipelines) currently associated with reparables management seem to be excessive. For example, as we noted earlier, the process of returning an unserviceable reparable (commonly referred to by the USCG as a "265") from an air station to AR&SC requires an average of 47 days. Once the maintenance organization decides to induct and repair a reparable item, it takes an average of more than 200 days before the item is repaired and ready for issue to an air station customer.

Retrograde Processing

Current USCG retrograde management policies and procedures have a detrimental effect on inventory investment, air station workload, and in some cases, customer support since they contribute significantly to the excessive time required to remove, turn-in, and ship unserviceable components at the air station and to receive and store these components at AR&SC. The normal mean component retrograde pipeline time is about 27 days from the time a requisition is generated at the air station for a replacement item until the failed reparable is received and stored at AR&SC. However, Table 4-8 shows that this normal retrograde pipeline time does not recognize the substantial number of delayed reparables (31 percent of the items and 60 percent of the 265 dollar value) that are considered "late" by USCG standards; when these delayed retrograde components are considered, USCG aggregate financial data indicate an overall mean retrograde pipeline time of more than 40 days with an associated dollar-value investment of $34.5 million.

If we focus our attention on those components that are, by USCG definition, "late or overdue," we see that components are delayed (or late) by an average of

TABLE 4-8

USCG RETROGRADE PROCESSING PERFORMANCE

Dollar value 265 due in to AR&SC	$34.5 million
Days 265 due in to AR&SC	42 days
Number of 265 due in to AR&SC	2,672
Number of due in 265 late	817 (31%)
Dollar value 265 due in late	$20.8 million (60%)
Average days 265 late	46.1 days
Top nine air stations with 265 due in late	$15.6 million
Late 265 with AR&SC backorders	28.3%

Source: AR&SC Management Report PGM SM 410, *265 Due In Summary,* 15 May 1992, and AR&SC Management Report PGM SM 105, 22 May 1992.

Note: 265 = unserviceable reparables.

46.1 days, and nine air stations are late returning at least $1 million in unserviceable components reparables each (their total is $15.6 million); the value of late 265 for those nine air stations constitute 75 percent of the total dollar value of late unserviceable reparables. In the case of six air stations, over 45 percent of all retrograde items are late.

If we assume that a retrograde pipeline of approximately 27 days is realistic under normal processing time, the associated investment in inventory would be about $21.6 million rather than the $34.5 million shown in Table 4-8. Thus, the *potential* excess inventory investment associated with current retrograde flows is almost $13 million. However, in addition to this over investment in pipeline inventories, more than 28 percent of the items with delayed carcasses also have backorders at AR&SC indicating a potential negative impact on aircraft readiness. This potential aircraft support issue goes beyond just unnecessary inventory investment, but we did not analyze the individual line items involved to determine the degree to which the lack of adequate carcasses for repair was actually affecting the support posture on these items.

The USCG is aware of the problems noted here and is acting to reduce retrograde processing times though increased monitoring, better air station controls, and more expeditious processing of receipts at AR&SC. These efforts will ultimately improve the timeliness of the return of unserviceable components. Indeed, we noted few retrograde processing queues at either the air stations we visited or at AR&SC. This leads to two conclusions. First, the retrograde pipeline data may not be valid, and as a result, repair and procurement budget requirements to accommodate the measured retrograde pipeline may be overstated. Second, many of the unserviceable components, including those that are late, may still be installed in the aircraft. While we address this issue in greater detail in the section on air station supply management below, it is important to note here that control of component removal and turn in at the air station level is critical to effective supply support in a system such as the USCG system that is predicated on the timely flow of unserviceable components through the repair process. Our discussions with air station maintenance and supply personnel and with AR&SC inventory management personnel indicate that both data validity problems and poor control of component removals are important factors in understanding and resolving the current retrograde processing problem.

Requirements Determination Policies

Inventory managers at AR&SC are responsible for determining the range and depth of reparable components to be stocked there to support air station operations. A part of requirements determination is to decide when to buy and when to repair an item and, once the decision to buy or repair is made, to determine how many units should be bought or repaired.

In many inventory management systems, recommendations about "when to buy and where to repair" and "how much" to buy or repair are internally generated using line item data, and the item manager reviews, revises, or approves these recommendations. Such inventory models use the so-called "reorder point" established for the item to determine when to act and the "order/repair quantity" for the item to determine the appropriate quantity.

By comparison, the "requirements determination" process for reparable items managed by AR&SC is limited under current policies in that the computational models used do not explicitly recognize the unique nature of reparables and do not generate clear repair recommendations. First, reparable items are treated in the computational logic as though they were consumable items and all machine-generated recommendations are related to the procurement of new assets. What this means is that most reparable requirements are not determined by the computational model and the supporting data system but rather are determined by the inventory manager on an ad hoc basis. Using a cyclic review period that has ranged from two weeks to one month, individual inventory managers essentially review the basic inventory management data for each reparable item, compare assets to projected requirements, determine as to whether repair action is warranted, and decide how many units should be repaired. Given component repair times of 3 to 6 months, a delay in the initial recognition of the need to repair an item of up to one month introduces a "support gap" that is not anticipated in the inventory models being used.

Second, the current process relies heavily on the expertise of the individual item manager and introduces the possibility not only of creating inconsistencies in approach from one item manager to another but also of having an item manager who will either fail to react to a needed repair requirement or, alternatively, will overreact and decide prematurely to repair too many units of an individual item. Our analysis of approximately 50 reparable items for the HH-65 aircraft indicated that when an item is cyclically reviewed, the item manager, as a general rule, appeared to schedule repair of all unserviceable components available at the time of the review. In some cases, the demand pattern and available serviceable assets on hand did not appear to warrant such repair action.

Finally, without clear-cut requirements determination policies embedded in the inventory management system, budgeting and control of AFC 41 funds becomes extremely difficult.

The USCG has recognized the deficiency in the current process for requirements determination for reparables and plans are under way for major enhancements with the evolution of the aviation logistics MISs.

Induction Quantities and Scheduling

Earlier, we introduced aggregate AR&SC financial data that showed a DRCT pipeline investment of more than 200 days. Based on sampling, AR&SC estimates for FY92 indicate an average DRCT processing time of 149 days for a typical component. Financial estimates and budgets are based on an FY93 goal of 99 days. For general management purposes, target DRCTs are 45 days for AR&SC repair and 90 days for commercial repair. Regardless of the specific performance parameter selected, DRCTs that exceed 100 days are not only longer than comparable non-USCG operations but are also far in excess of the DRCT goals envisioned in USCG planning, requirements determination, and budgeting processes that are based on an organic or internal AR&SC DRCT of about 45 days and a commercial DRCT of 90 days. Moreover, the *potential* one-time savings in inventory pipeline investment that would be realized by the USCG from a 100-day reduction (from 200 to 100 days, for example) in the DRCT pipeline is approximately $80 million.

Extremely lengthy DRCTs are generally indicative of poor induction management and tracking or, in the case of commercial repair, unresponsive procurement and contracting processes. Determination of appropriate induction quantities, depot repair scheduling to minimize throughput delays, visibility, and active monitoring of the repair status of particular batches (particularly those in commercial repair pipelines) are important and necessary ingredients for effective component rework and for minimizing DRCT.

In general, we believe that the priority afforded to component repair scheduling and induction control must be improved. Scheduling procedures and delays should recognize the inherent cost in inventory investment imposed by longer DRCTs. Induction quantities should adequately reflect the inventory costs of large repair batches and, where possible, should be limited to improve flexibility and reduce unnecessary inventory investment. Specific commercial repair sources should be used on the basis of the actual cost of repair and the time it takes to complete repair. This aggressive effort to reduce and manage DRCT will require internal changes in inventory management and in repair and procurement. We believe that the inventory manager must essentially control the process of repair at the line item level. That control implies not only taking a more active role at AR&SC but promoting enhanced repair scheduling and induction procedures, better visibility of assets undergoing repair, and the development and implementation of more sophisticated information systems and linkages.

Recommendations

In view of our analysis of reparables management and the need to improve retrograde processing, requirements determination for reparables, and DRCT management, we recommend the USCG

- Direct top management attention to improving unserviceable reparables (265) processing to eliminate the lengthy delays currently experienced in the flow of retrograde assets from the field to AR&SC. This effort should begin with a validation of the data actually being used for monitoring to ensure that those data provide a realistic picture of current performance. Once the data have been validated, specific goals, monitoring, and report/feedback procedures should be initiated at AR&SC to highlight problem items or problem air stations for G-EAE and G-OAV action.

- Develop an item-specific mandatory remain-in-place (RIP) list for each aircraft type that will indicate those line items that may be retained in the aircraft while supply action is underway. Once the appropriate RIP list is developed, specific policies and procedures should be put in place to ensure the removal and return of all other items at the time a requisition is placed on the supply system.

- Develop a comprehensive requirements determination process for reparable items at AR&SC as discussed in this and the section of this chapter on provisioning policies and procedures. Such a reparables requirements determination process should include the specific identification of when repair action is required and the automated capability to determine the appropriate economic repair quantity or economic repair batch size for a specific line item given set-up cost versus inventory holding cost tradeoffs. In general, repair lot sizes should be minimized and tailored to the repair capability of the repair activity so that delays (scheduling queues) within the repair facility are minimized. Inductions should be scheduled so that repair action on a given batch can begin within a reasonable period of time: for example, 1 or 2 days following receipt in the repair facility.

- Reverse current AR&SC repair scheduling and induction-processing procedures to place responsibility for initiating the repair action (the timing, the quantity, and the required completion date) on the cognizant inventory manager for the item. Once the item manager has determined that an item should be repaired, the induction quantity of the item required should be passed directly to the warehouse and unserviceable assets pulled and moved to the Repair Division for repair scheduling and actual repair.

- Base the measured DRCT (and DRCT requirements) on the "first unit" completion time for an individual line item to focus attention on control and scheduling discipline in the repair process and to minimize the inventory investment impacts of extended repair delays for large batches that are completed sporadically over time once inducted.

- Develop internal AR&SC and commercial repair vendor data management systems and interfaces to increase the visibility of reparable assets undergoing repair. This enhanced management visibility should include, as a minimum, an estimate of the "next unit" completion (availability) date and "days to complete the lot" information that is updated during the actual repair process. Further, the system should allow the item manager (in conjunction with the repair facility) to reset priorities for repair as asset needs change to ensure that the repair source is focused on the most critical materiel requirements at any given point in time.

- Establish incentives for commercial repair vendors to reduce commercial DRCT to recognize the USCG inventory investment in pipeline spares by including the DRCT in addition to repair cost as a competitive factor in evaluating and awarding commercial repair contracts.

- Evaluate the benefits of expanded use of long-term (multiyear) requirements type contracts for commercial component repair. Ensure that such contracts include the provision that unserviceable units would be returned by air stations directly to the designated repair vendor and held pending a specific induction request from AR&SC. This change in the processing flow will require data system changes to separately reflect the quantity of unserviceable items on hand and in work at commercial repair sources.

AIR STATION SUPPLY MANAGEMENT

Based on our analysis to date of USCG air station supply operations, no meaningful focus appears to have been placed on supply management beyond the physical processing of customer orders (from maintenance technicians), physical processing of receipts to inventory, physical processing of unserviceable components (not-ready-for-issue reparables) for return to AR&SC, and the replenishment of air station inventories based on existing 298 Allowance List quantities. Our air station visits indicated very limited demand recording and analysis at the air stations by supply personnel. Further, we found no clear relationship among the decision to stock an item, the depth of inventory stocked for an item, and the required supply performance expected from the air stations inventory. As a result, current air station allowances have little conceptual validity and are viewed by many at AR&SC as suspect. Finally, our discussions with air station supply personnel pointed out that many of them need to improve their appreciation and understanding of the basics of inventory management, of how to implement demand forecasting, and of how to upgrade requirements determination capabilities. Moreover, at the air stations we visited, supply management clearly does not receive the attention and emphasis, either locally or by G-EAE, afforded to the air station maintenance. We address each of these issues in USCG air station supply management in the following sections.

298 Allowance List Integrity (Range and Depth)

The air station 298 Allowance List developed and promulgated by AR&SC is the foundation of support for aircraft maintenance at the air station level. It prescribes Types I, II, and IV allowance quantities, and the air station must have the specified allowance quantity either on hand or on order from AR&SC at any point in time. No reorder point is defined, and assets are "reordered" equivalent to requisition priority 12/13 requirement on a one-for-one basis as materiel is used at the air station. Our analysis of the 298 Allowance List development, budgeting, and update process; of air station management of 298 Allowance List assets; and of AR&SC response to 298 Allowance List replenishment requisitions indicates a general lack of integrity in basic 298 Allowance List policies and procedures. Because air station supply performance (gross and net requisition effectiveness) is not measured, the support impacts of 298 Allowance List deficiencies are hard to assess. The 298 Allowance List quantities needed to reach overall USCG MLDT goals could be higher or lower than current quantities. Nevertheless, major deficiencies or shortfalls that should be addressed by G-EAE include the following issues:

- The gross requisition effectiveness (the percentage of total air station demand filled from 298 Allowance List assets) provided by the 298 Allowance List is suspect. First, gross requisition effectiveness is not used in the construction of the 298 Allowance List and is not measured over time. Second, the air station demand recording process does not provide any comprehensive capability to record demand for items that are not stocked and to use that demand to adjust the 298 Allowance List. Our review of approximately 100 reparable items at AR&SC indicated that a large number of these items (perhaps as many as 75 percent of the ones reviewed with air station backorders) reflected air station backorders at AR&SC but no 298 Allowance List quantities for the same air station. This discrepancy is an indication of a potential range problem in 298 Allowance List development.

- The 298 Allowance List is prepared at the time an aircraft is introduced at a given air station (or when the aircraft number/mix changes) but no comprehensive cyclic update process is initiated by AR&SC to periodically update the 298 Allowance List based on demand changes, etc. While the allowance change request (ACR) process provides a vehicle for updating the 298 Allowance List by air stations, our review indicates that ACR procedures are largely used on a sporadic basis by air stations to add "problem items" to the 298 Allowance List or increase the depth of "problem items"; ACR processes do not address, in any systematic way, all potential range and depth changes that one would anticipate in keeping any allowance list up to date.

- The 298 Allowance List, as currently constructed by AR&SC, provides a depth for items on the list of 180 days of anticipated demand. This fixed "days-of-stock" approach to 298 Allowance List depth does not provide for any given net requisition effectiveness (the percentage of demand for stocked items filled from 298 Allowance List assets) either at the individual line item level or for the 298 Allowance List as a whole. Thus, there is a clear "disconnect" between USCG net requisition effectiveness goals and the 298 Allowance List quantities being computed. Since net requisition effectiveness is not measured at the air station, AR&SC does not know the actual level of net requisition effectiveness generated by the 298 Allowance List. Finally, AR&SC's plan to reduce the 298 Allowance List depth to 90 days of stock is difficult to analyze or support in that the impact on net requisition effectiveness (and, ultimately, NMCS rates) is unclear.

- The current validity of 298 Allowance List requirements is considered questionable at AR&SC. First, our discussions with AR&SC's budget development personnel indicate that recent AR&SC budgets have not included a full recognition of 298 Allowance List requirements and that these requirements have been deliberately constrained in budget development and submission. Second, our review of the procurement and repair logic being used by AR&SC inventory managers indicated that no procurement or repair action is taken solely to fill 298 Allowance List replenishment requirements. As a result, unless an item otherwise qualifies for procurement or repair based on AR&SC requirements or based on air station requisition priority 02/05 requirements, the inventory manager at AR&SC is not routinely acting to fill air station allowances. The result of this lack of 298 Allowance List credibility is that a very large percentage of air station backorders held at AR&SC are for 298 Allowance List replenishment requirements. As shown in Table 4-9, almost 70 percent of the total dollar-value of backordered requirements at AR&SC are for 298 Allowance List replenishment requirements.

As indicated, the process of demand recording at the air station level is limited in terms of the scope of the effort and in terms of the management priorities afforded to the analysis of air station demand. Improvement in the recording and analysis of demand is needed in three major areas.

The USCG has no effective process for the air stations to use to record and analyze demand data for items not stocked in inventory. To overcome this weakness, demand for items not stocked at the air station must be recorded in some consistent fashion. The establishment of a "not-carried demand history file" at the air station within the SASI system is the first step to improving the range of materiel carried in inventory at the air station. Using this demand history file, the air station supply organization should, in turn, review actual demand on a quarterly basis for potential

TABLE 4-9

DOLLAR VALUE OF AIR STATION BACKORDERS HELD AT AR&SC

Aircraft types	Priority 02/03	Priority 05/06	Priority 12/13	Total
HC-130	43,909	1,735,250	6,770,554	8,549,713
HH-3	963,807	1,217,298	2,426,105	4,607,210
HH-60	103,242	889,559	5,649,986	6,642,787
HH-25	850,181	7,649,285	9,773,589	18,273,055
HH-65	779,919	5,360,344	13,546,433	19,686,696
Miscellaneous	17,513	586,272	891,164	1,494,949
Total (percentage of total)	2,758,571 5%	17,438,008 29%	39,057,831 66%	59,254,410 100%

stockage of new items. In this way, the range of materiel stocked at the air station can be effectively adjusted over time to reflect the demand being experienced.

Second, the USCG has no process other than piecemeal use of ACR procedures to periodically adjust to the demand actually experienced for items carried in inventory at the air station. To remedy this deficiency, for items stocked at the air station either as 298 Allowance List items (Types I, II, and IV materiel) or as a local option item (Types III and V materiel), the SASI must record actual demand data and analyze those data to update the depth of stockage required to meet established supply support standards.

Third, air station maintenance and supply procedures often result in erroneous demand transactions. Removal of components later determined to be serviceable (false removals) results in placement of an order on supply that overstates the true demand; at the same time, local repair actions that do not result in placement of an order on supply understate true demand. As the analysis and use of demand information increases at the air station,the USCG must pay greater attention to the maintenance-supply interface at the air station to ensure that accurate failure data are reflected as demand in the supply files.

Supply Responsibilities and Management Expertise

On the basis of our site visits and discussions with USCG aviation logistics personnel at AR&SC and Headquarters, we believe that the air station supply function must be restructured to play a more active and more involved role in support of aviation maintenance. First, the basic responsibilities assigned to the air station supply function should extend beyond simply processing orders, issuing 298 Allowance List items, and receiving and issuing items stocked in inventory. The air station supply organization should be responsible for the overall level of materiel support provided to the maintenance function. That responsibility includes the following additional activities:

- Demand recording and analysis to ensure that the range and depth of materiel stocked is adequate to meet established support standards.
- Cyclic review – either quarterly, semiannually, or annually – of all 298 Allowance List quantities and updating of those quantities on the basis of actual demand experienced at the air station.
- Management and control of removal and retrograde processing of items, including the policing of RIP items held by maintenance for which a replacement item has been received. This activity should include direct involvement in tracking the removed component while still in the air station environment.
- Initiation and approval of all ACRs submitted by the air station.
- Direct management of Types III and Type V materiel inventories and related requirements
- Measurement and analysis of materiel support performance and resolution of problems affecting supply support to the maintenance effort at the air station.

Second, to meet the added aviation supply management responsibilities outlined above successfully, the supply organization will have to upgrade the level of supply management expertise resident in the air station supply organization. Improved understanding of basic inventory theory, better appreciation of the importance of demand forecasting and analysis and the use of demand in requirements determination, and a broader vision of the role of supply in effective aviation logistics support will jointly serve to upgrade the air station supply function expertise and to improve air station supply support.

Recommendations

In view of our discussion of air station supply management and the need to improve 298 Allowance List integrity, demand recording and analysis, and supply management capabilities and expertise at the air station, we recommend the USCG

- Establish clear gross requisition effectiveness and net requisition effectiveness performance standards for the air stations and apply them directly in 298 Allowance List development and evaluation through the use of variable-level inventory models.
- Establish AR&SC procedures to update all air station 298 Allowance Lists on a cyclic (perhaps annual) basis using most recent air station demand and maintenance data.
- Include 298 Allowance List requirements in AFC 41 budget formulation and in execution at AR&SC by making 298 Allowance List requirements an explicit part of procurement and repair computations.
- Develop and implement policy and USCG standard work station capabilities (together with related procedures and SASI applications) to record and analyze demand for "not stocked" items at the air station.
- Evaluate current air station aviation supply responsibilities, organization, and management expertise and implement alternative organizational responsibilities and structures to improve the management of all materiel at the air station.

CHAPTER 5

MEASURING THE COST OF THE COAST GUARD AVIATION LOGISTICS SUPPORT PROGRAM

INTRODUCTION

Coast Guard financial data should provide Headquarters [G-EAE and Chief, Financial Management Division (G-CFM), Office of the Resource Director/ Comptroller] with valuable indicators for measuring aviation logistics support performance. The quality of aviation logistics support is directly related to the availability of funds, and the use of those funds provides a basis for measuring supply and maintenance performance. "Budgeting is the process by which planned operations and objectives are translated into their related financial requirements for purposes of estimating and executing those plans. To be effective, the budget must present a clear and accurate picture of recent accomplishments and future plans in relation to the costs involved." It must also "provide measurable standards and/or goals which would allow progress in the accomplishment of [an] approved program to be measured or proposed plan changes evaluated."[1]

This chapter examines the degree to which operating expenses-related financial budgeting and measurement for the USCG's aviation logistics support program contributes to achieving the required results.

OVERVIEW OF AVIATION LOGISTICS BUDGET PROCESS

Figure 5-1 shows Coast Guard organizational interactions supporting the three principal aviation logistics support AFCs: AFC 41, 30, and 56.[2] Of the three, G-EAE is most deeply involved with the AFC 41 funding process. AFC 41 funds Headquarters-related aircraft programs including PDM, overhaul, major repair, and modification of aircraft and aeronautical equipment; aviation materiel (except types III and V); technical engineering support; and other related aviation activities

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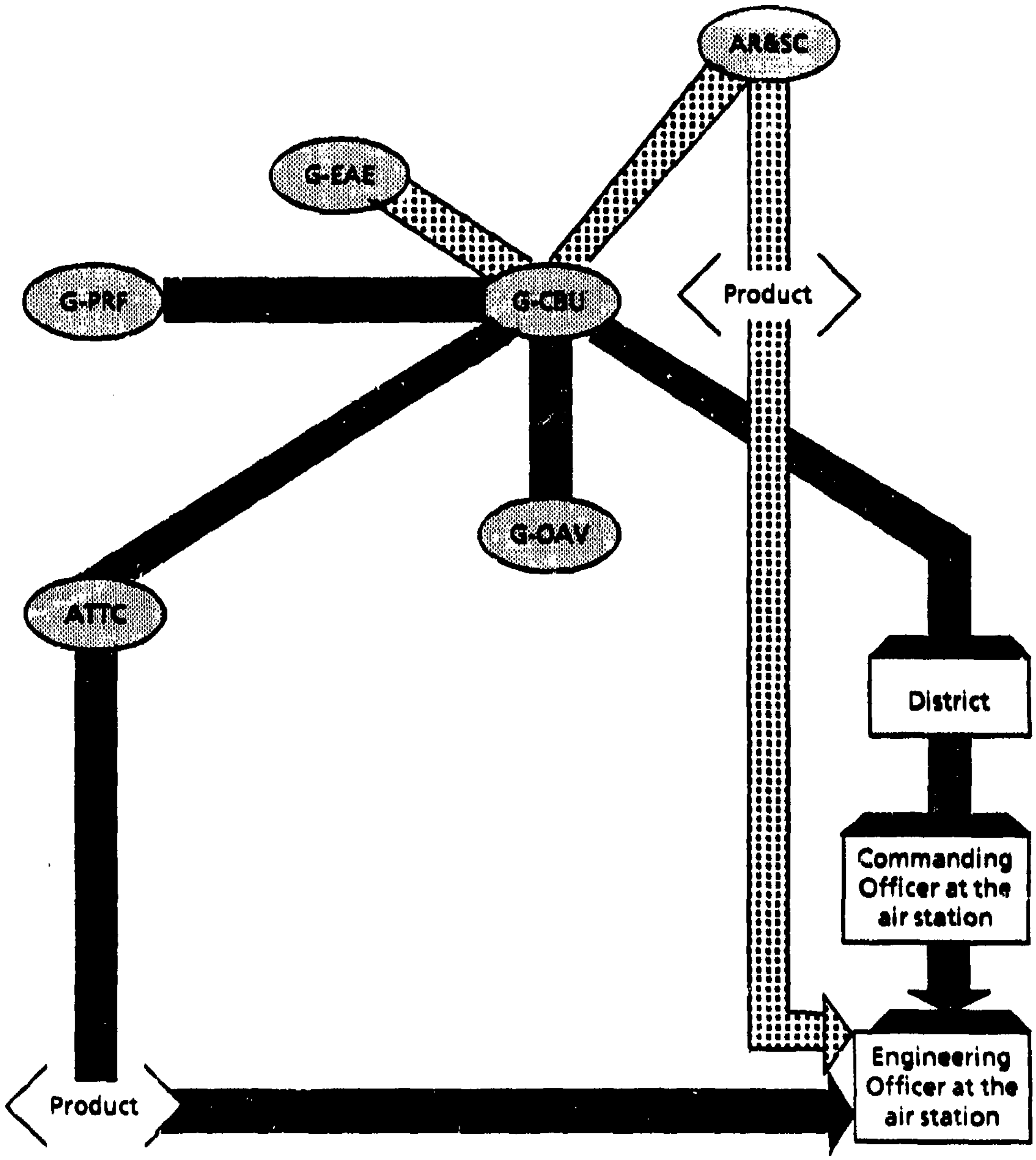
[1]COMDTINST M7100.3, *Manual of Budgetary Administration*, undated.

[2]AFC 41 = aircraft program depot-level maintenance; AFC 30 = operating and maintenance (O&M) costs -- aircraft program -- funds operating aviation units; AFC 56 = personnel training and education.



AFC 56 flow of funds
AFC 30 flow of funds
AFC 41 flow of funds

Note: G-CBU = Budget Division, Office of the Resource Director/Comptroller
ATTC = Aviation Technical Training Center
G-PRF = Performance Systems Division, Office of Personnel and Training

FIG. 5-1. AVIATION LOGISTICS SUPPORT FLOW OF FUNDS performed at AR&SC. After obtaining input from AR&SC, G-EAE submits the AFC 41 budget request to Chief, Budget Division (G-CBU), Office of the Resource Director/Comptroller, via the Office of Engineering, Logistics and Development (G-E). After the AFC 41 fiscal year funding level is finalized, G-CBU, as the manager of the Operating Expense (OE) appropriation throughout the USCG, allocates funds for the AFC 41 budget to G-EAE via G-E. Subsequently, G-EAE provides AFC 41 funding to AR&SC.[3]

The AFC 30 funds are used for normal and ordinary O&M costs in support of operating aircraft units. The AFC 30 budget process can be viewed as two distinctly different subprocesses.[4] At the Headquarters level, G-OAV, the designated USCG air station facility manager, acts as the air stations advocate in guiding the AFC 30 budget request through the funding process. AFC 30 budget requests are passed from G-OAV to G-CBU through the Office of Law Enforcement and Defense Operations (G-O) as a fixed dollar per flight hour per mission and actual funding levels are allocated by aircraft flight hours. Table 5-1 shows the USCG aircraft hourly O&M funding levels for FY92. Based on the number and type of aircraft at each air station, AFC 30 funding is provided to each cognizant Coast Guard District (funds are provided consistent with the programmed flying hour rate shown in Table 5-1). A second subprocess occurs at the district level as AFC-30 provided funds go through a reallocation process that ultimately determines how much total funding will be provided to the air station; including specific air station engineering-related requirements. Throughout this subprocess, great discretion exists as to how funds will actually be used. Initially, the district determines the percentage of funds it will retain to fund internal district operations in support of the air station. Each district appears to exercise discretion in determining this percentage. Subsequently, the air station interacts with the district budget office to create an air station operating target for each air station expense code.[5] The air station Commanding Officer determines how the funds allocated to the air station will be spent. The original operating targets can be revised and are typically allocated between various air

[3]The vast majority of AFC 41 funding is used for AR&SC operations; however, some AFC 41 funds are retained by G-EAE to fund HC-130 PDM and other special projects (in FY92, approximately $125 million to $130 million of the total AFC 41 budget of approximately $145 million to $150 million was provided to AR&SC).

[4]This discussion is not applicable to AFC 30 aviation-related fuel funds. Fuel funds are retained and managed at USCG Headquarters by the Office of the Resource Director/Comptroller.

[5]Typical air station expense codes are aircraft maintenance, contract services, electronic maintenance, housekeeping, telephones, shore unit maintenance, travel/training, and vehicle rental.

station requirements.[6] In fact, since some air station Commanding Officers also serve as Group Commanding Officers, they would have the flexibility to utilize some AFC 30 funds for boat maintenance. As one might expect from the above description of this process, the funds actually spent in support of air station maintenance often bear little relation to the dollars per operating hour provided by Headquarters.

TABLE 5-1

FY92 COAST GUARD AIRCRAFT HOURLY O&M COSTS

Allocation factor	HH-65A			HH-3F/CH-3F		HH-60J	HC-130H		HU-25 A/B/C[a]
	SAR	ALPAT	POPDIV	Non-OPBAT	OPBAT		1 Allow	1 Augmt.	
Programmed rate (hrs/yr)	645	325	275	700	770	700	800	400	800
Fuel consumption (gal./hr)	94	94	94	180	180	143	870	870	310
AFC-30 fuel	$94.00	$94.00	$94.00	$180.00	$180.00	$143.00	$870.00	$870.00	$310.00
AFCAFC-30 unit level maintenance	$93.19	$93.19		$93.19	$88.96	$203.00	$114.95	$57.48	

Note: SAR = search and rescue; ALPAT = Alaska Patrol; POPDIV = Polar Operations Division; OPBAT = Operations Bahamas, Turks, and Caicos Islands; Allow. = allowance; Augmt. = augmentation.

[a] Additional funds provided for HU-25C and HU-25B support.

Funds from AFC 56 are designated for personnel training and are administered by the Chief, Performance Systems Division (G-PRF), Office of Personnel and Training (G-P). G-PRF coordinates overall Coast Guard training requirements, including those for the USCG Aviation Technical Training Center (ATTC). G-PRF submits the AFC 56 budget request to G-CBU via G-P. After the AFC 56 fiscal year funding level is finalized, G-CBU allocates funds for ATTC training programs via G-P and G-PRF.

FINDINGS AND CONCLUSIONS

We found that the USCG budget process does not provide a capability to measure the "full" cost of USCG logistics because the principles underlying the AFC 30 funding process make it difficult to measure the funds actually spent for

[6]Typical air station requirements include engineering, public works, operations, information resources, administration, supply, training, medical, and safety.

aviation logistics support and because the AFC 41 budget process has not allowed actual expenditure and significant variances to be evaluated.

Fully Identifying and Accounting for AFC 30 Funds

The following principles underlie the AFC 30 funding process:

- "In order to work effectively, funds for AFC 30 costs must be passed to the level bearing both the operational and funding responsibility"
- "AFC 30 was formed to allow unit commanders necessary flexibility in funding for normal recurring expenses."[7]

While the AFC 30 process achieves these goals, its flexibility results in a system in which tracking the funds actually spent on aviation logistics is different. While Headquarters allocates aviation-related funds to the various USCG districts, it has no feedback or tracking mechanism to measure the actual funds spent on unit level aviation logistics support by the 27 air stations. No system is in place to track either the funds actually provided to each air station or the obligations and expenditures actually incurred by each USCG air station.

AR&SC Plans to Modify AFC 41 Budget Process

The G-EAE receives an annual budget submission from AR&SC for AFC 41-related funds. Other financial data are not regularly exchanged between AR&SC and G-EAE. "The AR&SC annual budget has typically been a spending plan rather than a budget for future requirements. Budget projections have not been feasible because of inaccurate and unavailable AR&SC data. However, AR&SC has performed an in-depth study using a zero base budget approach to develop actual budget projections.[8] AR&SC has established a goal to restructure their accounting ledgers to identify costs in a manner consistent with the zero base budget approach and to implement the zero base approach as the budget standard."[9]

Capability to Fully Identify and Account for AFC 41 Funds

From a financial management standpoint, we were unable to evaluate the cost-effectiveness of the aviation logistics support program provided by AR&SC-related

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[7]COMDTINST M7100.3, op. cit.

[8]Zero base budgeting is done based on materiel issues to aircraft, repair costs, and scrap rates to determine assets required either from inventory or from the annual budget process.

[9]AR&SC Instruction (ARSCINST)5224.1, *Five-Year Business Plan*, 20 April 1992.

AFC 41 funds because through FY91, AR&SC did not compile a sufficient range of cost accounting data.[10] The following are examples of AR&SC AFC 41 data we believe are required for accurate evaluation but are either not available, incomplete, or inaccurate through FY91:

- *Accurate cost data associated with the AR&SC repair division.* Those data are uncertain, especially for items repaired organically.[11] Data are not available to determine the annual cost for organic repair of a given national stock number item. Also, AR&SC has not analyzed data on PDM cost per aircraft to validate their accuracy. Anomalies also exist in the way PDMs account for engine repair so that, under certain circumstances engine-related PDM work is costed artificially high. Finally, as discussed in Chapter 3, the process for applying overhead costs should be evaluated.
- *Data on whether materiel issues are for consumable or reparable items.* AR&SC could not distinguish these issues. Additionally, accounting corrections made after materiel was issued could not be completed.
- *Credit for retrograde items.* AR&SC provides each air station with a 75 percent credit for each 265 item returned rather than crediting for the actual annual average cost to repair the given item.

Future Capability to Fully Identify and Account for AFC 41 Funds

During FY92, AR&SC implemented new management and financial practices that will permit accurate evaluation of FY92 data; those practices will resolve most of the deficiencies noted above. Refinement of the percent credit provided to air station for materiel returns will not be corrected until AMMIS is implemented.

With the addition of a financial analyst to its staff, AR&SC now has the ability to analyze the data in the work order system to validate existing PDM data and analyze the cost of organic component repair. This capability will enable AR&SC to significantly improve its measurement of overall cost-effectiveness of the AFC 41 funds provided. Also, future AFC 41 zero base budgets will be able to forecast AFC 41 funding requirements accurately. AR&SC also plans to conduct sensitivity analyses to examine the degree to which changes in the individual cost elements comprising the zero base budget can improve the overall cost-effectiveness of the aviation logistics support achieved from the AFC 41 funds. "This would allow actual

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[10]Chapters 3 and 4 discuss from maintenance and supply perspectives, respectively, the reasons we are unable to evaluate the cost-effectiveness of the AR&SC use of AFC 41 funds.

[11]Organic repair refers to components repaired by the AR&SC Repair Division.

expenditures and significant variances to be evaluated, potential trends to be identified, as well as more relevant calculations of inventory turnover rates and ratio analysis to occur."[12] It will also facilitate examination of existing AR&SC supply and maintenance business practices to determine the extent to which changes to aviation logistics support business practices can improve the AFC 41-related cost-effectiveness.

Varying the Resource Levels Between Air Stations

Headquarters allocates AFC 30 funds in a standardized manner so that a fixed dollar per flight hour per mission is provided for each aircraft type. However, different staffing levels, climates, facilities, locations, and materiel conditions prevail at the various air stations supporting the same types of aircraft.[13] For that reason, we believe varying resource allocation levels among USCG air stations would be a significant step in recognizing that different expenditure levels are necessary if the aviation community is going to maximize it's overall maintenance and cost-effectiveness.

Overall, the USCG budget process for AFC 30 and AFC 41 does not provide sufficient data for a determination of whether Coast Guard aviation logistics support is cost-effective. In general, the current system provides some air stations with a level of AFC 30 resources that permits great flexibility and latitude in obtaining aviation logistics support needs while other air stations are constrained in their capability to fund aviation support requirements.

Tracking the Full Cost of Aviation Logistics Support

Tracking the "full" cost of logistics support requires the development of a series of financial reports that can be used to evaluate aviation logistics support costs in

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[12] ARSCINST 5224.1, op. cit.

[13] An example of each of these factors is (1) for each HH-65A aircraft it operates Air Station Miami is authorized fewer personnel than is Air Station New Orleans; (2) HH-60J aircraft operated from Air Station Traverse City, a fresh water, relatively low humidity environment, can be expected to experience less corrosion-related maintenance problems than the same aircraft stationed at Air Station Mobile; (3) Air Station Clearwater is constructing new hangers that will be specifically configured to readily support the particular HC-130 aircraft maintenance requirements (an example would be providing an overhead crane capability and aircraft-specific electrical specifications), while other air stations' hanger facilities supporting this aircraft may not be as well configured; (4) Air Station Miami is located close to a major aviation complex that can provide assistance on an as-needed basis, while Air Station Cape May is not located in close proximity to other aviation facilities; (5) the materiel condition of the support equipments used at the air stations varies.

terms of the resources required to meet unit readiness and mission requirements.[14] Additionally, to achieve management effectiveness, the USCG must ensure funds are used for the purpose requested and controls are implemented to limit financial flexibility. Once that effectiveness is established, budget managers can begin to make tradeoff decisions between AFC 41 and AFC 30 funding levels because they would have the capability to evaluate aviation logistics costs against the element at which these costs actually occur. These cost elements should be built to the level of detail required to actually measure the degree with which the logistics system is delivering support consistent with meeting mission requirements at the minimum cost to the overall system. Expenses should also be recorded to the same level of detail. Together, these results should provide the required feedback to track the cost of supporting aircraft; however, we believe these results are achieved in an environment in which flexibility is limited.

RECOMMENDATIONS

We recommend the USCG, specifically G-EAE in coordination with G-CFM, upgrade and utilize the Headquarters corporate data base to develop a set of financial reports to measure aviation logistics support costs and to review the execution of those costs against the budget. The Headquarters corporate data base provides capability for measuring the cost-effectiveness of the USCG's aviation logistics support program. The recommended financial reports should provide an analytical framework for the following:

- Measuring the total funds spent for USCG aviation logistics support, including reporting AFC 41, AFC 30, and AFC 56 funds actually budgeted and reporting obligations and expenditures actually incurred by these AFCs
- Establishing a zero base budget approach for AFC 41 funding, and evaluating the feasibility of establishing zero base budget approaches for AFC 30 and AFC 56
- Evaluating significant variances and potential trends
- Determining the most cost-effective allocation of resources among the aviation AFCs

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[14]Paul K. Brace, et al., *Reporting of Service Efforts and Accomplishments*, Financial Accounting Standards Board Research Report (Stamford, Conn.: FASB, 1980), pp. 5–8 discusses that "The operating efficiency of a program is generally evaluated by inputs (efforts and resources) required to produce the program's outputs (services or goods); or, the units of inputs required to produce a unit of output."

- Determining the most cost-effective allocation of resources among the Coast Guard air stations and between the Coast Guard air stations and AR&SC
- Determining whether the cost of aviation logistics support is too high or too low.

GLOSSARY

ACMS	=	Aviation Computerized Maintenance System
ACR	=	allowance change request
AFC	=	Allotment Fund Code
AFLC	=	Air Force Logistics Command
ALPAT	=	Alaska Patrol
AMMIS	=	Aviation Maintenance Management Information System
Ao	=	operational availability
AR&SC	=	Aircraft Repair and Supply Center
ASE	=	aircraft system effectiveness
ASO	=	Aviation Supply Office
ATIMS	=	Aircraft Technical Information Management System
ATTC	=	Aviation Technical Training Center
AVSCOM	=	Army Aviation Systems Command
B0	=	Bravo Zero
CI	=	continuous improvement
COMDTINST	=	Commandant Instruction
DoD	=	Department of Defense
DRCT	=	depot repair cycle time
E-mail	=	electronic mail
ERQ	=	economic repair quantity
FHP	=	flying-hour programs
G&A	=	general and administrative
G-CBU	=	Budget Division, Office of the Resource Director/Comptroller

G-CFM	=	Chief, Financial Management Division
G-EAE	=	Chief, Aeronautical Engineering Division
G-ELM	=	Chief, Logistics Management Division
G-OAV	=	Chief, Aviation Operations Division
G-O	=	Office of Law Enforcement and Defense Operations
G-P	=	Office of Personnel and Training
G-PRF	=	Performance Systems Division, Office of Personnel and Training
ICPs	=	inventory control points
ILSP	=	integrated logistics support planning
JCS	=	Joint Chiefs of Staff
MC	=	mission-capable
MISs	=	management information systems
MLDT	=	mean logistics delay time
MRR	=	medium range and recovery
MTBF	=	mean time between failure
$MTBM_u$	=	mean time between maintenance $_{uncontrollable}$
MTTR	=	mean time to repair
N/A	=	not applicable
NM	=	not measured
NMC	=	not-mission-capable
NMCB	=	not-mission-capable due to both maintenance and supply
NMCM	=	NMC due to maintenance
NMCS	=	NMC due to supply
OE	=	Operating Expense
OGAs	=	other Government activities
OPBAT	=	Operations Bahamas, Turks, and Caicos Islands

PDM	=	programmed depot maintenance
PFH	=	programmed flying hours
PICA	=	primary inventory control activity
POPDIV	=	Polar Operations Division
RCM	=	reliability-centered maintenance
RIP	=	remain-in-place
SAR	=	search and rescue
SASI	=	Standardized Air Station Inventory
SICA	=	secondary inventory control activity
S.M.	=	scheduled missions
TAMSCO	=	Technical and Management Services Corporation
TQM	=	total quality management
URs	=	unsatisfactory reports
USCG	=	U.S. Coast Guard

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13. ABSTRACT *(Maximum 200 words)*

The goal of the Coast Guard's aviation logistics system is to ensure that each air station has an average mission capable rate of 71 percent, by aircraft type, to support its readiness requirement. The search-and-rescue mission imposes the most stringent readiness requirement — the ability to put an aircraft in the air within 30 minutes. In this study, we review the management and cost-effectiveness of aviation logistics support, examine current modernization projects, and recommend improvements to the Coast Guard's short-term and strategic plans. To evaluate management and cost-effectiveness, we analyzed, at a macro level, aviation logistics support functions, and we assessed the current approach and related costs of providing the 71 percent mission capable rate. Overall, we found that the logistics organization's management is sound and oriented toward problem solving; its maintenance program produces quality aircraft; its supply system responds to the air stations' priority requests; and its management information system (MIS) ably supports the air stations' maintenance schedules and partially meets the Aviation Repair and Supply Center (AR&SC) management needs; however, we also found that its MIS is almost completely unable to forecast requirements and measure and report performance. We had difficulty assessing cost-effectiveness at either a macro or micro level. The data do not exist or must be aggregated from too many sources for useful cost analysis. We believe AR&SC's ability to perform cost analysis will be enhanced by implementing the new financial module of the center's MIS. Analyzing other cost-effectiveness indicators such as inventory investment and lead times must await implementation of the supply module. We provide a number of recommendations that will improve support, establish the capability to assess system performance, and focus strategic planning on implementing management and cost-effectiveness processes.

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