Logistics Management Institute

Aviation Maintenance Contract Management

A Survey of Defense and Commercial Practices

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Executive Summary

A series of accidents in commercial aviation during 1996 highlighted the need for effective management of contract maintenance. After the commercial airline industry was deregulated in 1977, "new start" airlines and many established carriers chose to outsource a substantial portion of their aviation maintenance requirements. Since that time, they have doubled the extent of their reliance on contract support (currently about 23 percent of the dollars spent on maintenance). Traditionally, safety is of such importance to the public that safety considerations permeate all aspects of commercial airline operations. The Federal Aviation Administration reacted to the 1996 accidents with a series of initiatives to strengthen the oversight of new operators and reassure the public that its oversight is effective.

DoD operates a fleet of about 17,000 aircraft that is comparable in many respects to its commercial counterpart. It is increasing its reliance on contract maintenance for aircraft and employs an expanding portion of contractor-supported commercial derivative aircraft in its operations. We estimate that DoD currently spends about $1.6 billion for contract depot maintenance, about 35 percent of the total aviation depot maintenance costs. Safety is also an important consideration for DoD and is one of several factors that influence mission effectiveness and operational capability.

Acquisition reform initiatives have allowed commercial standards and practices to replace most of the former system of military specifications and standards for maintenance contracting. In addition, these initiatives have led Defense contract management activities to adopt commercial concepts, such as a process orientation in production and the use of vendor histories in source selection. Contract maintenance management activities are organizationally more segmented in DoD than in commercial aviation, but their interrelationships allow for a stronger ability to recover from instances of poor performance.

The Logistics Management Institute was tasked to survey the commercial and Defense processes for contract maintenance management in light of the dynamic

environment in which both systems operate. Our study focused on two primary areas:

- *Supporting expanded use of contract maintenance.* We found that aircraft contract maintenance has proven itself to be a reliable production source within DoD and capable of expanding to accommodate further outsourcing. However, DoD needs to issue guidance to support the increasing use of contracting contemplated in Defense acquisition policy. The guidance should address the need for adequate transition planning, better information systems, and improved metrics to manage the increasing workload.

  Organizations that have converted from in-house to contract maintenance emphasized that there are special resource requirements to support outsourcing decisions, including different personnel skills and funding processes. The best management practices we found included careful planning for outsourcing and centralization of management activities to encourage dissemination of lessons learned.

  Aircraft maintenance contracting is a unique blend of production and service contracting procedures. Contract management organizations need to develop a fairly sophisticated structure for these contracts, including combinations of incentive and award fee provisions. They would benefit from sharing their approaches to contract structure, as well as other innovations that have been made possible through acquisition reform.

  Focused training, including joint service interaction, would better prepare an emerging work force to support aircraft maintenance outsourcing. Most managers we interviewed are avid students of commercial practices and seek ways to compare their approaches with their interservice counterparts.

- *The use of commercial practices.* Rescinded military specifications and standards are being replaced by a proliferation of alternative commercial practices, which leads to confusion and additional administrative burdens at contract facilities. Contract management activities are working to adopt single commercial practices on a site-by-site basis but would benefit from DoD-wide designation of preferred commercial standards. For example, DoD should designate AS9000, *Aerospace Basic Quality System Standard,*[1] an aerospace adaptation of the International Standard ISO 9001,[2] as the preferred commercial quality standard for aircraft maintenance contracting.

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[1] Developed by the American Society of Quality Control (ASQC) and published jointly with the Society of Automotive Engineers.

[2] ISO 9001:1994, *Quality Systems—Model for Quality Assurance in Design, Development, Production, Installation, and Servicing*, equivalent to ANSI/ISO/ASQC Q9001:1994 in the United States.

DoD might benefit from commercial licensing of in-house maintenance technicians and repair stations. A test, using selected commercial off-the-shelf aircraft, would help make this determination. DoD's use of commercial sources would benefit from improved cross-service coordination of market research efforts and sharing of lessons learned. Further changes to acquisition rules may be needed to accept external (third party) certifications and audits of commercial sources.

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Without naming them to protect their promised anonymity, the authors sincerely thank the many people in commercial aviation who provided their expertise and experience in the fields of aircraft maintenance and contract and quality management. In addition to the sponsors of this project, the authors thank the members of the OSD staff and military services who offered the benefit of their time and expertise in the maintenance of the aircraft operated or represented by their organizations. To the staffs at each of the visited commands, our sincere thanks are extended to each interviewee as well. Within the FAA, the authors extend sincere thanks to Ms. Carol Giles who acted as our principal point of contact for regulatory matters and to Mr. Robert Tessier for his help with the Aircraft Certification Systems Evaluation Program (ACSEP).

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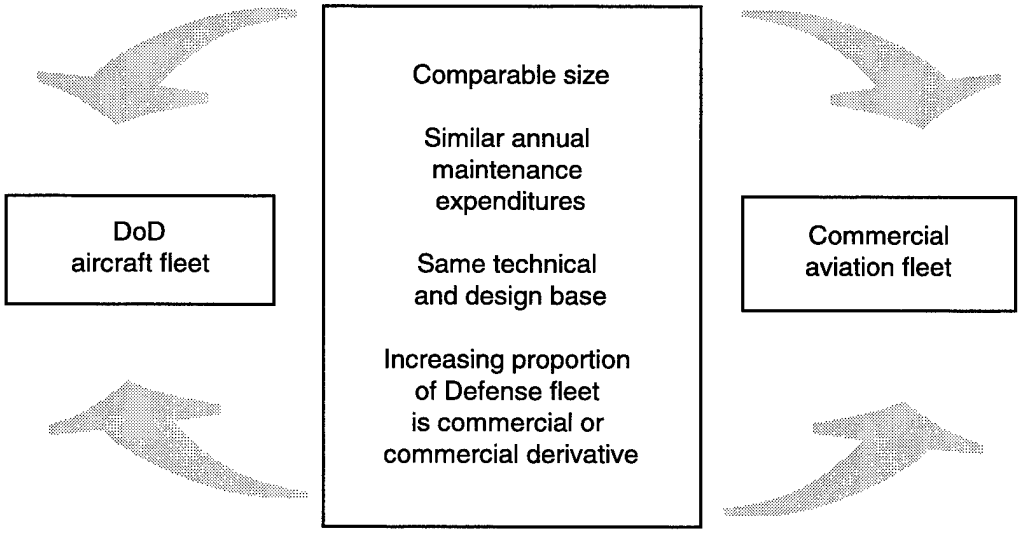
Chapter 1
Introduction and Overview

BACKGROUND

This report surveys commercial and Defense contract management practices for aircraft maintenance. The impetus for the report was a series of commercial aviation accidents during 1996, in which commercial contract maintenance practices were implicated as contributing causes. Senior Defense managers asked whether those causes could reflect potential problems for DoD contract maintenance management as well. To determine the similarities and differences between Defense and commercial practices, we conducted a series of interviews with major airlines and industry associations, as well as a number of organizations within the military services and the Defense Logistics Agency (DLA). Appendix A lists the contributing organizations.

Commercial and Defense aviation activities are comparable in a number of aspects, as depicted in Figure 1-1.

Figure 1-1. Comparability of Commercial and Defense Aviation Fleets



Approximately 23 percent of commercial airline maintenance expense is outsourced, a rate that has remained relatively stable through the 1990s.[1] DoD also traditionally outsources a substantial portion of its aviation maintenance workloads;

[1] Based on data from Department of Transportation (DOT) Bureau of Transportation Statistics (BTS) Form 41, *Uniform System of Accounts and Reports for Large Certificated Air Carriers.*

we estimate approximately 34 percent of Defense aviation depot maintenance is currently outsourced.[2] In recent years, DoD has been interested in outsourcing more segments of aircraft maintenance, reflecting a combination of factors:[3]

- The Department's need to focus on its core combat competencies
- The drive for efficiencies from a smaller Defense infrastructure, stemming from the widespread belief that contract maintenance is more efficient than organic (in-house)
- The continuing decline in Defense budgets, coupled with the need to afford acquisition of new and updated weapon systems.

In general, we found DoD organizations responsible for contract maintenance management are being challenged to keep up with increasing demands for outsourcing as their organizations are reduced in size and units realigned. (For the purposes of this report, the term *contract maintenance management* encompasses the full range of activities needed to generate and execute aircraft maintenance contracts, including efforts by requiring/engineering activities, contracting organizations, oversight activities, and supporting organizations.)

The following sections describe basic types of DoD maintenance programs and management organizations and the various types of maintenance contracting that are employed by those management organizations.

MAINTENANCE PROGRAMS

The commercial airlines maintain their aircraft with single maintenance programs, without regard to levels or sources of repair. In particular, the "intermediate" level of maintenance capability is practically nonexistent. To avoid the cost of removing entire aircraft from scheduled revenue service for maintenance, specific "line stations" (analogous to operating units) may possess some degree of inspection and repair capability for airframes. All but the "heaviest" airframe inspections are performed at night at a line station somewhere in the airline's route system, and the aircraft are typically returned to service the next morning. Airframe inspections may be broken into smaller packages of work to enable each package to be accomplished on an overnight visit to an inspection hangar. Components are typically returned to a single repair site or transshipment location for maintenance, analogous to a military depot. Each airline ordinarily has a program to conduct a fault verification inspection of components before they are shipped to contractors for repair, in an effort to save the cost of unnecessary maintenance. In turn, the

[2] Based on data in the *Defense Depot Maintenance Council Business Plan, FY96–01*, 14 January 1997.

[3] For depot maintenance, Ibid. For outsourcing in general, see Logistics Management Institute, *Enhancing the Success of DoD's Outsourcing Initiative*, Report EC508LN3, John D. Christie and William Fedorochko Jr., April 1996.

transshipment point serves as a receiving point for inspection of new or repaired items prior to their induction into the airline's supply system.

In contrast, military aircraft have been classically supported with a three-level maintenance program that consists of organizational, intermediate, and depot maintenance tasks. This structure is outlined in DoD Directive 4151.18, *Maintenance of Military Materiel.*[4] The three levels are as follows:

- *Organizational maintenance* focuses on unit-level, on-equipment (flight line) tasks, such as daily inspections, servicing, and component replacement.

- *Intermediate maintenance* is the unit-level repair capability that includes off-equipment maintenance, such as in-shop component repair, and on-equipment scheduled inspection and repair of aircraft. Components and systems may be repaired at the operating unit or a consolidated repair location or returned to a depot facility, depending on the specific discrepancy and the unit's repair capability.

- *Depot maintenance* is the most comprehensive repair, modification, and overhaul capability for systems, equipment, and components, including rebuild, manufacture, or remanufacture of parts. In general, more extensive repairs are performed by depot maintenance activities, either on-site with field teams or at depot facilities. Maintenance depots are usually managed by separate logistics support commands.

The military services have begun to seek economic benefits from the consolidation or streamlining of these classical levels, largely through the elimination of intermediate maintenance organizations when an item's reliability and spares level will allow the service to rely on premium transportation of parts between the operating unit and a repair depot or area repair center.

In commercial aviation, the Federal Aviation Administration (FAA) approves and monitors an airline's maintenance program as a part of the overall certification of the airline as a licensed operator. Commercial aircraft are also certified to be airworthy by the FAA. Maintenance and alterations are capable of affecting that certification and require an airworthiness determination before an aircraft may be returned to service. Commercial aircraft generally lose their certification when they are operated by the military services and are termed "public aircraft" not subject to FAA oversight.[5]

DoD develops its own maintenance programs for its aircraft weapon systems, largely in conjunction with the original equipment manufacturer (OEM). Commercial aircraft in operation in DoD generally retain the commercial heritage

[4] DoDD 4151.18, *Maintenance of Military Materiel,* 12 August 1992.

[5] FAA Advisory Circular 00-1.1, *Government Aircraft Operations*, 19 April 1995.

of their maintenance programs, although there is significantly less emphasis on maintenance program adjustment and retention of airworthiness certification than in the commercial world.

Types of Maintenance Contracted

Throughout this report, we refer to *system-level* and *unit-level* contracting and the management organizations that accomplish such contracting. These terms are meant to incorporate aggregations of the major types of aircraft maintenance contracting within DoD. Commercial aviation does not make similar distinctions as to maintenance types.

The major elements of system-level contracting within DoD include the following:

- *Depot maintenance* contracting is the largest type in terms of dollar value. We estimate approximately 34 percent, or $1.6 billion of the estimated total DoD aircraft depot maintenance program of $4.7 billion, is applied to aircraft depot maintenance contracting.[6]

- *Interim contractor support (ICS)* is used for new systems to delay the acquisition of support equipment and technical data until the system configuration has matured. ICS replaces the intermediate and depot levels of maintenance for affected parts. ICS funding is in decline as the number of new systems is also reduced; the military services reported FY96 ICS expenditures in combination with contractor logistics support.

- *Contractor logistics support (CLS)* is principally applied to commercial off-the-shelf (COTS) and commercial derivative aircraft. The scope of work can include all or portions of organizational, intermediate, and depot maintenance (as well as other logistics functions) for components and entire systems. CLS arrangements typically use a prime contractor with a network of subcontractors to accomplish heavy airframe checks or specialized component and engine repairs. We identified $640 million in aviation maintenance expenditures in CLS and ICS contracts during 1996.

- *Contractor field teams (CFTs)* are contract personnel utilized by base-level and depot-level requiring activities of all military services worldwide. During FY96, CFTs were tasked to work at a total of 804 individual work sites around the world, for a total expenditure in excess of $272 million.

Unit-level maintenance can include any amount or combination of the classic organizational and intermediate levels described in DoDD 4151.18. There is no available database that quantifies the amount of unit-level contracting, but we found approximately $500 million of unit-level contracting during our survey.

[6] See Note 2, this chapter, plus Service interviews.

(The term *unit-level contracting* in this report applies to all types of maintenance contracts issued by commands and units to accomplish organizational and intermediate maintenance tasks.)

All of these contract types and groupings are capable of accomplishing any level of maintenance required to maintain the affected aircraft. Table 1-1 summarizes the magnitudes of the various types of aircraft maintenance contracting found in use within DoD.

Table 1-1. Magnitudes of the Various Types of DoD Aircraft Maintenance Contracting

Type	1996 value ($ million)
Depot maintenance	1,647
CLS and ICS	640
CFTs	272
Unit-level contracts	500[a]
Total	3,059

[a] Estimated.

Overall, we estimate the total value of contracted aircraft maintenance to be approximately 20 percent of DoD's total aviation maintenance costs (including military personnel), which are at least $15 billion per year.

Contract Management Organizations

Within commercial aviation, all of the airlines we interviewed indicated they have a single contracting activity for aviation maintenance and a single system of oversight for the contracts awarded. Some of the oversight responsibility may be shared between airlines. The FAA provides regulatory oversight, extending to personnel qualifications, maintenance processes, and equipment condition. FAA offices are located near each airline's management offices to facilitate oversight.

In contrast with the commercial organizations, our interviews with DoD activities revealed an extensive variety of organizations that manage aircraft maintenance contracts in a segmented organizational structure. These organizations are organizationally and geographically separated from one another rather than integrated, in marked contrast to the management practices in commercial airlines.

The major organizational titles used in this report are meant to be generic descriptions for types of units that have unique names in each military service. The major titles are as follows:

- *Program offices* manage the acquisition and lifetime support of major aircraft types.
- *Inventory control points (ICPs)* manage logistics support for in-service materiel, including acquisition of contract maintenance support. Depending on the particular service and organization, ICPs may be responsible for in-service items and systems; other ICPs may be responsible only for in-service items, with program offices in separate organizations responsible for managing in-service systems.
- *Unit-level contract management activities* contract for aviation maintenance performed at operating units. These organizations may be augmented with central offices at headquarters commands.
- *The Defense Contract Management Command (DCMC)* oversees system-level contracts at contractor facilities.

There are a number of additional supporting organizations that play essential roles in the overall management of aircraft maintenance contracting, including the Defense and service audit agencies, Defense Finance and Accounting Service, and service cost estimating and analysis activities.

We do not make organizational suggestions in this report because operating efficiency was not the focus of the research question we were tasked to address. Instead, we focused on functional processes. For example, while DoD activities are often concentrated on the administrative or procedural aspects of their contracts, commercial airlines are more concerned with the production itself, to obtain continuously improving quality products delivered in a timely manner. Table 1-2 summarizes the interrelationships of the various types of maintenance contracted with the primary categories of contract maintenance management organizations that exist within DoD.

Contract maintenance providers tend to have either a military or commercial orientation, reflecting the marked differences in the contract structures and management processes of the two ways of doing business.

Table 1-2. Contract Management for DoD Aircraft Maintenance

Type of maintenance contracted	Organizations that perform contract management			
	Program office	ICP	Operating unit	DCMC (oversight)[a]
Depot maintenance	✔	✔	—	✔
Unit-level maintenance	✔	—	✔	—
ICS	✔	✔	—	✔
CLS	✔	✔	—	✔
CFTs	✔ (order)[b]	✔ (order)	—	—

[a] DCMC performs contract administration services for system-level contracting activities; it does not normally contract for maintenance.

[b] The basic contracting for CFTs is performed by the Oklahoma City Air Logistics Center; other program offices and ICPs obtain CFTs by issuing an order against the master contract.

TYPES OF DOD AIRCRAFT

Military aircraft that were originally designed and produced as military equipment are generally unique to the military and thus have less potential to have their maintenance contracted to commercially oriented repair sources. Instead, the aircraft are typically contracted to Defense-oriented contractors that are specially equipped for the workload.

COTS aircraft were originally designed with FAA certification and fall into two categories. The first category includes the few aircraft (predominantly the TH-67 Bell Jet Ranger training helicopter) operated and maintained in military service as commercially certified aircraft. The second category includes aircraft and components that have lost their FAA certification but are still maintained by FAA-certified repair sources, such as the C-21 (equivalent to the commercial Learjet 35). This includes many of the aircraft supported by CLS.

Commercial derivative aircraft are the final type of DoD aircraft and include those that have been extensively modified from their commercial baseline. An example is the OH-58 Kiowa helicopter, which was originally derived from the commercial Bell Jet Ranger design, but is now filled with mission equipment.

A DYNAMIC ENVIRONMENT

The research for this report was conducted from September 1996 through June 1997. During that time, most of the organizations interviewed indicated they had some form of initiative planned or underway that would significantly affect the management of their aircraft maintenance operations or management structure.

Examples include the following:

- The FAA is engaged in rule-making to increase certain quality requirements for FAA-licensed repair stations and is revising its internal processes to allow a variable amount of oversight for operators and repair stations based on a risk assessment. The concept of variable oversight is an alternative to a wholesale increase in the number of FAA inspectors assigned to oversee commercial maintenance and could have applications in DCMC, where the basic manning model for oversight is at least partially keyed to the size of the company to be overseen.[7]

- The military services and FAA are negotiating agreements to allow for FAA monitoring of military purchases of commercially certified aircraft and for surplus resale of materiel that was formerly FAA certified. The military could benefit from FAA expertise in these instances (albeit on a cost-reimbursable basis).

- Commercial quality standards are rapidly replacing the military specifications rescinded under Defense acquisition reform initiatives:[8] for example, the number of aviation industry enterprises certified under the International Organization for Standardization, document number ISO 9000[9] series of quality standards increased from 19 to 69 in a recent 12-month period, and this trend is projected to continue. The first commercial aviation FAA-licensed repair station became certified to ISO 9002 about a year ago.[10] DoD contracting activities are receiving an increasing number of contract proposals with quality systems based on ISO certification. (See Appendix B.)

- The Army Aviation and Troop Command moved its aviation ICP and program office functions to a new command in Huntsville, AL, and the Naval Air Systems Command moved to the Patuxent River Naval Air Station, MD, both as a result of Base Realignment and Closure initiatives. Both commands lost a significant portion of their experienced civilian management work force during the move, with senior civilians taking retirement in lieu of moving. This loss of expertise placed an additional workload

[7] Defense Logistics Agency, *Defense Contract Management Command Staffing Assistance Model*, Report DLA-92-P10093, Operations Research and Economic Analysis Office, May 1992.

[8] Memorandum for Secretaries of the Military Departments et al., from Dr. William Perry, Secretary of Defense, Subject, *Specifications and Standards—A New Way of Doing Business*, 29 June 1994.

[9] International Organization for Standardization ISO 9000 Series, *Quality Systems—Model for Quality Assurance in Design, Development, Production, Installation, and Servicing*, 1994. ISO is a designation for standards produced by the International Organization for Standardization based in Geneva, Switzerland. ISO is not an acronym but a word, derived from the Greek "isos," meaning equal, which is the root of the prefix "iso-." See Appendix B.

[10] ISO 9002:1994, *Quality Systems: Model for Quality Assurance for Production and Installation.*

burden on the remaining managers as the commands completed their moves.

- DCMC is nearing the end of its work force reduction from 30,000 personnel when it was formed in 1990 to 12,000 by the end of FY97. While the reduction is commensurate with the reduction in Defense production contracting, it places particular strains on the command as it works to implement several new management initiatives and cope with increasing workloads in contract maintenance.

- We found a number of noteworthy initiatives underway in the airlines and military commands we interviewed. Appendix C contains a sample of these initiatives, which we identified as best practices.

DoD has traditionally measured its contracting effectiveness in terms of production schedules and cost control. DCMC has begun to add additional measures, including safety metrics and other process-oriented parameters. DCMC has also established an Alerts Project to receive and track problem reports from customers. As DoD extends the breadth and depth of its aircraft maintenance contracting, better techniques will be needed to collect and assess the classical elements of quality, reliability, and safety measures and their influence on overall maintenance programs.

OVERVIEW, CONCLUSIONS, AND RECOMMENDATIONS

Supporting Expanded Use of Contract Maintenance

The first issue relates to the ability of DoD's contract maintenance management organizations to execute their contract management responsibilities, given the department's extensive and segmented aircraft contract maintenance management infrastructure.

Maintenance contracting has proven itself to be a safe and effective source of repair for DoD. While the military services use a wide variety of interconnected organizational segments to execute and manage aircraft maintenance contracts, they have been able use the organizational network as a safety net to recover from management problems. When any one organizational segment has encountered difficulty, another segment has been able to help address the problem.

There is little or no guidance at the OSD level specific to aircraft contract maintenance management, despite the increasing use of contracting to provide continuous mission support and the similarity of the management effort in each of the military services.

Approximately 8 percent of the DoD aircraft fleet (roughly 1,400 aircraft) are commercial or commercial derivative aircraft. COTS aircraft make up the largest

subset, with approximately 1,300 aircraft, and comprise the predominant fleets supported by CLS. Aircraft supported by CLS consume 25 percent of the flying hours of at least one military service.[11] CLS is more like the type of contracting performed by commercial airlines but is still distinctively military. Less than 300 aircraft are actually operated as commercially certified aircraft within DoD. There is a large population of other aircraft that had commercial counterparts, such as the P-3 (Lockheed Electra) and KC-135 (Boeing 707), but the commercial counterpart fleets are largely retired and the aircraft are not counted as derivatives.

Outsourcing (changing from DoD in-house to contract support) requires careful transition planning to avoid workload and operational disruptions.[12] This includes establishment of contract management organizations with adequate resources (including training for the work force) for the new contract management task.[13] Commercial airlines also have recently been reminded of this requirement in the aftermath of the major accidents that occurred in 1996. DoD is also refining its use of market research techniques to make better decisions for outsourcing.

DoD infrastructure involved in the management of contract maintenance is more of a "virtual organization" than a single entity because of its many segments, diverse guidance and contract management practices, and widely dispersed staffing and training resources. The effective coordination of these disparate elements requires extensive communication but has benefited from several efforts to standardize or centralize management approaches within operating and supporting commands. OSD can take some specific steps to further help the communication and standardization process.

CLS management activities have stable, long-range maintenance requirements that are predictable well in advance of the maintenance due date. Unfortunately, the Office of Management and Budget and DoD funding policies often limit the amount of available funding to quarterly or monthly funding allocations. Contracting activities spend an inordinate amount of their management attention (estimated at 80 percent in one interview) structuring contracts to suit the funding allocations.[14] In general, commercial airlines are much more flexible and nonstandard in their funding processes and are capable of making longer-term commitments for their workloads.

There is no comprehensive database that quantifies the size and extent of DoD's aircraft maintenance contracts. Commercial airlines also lack such a database, but

[11] Naval Air Systems Command Program Management Activity 227 briefing, 5 March 1997.

[12] LtCol Mary B. Hamlin, USAF, *Privatization of Aircraft Maintenance: Maximizing Contract Effectiveness*, Air War College Research Report, May 1990.

[13] GAO Testimony T-GGD-97-134, *Privatization and Competition: Comments on S.314,The Freedom From Government Competition Act*, 18 June 1997.

[14] Col Jan D. Edeburn, USAF, *Contractor Logistics Support for the Tactical Air Force: Can It Be Made Affordable?*, Air War College Research Report, January 1990.

the airlines do submit contract financial data in summary form to the DOT.[15] The lack of reporting and standardization makes it harder to assess the effectiveness of management organizations or to obtain information about other successful contracting activities, including best practices.

Reliability analysis techniques that would support improvements in maintenance programs within DoD are not widely used, principally due to resource constraints. The commercial airlines actively employ reliability techniques as a part of their continuing analysis and surveillance programs.[16]

Contracting within DoD for aircraft maintenance requires a blend of production and services contracting practices because aircraft maintenance encompasses both types of work requirements. For example, inspection and servicing are service functions, while repair, local manufacture, modification, and scheduling are production functions. The commercial airlines are not constrained by contract types. The DoD blend requires more sophisticated contracting capabilities that are the specialty of system-level contracting organizations but which may not exist in unit-level contracting activities.

While most of the military services and the DLA have instituted training classes for various aspects of overall contract management,[17] there is no joint service training focused on maintenance, nor structured interaction to allow aircraft contract maintenance management activities to benefit from each other's experience. While the commercial airlines may deem their contracting structures as proprietary information, they actively participate in rule-making exercises, selective benchmarking, cooperative quality ventures, and conferences that help to reduce their contract management costs and facilitate information sharing. The Defense Acquisition University (DAU) has a course review mechanism that could be used to develop training programs regarding the application of tailored contract management and quality assurance practices to aircraft maintenance contracts.[18]

CONCLUSIONS

In regard to supporting the expanded use of contract maintenance, we concluded the following:

- DoD's contract maintenance management structure is effective and capable of ensuring that maintenance production is delivered safely, given the structure's current level of effort and staffing levels, but there are a number of opportunities for improvements.

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[15] See Note 1, this chapter.

[16] Required by Title 14, Code of Federal Regulations, Part 121.373.

[17] DCMC Memorandum, Subject, *Development of DCMC Training Matrices via Training Analysis Sessions*, 26 June 1996.

[18] Defense Acquisition University, Under Secretary of Defense for Acquisition and Technology, Draft Brochure, *Assignment-Specific Training: Program and Policies*, 12 June 1997.

- DoD needs better information and data to manage and oversee its increasing use of maintenance contracting.
- Outsourcing is not resource-neutral. It impacts the existing DoD maintenance work force, and it requires adequate resources for management structures and careful transitions to convert ongoing workloads to contract accomplishment.
- CLS management is often distracted by funding processes and the use of inefficient, manpower-intensive contracting techniques. Attention is being diverted from management of the fleets. Stabilized, production-like funding would allow significantly more management attention to be focused on contract performance.
- Performance of DoD aircraft contract maintenance managers would be improved by better information, e.g., the cross-pollination of best practices and the use of new standard metrics and market research techniques compatible with commercial aviation.
- Management of contract-supported materiel would be enhanced by increased use of reliability analysis to identify emerging trends and opportunities for improvements in maintenance programs.
- Aircraft maintenance contracting should be recognized within DoD for its unique blend of production and service contracting components.
- Opportunities for structured interaction between contracting activities would improve coordination between functions and across services, including improving the personnel practices (qualification, selection, training, and career management) involved with aircraft contract maintenance management.
- Standard training courses should be developed to reflect the particular needs of aircraft maintenance contracting.

RECOMMENDATIONS

The Deputy Under Secretary of Defense (Logistics) should *issue policy guidance for management of contractor-supported aircraft maintenance*. This guidance should include the following items:

- Include basic guidance on the establishment of, and transition to, all types of contract maintenance support and encourage the development of maintenance-specific tools, such as market research techniques.

- Implement standardized performance measures and safety metrics, compatible with commercial aviation, for application across the services (DCMC metrics may serve as a model).
- Apply production-like funding arrangements for maintenance contracts, especially for commercial derivative aircraft.
- Require the use of reliability analysis for aircraft maintained by contract to allow for earlier identification of operational problems and opportunities for adjustments and improvements to maintenance program requirements.
- Engage the course review mechanisms of DAU to develop tailored training course materials for aircraft maintenance contracting (e.g., deliverables, management oversight, administration, quality assurance, performance feedback, and transition planning).
- Establish a means to facilitate communication between aircraft contract maintenance management activities, including sharing of best practices, maintenance contracting techniques, and lessons learned (see later recommendation for lessons learned from application of commercial practices).
- Establish integrated teams to develop implementation plans for these recommendations, including the preparation of guidance materials as appropriate.

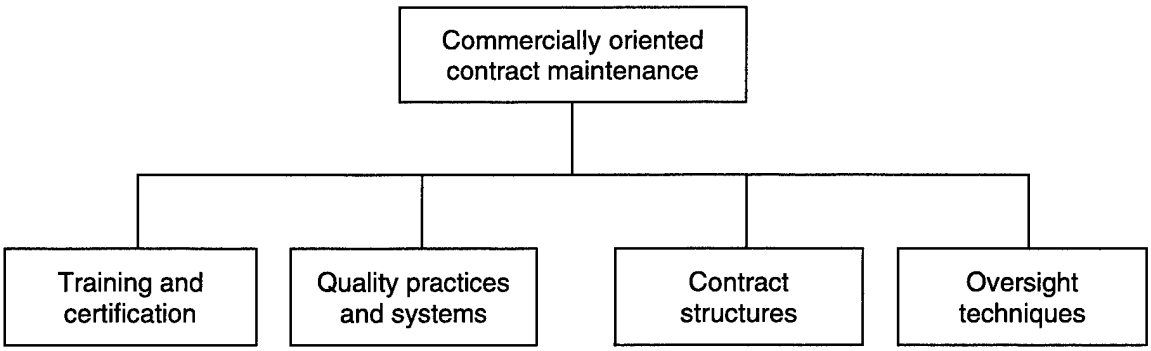
The Use of Commercial Practices

DoD has a long-standing policy to adopt commercial products and practices, including the acquisition of commercial aircraft supported by contract maintenance. Issuance of the Federal Acquisition Streamlining Act of 1994 and the Federal Acquisition Reform Act of 1996 removed most major legislative impediments to the acquisition of commercial products. Passage of these laws has created a strong preference for the use of commercial supplies and services and the use of commercial practices where appropriate. The Federal Acquisition Regulations (FAR) and DoD's new 5000 series documents have been revised to incorporate the necessary changes in procurement policies, practices, and procedures to reduce impediments to the use of commercial items.[19]

[19] DoD 5000.2-R, *Mandatory Procedures for Major Defense Acquisition Programs (MDAPs) and Major Automated Information Systems (MAIS) Acquisition Programs*, paragraph 3.3.1.1, 15 March 1996.

DoD deals with commercial sources to obtain contract support from the commercial marketplace for its fleets. Military contracting is in transition to more commercially oriented contracting as an increasing portion of military standards and practices are replaced with commercial counterparts. Figure 1-2 lists the major areas involved in the process.

Figure 1-2. DoD Contract Competencies in Transition



An increasing number of commercial practices are entering DoD's contract maintenance management. Examples include the adoption of commercial process standards as well as (optional) incorporation of ISO and ISO-like quality standards; incorporation of commercially derived maintenance processes, such as improved composite repairs and nondestructive test techniques; and the use of other commercial processes and standards to replace the rescinded military specifications and standards.

In our interviews, we found that the greatest interest in applying commercial practices resided in the management of COTS and commercial derivative workloads. One element of commercial practice concerns the FAA certification of aircraft. As we have already mentioned, we found only one COTS aircraft type that was operated with its FAA certification; however, we did discover that managers within the other services are interested in the concept.

In general, DoD does not support its COTS or commercial derivative fleets as FAA-licensed aircraft, even though they may receive contract support from FAA-licensed repair stations. The primary missing element is commercial licensing for DoD technicians who maintain the aircraft. There are several incentives for eventual commercial recertification of these aircraft, including the following:

- DoD would benefit from FAA interaction with DoD's commercially oriented contract maintenance operations.
- DoD would have access to a broader worldwide competitive repair market. At present, markets and sources of repair are limited to some extent because the DoD inventories cannot be intermingled with their commercial

counterparts (certified and noncertified parts must be separately marked and segregated).

- The worldwide service experience could be applied to the DoD fleet.
- The broader skills required for FAA-certified technicians would be incorporated.
- Contracting procedures would be streamlined through the further use of commercial standard processes.

Another element of the use of commercial practices concerns the transition to those practices. Some recent attempts within DoD to move from military-oriented to commercially oriented contract sources have experienced difficulties, raising the possibility that DoD might benefit from prototyping of its applications of commercial contracting techniques to identify and resolve transition issues related to military workloads. Impediments to the transition include the following:

- DoD has relatively less flexible contract administration.
- DoD contract management personnel may have relatively low commercial experience levels.
- DoD and commercial aircraft have differences in aircraft configuration.
- DoD and commercial airlines use different terminology.
- DoD has relatively slow and bureaucratic approval cycles for changes in work scope.
- Military flight safety procedures frequently require changes in commercial airport operations.

These transition issues are in addition to the earlier discussion of transitions from in-house to contract performance.

A third element of commercial practices concerns the adoption of commercial quality standards. DoD has not designated commercial replacements for its rescinded specifications and standards. As a result, system-level contracting activities are accepting a proliferation of quality processes with widely varying provisions due to the lack of guidance regarding the replacement of rescinded quality standards. Amidst the proliferation, ISO 9000 series standards and their

derivatives are being adopted at the fastest rate in the commercial aviation repair industry.[20]

The aviation industry has created a specialized derivative of ISO 9001 for aviation production and maintenance applications.[21] The new specification, AS9000, *Aerospace Basic Quality System Standard*,[22] has been submitted for acceptance as an American National Standard and an ISO-recognized document. The commercial airlines have endorsed the standard. No other standard approaches the same level of acceptance or could be used as a global guideline for quality. Designation of a preferred quality specification would limit the current proliferation of nonstandard quality systems and serve to reinforce the standard's acceptance on a global basis.

DoD is developing processes to consider past performance as an evaluation and award criterion. However, while contracting entities are now authorized to consider the past performance and commercial quality certifications of prospective contractors before award, post award there is no effective mechanism for taking action in the event a contractor loses those certifications or for reviewing the results of recertification audits.

CONCLUSIONS

DoD should exploit the benefits of commercial standards and practices by doing the following:

- *Removing impediments to the wider use of commercially oriented, FAA-licensed repair stations.* This would broaden the competitive market for Defense workloads by making the contracts attractive to more repair sources.

- *Obtaining FAA licensing of DoD maintenance technicians and repair stations.* This would lead to the retention of FAA certification for commercial aircraft in DoD, broaden the repair capabilities of the technicians, allow the use of commercial standard practices, such as technical data, and facilitate commercial support of the aircraft worldwide.

- *Providing new guidance for aviation contract maintenance to facilitate the transition to commercial sources and standards.* The transition to commercially licensed contract sources would also benefit from the use of

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[20] See, for example, Director, Strategic Systems Programs, *Technical Program Management and Quality System Requirements for Navy Strategic Systems Programs Acquisitions*, Document T9001A, Department of the Navy, 7 February 1996.

[21] ISO 9001:1994, *Quality Systems—Model for Quality Assurance in Design, Development, Production, Installation, and Servicing*, equivalent to ANSI/ISO/ASQC Q9001:1994 in the United States.

[22] Developed by the American Society of Quality Control (ASQC) and published jointly with the Society of Automotive Engineers.

prototype maintenance contracts to identify and resolve differences in Defense and commercial practices, terminology, and processes.

- *Providing guidance regarding the replacement of rescinded specifications and standards.* In particular, DoD needs to stop the proliferation of alternative standards and establish a single replacement for quality standards by designating the framework of AS9000 (rather than the actual implementation of the standard) as the preferred quality process, at least for contract aircraft maintenance. This designation should be accompanied with DoD participation on the international technical committees for the ISO standards.

- *Developing mechanisms to engage the commercial source qualification process.* This includes accepting third party certifications and devising a means to take action against contractors who lose their commercial quality certifications during contract execution.

RECOMMENDATIONS

The Deputy Under Secretary of Defense (Logistics) should *apply commercial practices and standards to military contract maintenance on a systematic basis*:

- Testing the full adoption of commercial maintenance practices for selected aircraft fleets, maintaining selected COTS aircraft to commercial airworthiness standards, and obtaining FAA certification of technicians and repair stations within DoD to support the fleet of aircraft in the test

- Encouraging increased use of FAA-licensed repair stations

- Instituting a system to capture lessons learned from maintenance contracting

- Identifying and resolving issues related to use of commercial sources, including contract structures, establishment of working relationships, and refinement of simplified management and oversight techniques

- Designating the framework of a single commercial quality standard, AS9000, as the preferred quality process for contract aircraft maintenance, including participation on the governing body for this standard[23]

[23] AS9000 also applies to the production of aerospace products, and the DoD designation of AS9000 as a preferred standard could also apply to defense production. However, such a recommendation is beyond the scope of this report.

- Establishing a process team to propose changes to policy and regulations to facilitate the use of commercial contract sources, such as
  - application of market research techniques to aircraft maintenance and development of a means to share results across management activities;
  - establishment of DoD's right to take action if a contractor's commercial licensing or quality certifications are brought into question, surrendered, superseded, or revoked during performance of a contract; and
  - development of provisions to require commercial sources to advise the government when a certifying or regulatory authority schedules an audit of the source and the results of those audits.

Chapters 2 through 4 provide additional information to support these findings, conclusions, and recommendations. Chapter 2 provides a comparison of commercial and Defense aviation and a general overview of commercial and Defense contract management processes. Chapters 3 and 4 focus on the issue areas outlined previously.

Chapter 2
Contrasting DoD and Commercial Airline Contract Maintenance Management

BACKGROUND

Commercial aviation suffered maintenance-related accidents during 1996 at a significantly higher than normal rate. One of the worst of the domestic accidents was the ValuJet crash in the Florida Everglades in May 1996. The National Transportation Safety Board (NTSB) hearings on the accident included testimony that ValuJet's ineffective management of its extensive maintenance contracts was a key contributing cause of the accident.[1] The airline temporarily ceased operations while its operating and maintenance procedures were overhauled.[2] Table 2-1 summarizes several commercial aviation accidents with contract maintenance implications that occurred in 1996.

Table 2-1. Maintenance-Related Accidents and Incidents in Commercial Aviation During 1996

Flight	Date	Location	Damage	Cause
ValuJet	Feb 1	Nashville, TN	Structural	Failed gear shock strut
Air South	March 20	Jacksonville, FL	Engine FOD	Failed taxi light bracket
ValuJet	May 11	Miami, FL	Hull loss, 110 fatalities	Cargo bay fire
Tower Air	June 20	New York, NY	In-flight fire	Improperly overhauled CSD

Source: NTSB accident database.
Note: FOD = foreign object damage; CSD = constant speed drive.

Commercial aviation experiences a relatively stable accident rate, averaging 0.3 accidents per 100,000 flying hours.[3] Accident rates in DoD are not directly comparable because of differences in categories and definitions, but DoD's first category of "Class A" accidents is approximately five times the overall commercial rate.[4]

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[1] NTSB hearings, Miami, FL, 18–22 November 1996.

[2] FAA-ValuJet consent order, 18 June 1996.

[3] Airplane Safety Engineering, *Statistical Summary of Commercial Jet Aircraft Accidents, Worldwide Operations, 1959–1995*, Boeing Commercial Airplane Group, April 1996.

[4] *Measures of Merit—Safety and Occupational Health, DoD Aviation Class A Accident Rate through FY97*, the Assistant Deputy Under Secretary of Defense (Safety and Occupational Health) at http://www.acq.osd.mil/ens/sh/cla.gif, undated.

INTRODUCTION

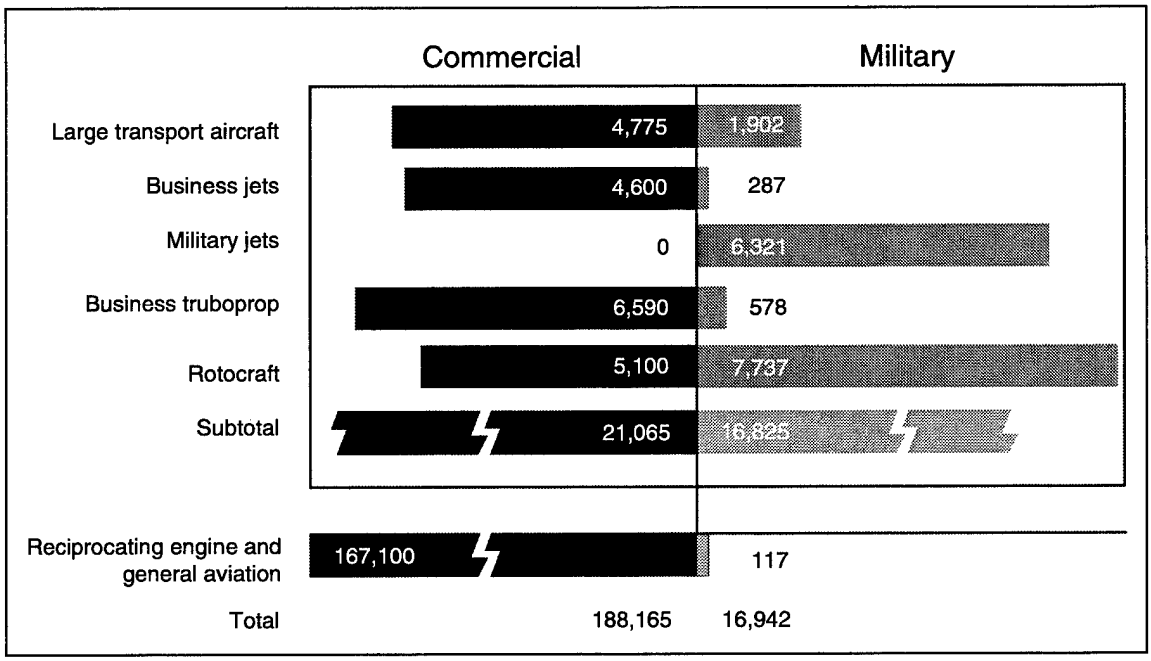
The nation's commercial airlines are comparable in many ways to DoD aviation. The two fleets are similar in size, incur roughly the same maintenance costs, and draw from the same technical base for maintenance processes. This chapter focuses on several major points of comparison, including management practices, to set the stage for the specific issues addressed in Chapters 3 and 4 and frame the recommendations found in Chapter 1.

The descriptions of commercial aviation practices in this chapter were derived from a series of interviews and reflect a composite view of "ideal" airline practices. Of course, no single airline is exactly like the descriptions, and no specific operation is perfect in its execution. This information forms a baseline for comparison with Defense aviation rather than highlighting best practices in commercial aviation. Several examples of best practices are outlined in Appendix C.

FLEET COMPARISON

The commercial and military fleets of aircraft are similar in size when general aviation aircraft are excluded. Figure 2-1 depicts the major categories of aircraft for Defense and commercial aviation.

Figure 2-1. Commercial-Military Aircraft Fleet Comparison



Source: FAA aviation forecasts, FY97–08, and military service offices of public affairs.

Table 2-2 compares several major aspects of commercial and Defense maintenance operations.

Table 2-2. Comparison of Commercial and Defense Aircraft Maintenance

Category	Commercial airlines	Military aviation
Annual maintenance ($ billion)	$8	$15
In-house maintenance workforce (number of people)	62,000	200,000
Outsourcing (percentage of maintenance funding)	23	34 (depot) < 10 (unit)
Repair stations/contract sources (number of stations/sources)	2,800	500
Repair contracts (number of contracts)	5,000	4,000

Sources: (1) Maintenance expenditures—commercial, Bureau of Transportation Statistics (BTS) Form 41 data; military, LMI estimate. (2) Workforce—commercial, FAA estimate; military, Defense Manpower Data Center. (3) Outsourcing—commercial, BTS Form 41 data; military, LMI estimate. (4) Repair stations—commercial, FAA Advisory Circular 140-7H, *Certificated Maintenance Agencies Directory*, July 24, 1995; military, LMI estimate. (5) Repair contracts—commercial, LMI estimate; military, General Accounting Office (GAO) Report NSIAD-96-161, *Defense Depot Maintenance: Commission on Roles and Missions Privatization Assumptions are Questionable*, July 1996.

Commercial Airlines

The $8 billion in annual maintenance expenditures reported by the commercial airlines does not include regional operators whose annual revenues are below the DOT reporting limits, nor does it include unscheduled, business, or charter operators. There is no database to estimate the expenditures of these additional categories of operators, but the total commercial aviation maintenance expenditure for turbine-powered aircraft is significantly more than the number listed.

The commercial airlines employ 62,000 of the 400,000 licensed airframe and powerplant mechanics believed to exist in America. Again, the total number associated with all categories of turbine-powered operator would be significantly larger. The same holds true for the percent of outsourcing.

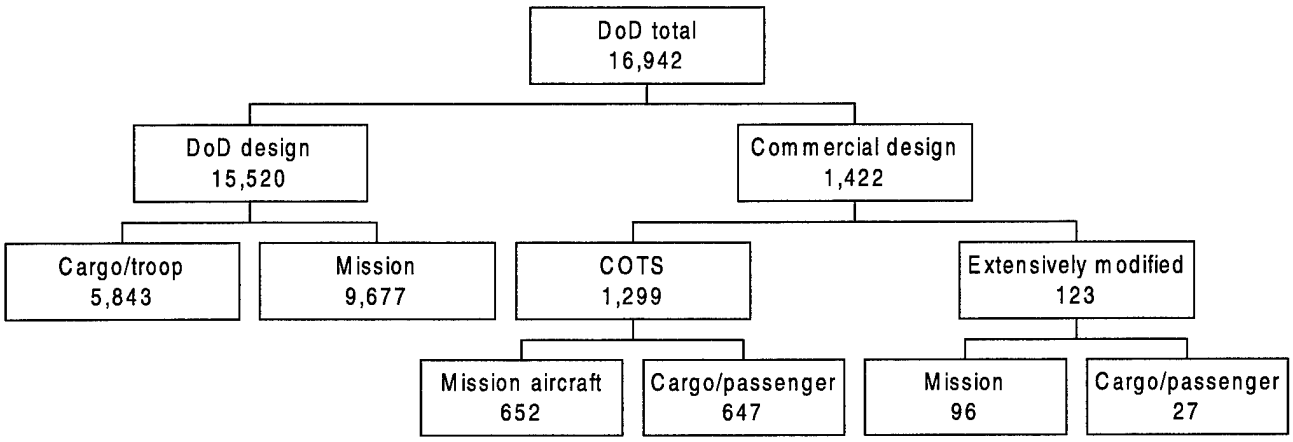
Approximately 2,800, or more than half, of the 4,300 FAA-licensed repair stations in the United States perform work on aircraft types used by the commercial airlines.[5] The number of contracts with these repair stations is unknown, but we estimate the number to be approximately 5,000 based on our interviews with airlines.

[5] Government Accounting Office, *Aviation Safety: FAA Oversight of Repair Stations Needs Improvement*, GAO Report number RCED-98-21, October 1997, p. 15.

DoD Aircraft Fleet

The DoD aircraft fleet is a mix of military-unique, commercial derivative, and COTS aircraft. The categories of all DoD aircraft, and their relative size, are listed in Figure 2-2.

Figure 2-2. DoD Aircraft Inventory



Source: Military service Office of Public Affairs.

Military-unique designs include the bulk of DoD's combat and specialized mission aircraft. Some of the aircraft types share a common design with commercial counterparts, even though they are not considered to be a commercial derivative. An example is the KC-135, which is a cousin to the Boeing 707.

Commercial derivative aircraft are basically defined as commercial aircraft that are modified to some extent for a military mission. The modifications can be relatively minor, such as adding a second set of flight controls to a training helicopter, or relatively major, such as the mission equipment package on the E-3 Airborne Warning and Control System.

COTS aircraft are largely the same as the their counterparts in commercial service, but with a military type designator. See Appendix D for the types and inventory of these aircraft.

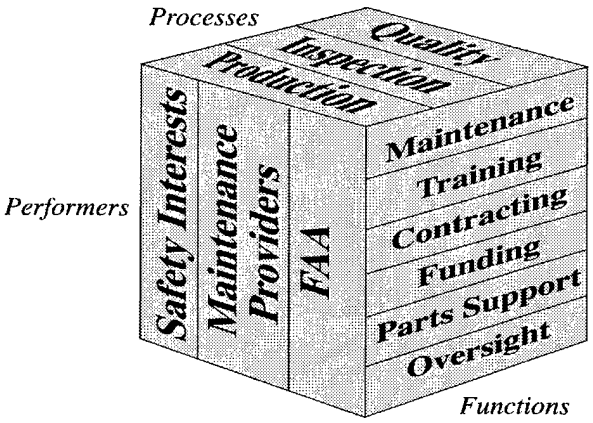
MANAGEMENT PRACTICES

Commercial Aviation

In our composite view of commercial aviation, there is a very evident framework for overseeing contract maintenance activities, which involves the airline, the FAA, and the contract provider. Airlines use a single organizational structure to

manage their overall maintenance programs, both organic and contract. The airlines' on-site quality representatives are predominantly selected based on their qualifications and expertise in the work being contracted. Contract documents can be relatively short and simple, with succinct work descriptions and clearly defined relationships. Airlines deal with a limited number of contract maintenance sources that are well known to them, with an increasing trend toward "partnerships" and other types of longer-term arrangements. The interactions of the performers, processes, and functions involved in commercial airline contract maintenance management can be depicted as a unitary system, as shown in Figure 2-3.

Figure 2-3. Commercial Airline Contract Maintenance Management



At the same time, the FAA has an independent, well-defined oversight role that is concerned with production quality as well as the safety impacts of the contract maintenance operation (including the adequacy of the oversight by the contracting airline as well as the production performance of the contractor). FAA offices are usually located close to an airline's technical operations and frequently have on-line access to the airline's management information systems. Contract maintenance sources are required by FAA regulations to develop and operate quality systems as a part of accomplishing their customers' workloads.[6] The same triad of operator, regulator, and contractor does not exist within DoD, because no single overarching organization serves as the regulator.

Defense Aviation

DoD employs a more segmented approach to contract maintenance management, which we have categorized in terms of system- and unit-level contracting. The following sections delineate some of the distinctions between the two categories.

[6] 14 CFR Part 145.

SYSTEM-LEVEL CONTRACTING

System-level maintenance contracting

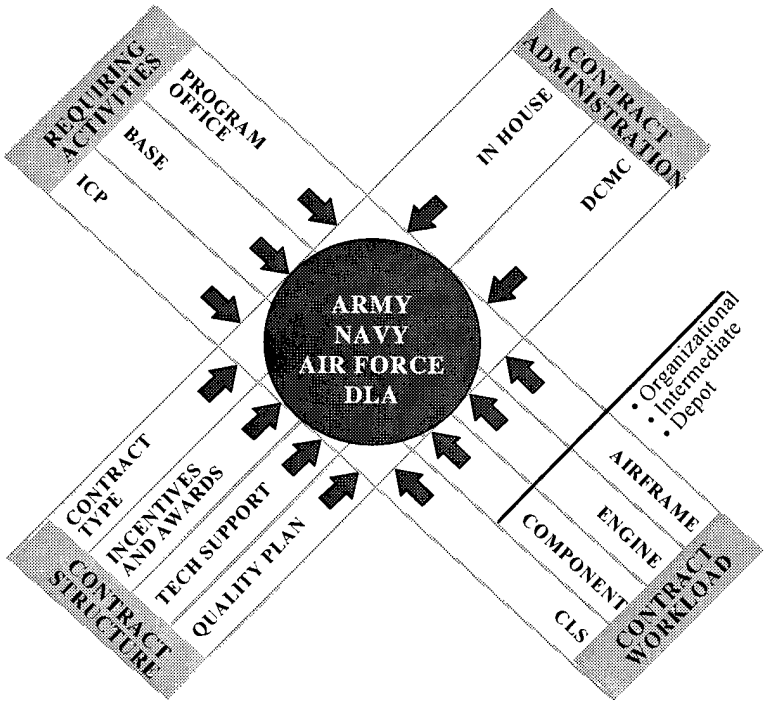
- is almost totally removed from the operating unit's purview;
- typically has delegated contract oversight to DCMC; and
- relies on processes, formal agreements, and standardization between large contract management organizations to replace direct oversight and streamlined accountability for their contract sources.

DCMC has been in existence for 7 years and is responsible for providing contract oversight for system-level contracts. While DCMC's oversight role is increasing for maintenance, its assigned manpower has decreased by more than half to reflect the steep reduction in production contracting. At the same time, resource shortages in the system-level contracting activities are forcing them to rely almost totally on DCMC for contract oversight. DCMC has a number of initiatives under way to cope with its shifting workload and campaigns vigorously for more and earlier involvement in contract planning on a joint service basis. Its "Early Contract Administration Services" ("Early CAS") initiative places their personnel on their customers' acquisition teams. There is no apparent relationship between DCMC manpower levels and the amount of delegated contract administration responsibility from contracting activities; eventually, resource constraints on both sides will force a clarification of roles with respect to available resources.[7]

DoD accomplishes its contracting by bringing together a requiring activity with a contracting activity for a given workload. The contracting activity assembles elements of a contract structure and assigns responsibility for contract administration as appropriate. The confluence of these disparate elements at a contracting activity is depicted in Figure 2-4.

[7] GAO Report T-NSIAD/AIMD-97-142, *DoD High Risk Areas: Eliminating Underlying Causes Will Avoid Billions of Dollars in Waste*, 1 May 1997, p. 17.

Figure 2-4. DoD Contract Maintenance Management Segments



UNIT-LEVEL CONTRACTING

Unit-level contracting

- is being challenged by shortages of expertise in the systems being supported, as the former experience base of military technicians is dissipated through downsizing and extensive outsourcing;
- has experienced difficulty with base-level contracting organizations that occasionally view maintenance exclusively in terms of a supply or service rather than including its additional dimension as a production and manufacturing operation; and
- is largely responsible for its own contract oversight (DCMC generally does not extend its oversight to operating locations).

Neither system- nor unit-level contracting activities appear to have established means to share best practices with one other. Several management activities indicated they considered available training (which might include an exposure to best practices) in aviation contract maintenance to be inadequate for their specific management roles. There appear to be few or no mechanisms for cross-feed or sharing of lessons learned about aircraft maintenance contracting across DoD.

Despite its challenges, the overall contract maintenance management process has worked effectively in DoD because the interlocking relationships between the

operating commands, logistics commands, and DCMC make it less likely that a management lapse in a single organization could jeopardize the entire structure. In effect, there is a functional counterpart in DoD to the role the FAA plays as the overseer in commercial aviation, even though it is dispersed through the management structure. Well-run unit-level contracts may actually tend to work better than system-level contracts because the unit managers have more direct control of their overall enterprise.

Operating Principles

There are some basic operating principles for commercial airline contract maintenance management:

- A fundamental starting point is the recognition that outsourcing is not free; that is, the decision to outsource maintenance has resource implications that begin with a conscious decision by the management organization itself to organize to manage what it outsources.

- The personnel involved in the management process also need specific types of backgrounds and support, as well as the resources to evaluate contract performance with focused reporting, monitoring, and analysis tools. This may involve different skills and information than was available when the workload was accomplished in-house.

- Airlines operate under an "umbrella of safety" that permeates their maintenance processes.

When these principles are not supported, the quality of contract maintenance production can suffer, as evidenced by the ValuJet catastrophe and other lapses that occurred during 1996 in commercial aviation contract maintenance operations.

In concept, the same basic principles apply to Defense management organizations. In fact, some of the strongest DoD managers are keen students of best commercial practices and work to incorporate them into their management processes. Unfortunately, there is also a very wide range of management approaches within DoD's many organizations associated with contract maintenance, from self-contained "islands" of expertise to massive central management organizations. These management structures are unique to each service and DLA, the parent of DCMC. There is little DoD-level guidance on the management of contract aircraft maintenance, little DoD-level emphasis on safety in contract management, no DoD-level encouragement for joint maintenance management (as distinct from joint contracting), and no structure to encourage cross-feed of best practice information between these organizations. Some organizations indicated they spend a minimal amount of time on benchmarking because they face all-consuming management issues related to funding shortages and the turmoil involved with Defense

restructuring. Organizations in such turmoil find it difficult to recruit and retain qualified personnel, let alone discover and implement best practices.

The Effects of Defense Acquisition Reform

DoD acquisition reforms are still in the process of full implementation and may further streamline the organizational structure for management of aircraft contract maintenance. However, at this moment, the Department's contract maintenance management approach remains a good deal less cohesive than its commercial equivalent. For example, system-level management activities have reduced or eliminated their on-site oversight and delegated the function to DCMC.

In addition, Defense contracting activities previously relied on a wealth of military specifications to achieve some degree of standardization in contract terms and conditions. Since many of these specifications have been rescinded, there is an ongoing effort throughout DoD to replace military specifications and standards with performance-based requirements that allow the use of commercial standards. The rescissions include the standards for contract quality and inspection, MIL-Q-9858A and MIL-I-45208A.[8] Some contracting activities are continuing to use these rescinded specifications in new contracts for want of standardized substitutes, although there is a growing tendency to accept a wide variety of commercial equivalents as replacements.

The Defense Standards Improvement Council has elected not to provide guidance for substitution of commercial standards as the military standards are rescinded, nor guidance for the transition to commercial practices. The Secretary of Defense issued a memo in 1994 expressing a preference for ISO or ISO-like quality systems, but it has not yet been incorporated into a formal directive.[9] DoD would benefit from designating certain commercial standards as preferred processes, including in particular the ISO 9000 series quality standards.

There is a major contrast in the information used to manage successful contracting in DoD and commercial aviation. The larger commercial airlines obtain a great deal more information about the "shop findings" of their contractors—they want to know what was found, and what was fixed, for every item subject to repair. The airlines combine the information from their contractors with their in-service experience in so-called "reliability programs" to periodically adjust their maintenance programs, including the intervals for scheduled maintenance tasks.[10]

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[8] MIL-Q-9858A, *Quality Program Requirements*, and MIL-I-45208A, *Inspection System Requirements*, were canceled effective 1 October 1996.

[9] Memorandum for Secretaries of the Military Departments et al., from Dr. William Perry, Secretary of Defense, Subject, *Specifications and Standards—A New Way of Doing Business*, 29 June 1994.

[10] 14 CFR Part 121.373 and FAA Advisory Circular AC 120-17B.

There is far less emphasis on in-service task adjustments in the military; instead, the focus is on "balanced support" to ensure the supply chain is sufficiently stocked with spares to meet the demand for replacement parts. So long as the DoD repair cycle can meet the demand, there is typically little incentive to intervene in the process. At the present time, there are no standards for performance metrics in DoD, nor is there an integrating mechanism for measuring or comparing the performance of aviation contract maintenance. Defense contracting activities indicate they are primarily concerned with customer feedback to monitor quality and effectiveness of maintenance contracts, rather than obtaining related information from the contract source. Several program management activities indicated they collect reliability information but lack sufficient manpower to analyze the data.

Application of Commercial Practices

Commercial aviation holds no panacea for successful contract maintenance management techniques. It is still possible for a ValuJet type of accident to happen, even in the midst of the additional oversight afforded by the FAA. In fact, the commercial aviation industry is presently working with the FAA to develop a "model contract" for aviation maintenance outsourcing in the interest of standardization and completeness. However, commercial practices can be an effective replacement or enhancement for Defense specifications and processes—when they are properly managed. The concept of "market research" is intended to identify such practices in addition to gathering information about the specific market segment that might respond to a contract solicitation.

In addition to DoD's heightened interest in outsourcing, there are several reasons to consider the adoption of commercial practices in DoD maintenance:

- The nature of force employment is becoming increasingly commercialized as operating units are more likely to find themselves in peacekeeping operations, supported by several types of contracts, than in actual combat. Commercial skills are beneficial when working with these contract sources.

- The services are operating fleets of aircraft that are increasingly derived from commercial equivalents and supported to some extent by commercial processes.

- Many aging military systems are projected to remain in service well into the 21st century. These aircraft are beginning to require a different set of skills for their support than was originally required. A key example is corrosion control expertise, which previously was deemphasized and incorporated into the structural repair specialty in at least one service. The services could benefit from training technicians with a broader set of skills, such as

are developed in commercial aviation maintenance technician (AMT) courses.[11]

- Public awareness of DoD flight operations is increasing and becoming more concerned with the public safety aspects of military passenger-carrying aircraft in response to accidents such as the loss of a T-43 aircraft carrying the Secretary of Commerce and numerous corporate executives. Commercial certification of technicians, as well as maintenance of such aircraft to current commercial airworthiness standards, would help to bolster the Department's overall approach to the safe peacetime operation of its aircraft.

- DoD fleet management activities have already begun to take advantage of commercial aviation service experience by maintaining segments of their COTS fleets to commercial airworthiness standards. Commercial certification of technicians could directly complement this effort by allowing the entire system to be operated under a commercial certificate.

- Adoption of commercial standards and practices would align DoD contracting with the business base it plans to employ in the future. This alignment will require the employment of technicians conversant in commercial terminology and practices. Benefits would include a reduction in overhead through reliance on commercial standards, as well as a simplification and streamlining of the number of quality systems requiring oversight.

- Finally, commercial practices, including commercial licensing, can effectively augment both standards and training for military personnel in areas other than aging aircraft. Examples include the training process itself, which could be modeled after FAA-certified training, and the professional career progression contemplated in the proposed new FAA licensing process for technicians.[12]

Recent experience indicates the conversion to commercial practices is not necessarily automatic, however; careful market research and some prototyping of commercial contracts may be necessary to develop operating norms and introduce new processes to established military management organizations. In addition, conversion from organic to contract accomplishment and the adoption of commercial standards require suitable transitions to avoid disruption of operating units.[13]

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[11] AMT is the new term for the former aviation and powerplant mechanic under a proposed revision to 14 CFR Part 65.

[12] 14 CFR Part 66 (proposed).

[13] LtCol Mary B. Hamlin, USAF, *Privatization of Aircraft Maintenance: Maximizing Contract Effectiveness*, Air War College Research Report, May 1990.

Chapter 3
Supporting Expanded Use of Contract Maintenance

INCREASING USE OF CONTRACT MAINTENANCE

Since the commercial airlines were deregulated in 1977, "new start" commercial airlines have chosen to outsource a substantial portion of their aviation maintenance requirements.[1] This avoids the cost of establishing a new repair capability for resource-constrained companies. It also avoids the problem that in-house repair tends to be difficult to adjust in terms of capacity and capability, due to the potential existence of restrictive labor-management relationships and the need to keep established "sunk cost" infrastructure economically employed once it exists. For similar reasons, established commercial airlines have a powerful, albeit restricted, incentive to economize by outsourcing costly or inefficient maintenance capacity. The commercial airlines have also found that their cost accounting systems, which were predominantly developed for in-house cost centers, are poorly suited to support make-buy decisions for outsourcing.

Since the last major airline recession began in the early 1990s, "third party"[2] contract repair capacity in the commercial aviation industry has been relatively plentiful and inexpensive, reflecting the available repair capacity that resulted from widespread cancellation of new aircraft orders that accompanied the recession. On an industry-wide basis, aviation maintenance, repair, and overhaul (MRO) is now estimated to be a $23 billion industry and is projected to grow by more than 40 percent to $33 billion by 2005.[3] The major airlines account for approximately one-third of that overall business base.

When outsourcing is not feasible, the established carriers may themselves offer to perform maintenance in the third party maintenance market to improve the utilization of their available capacity by performing maintenance for other operators. However, regardless of who performs the maintenance, FAA rules specify that the operator is ultimately responsible for the airworthiness of the aircraft, and the maintainer is responsible for the work actually performed.[4] A trend line for commercial aviation outsourcing is illustrated in Figure 3-1.

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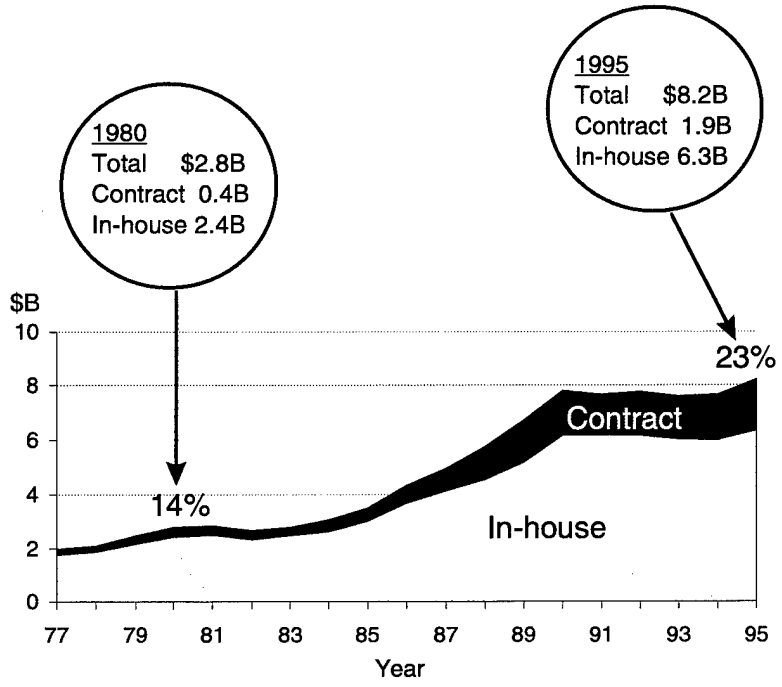
[1] BTS Form 41 data.

[2] Third party refers to contract sources other than the original equipment manufacturer or operator.

[3] MRO suppliers survey: "Three Challenges Facing MRO Today," *Aviation Week & Space Technology*, advertiser sponsored market supplement, 7 July 1997, p. S1.

[4] 14 CFR Parts 43 and 121 and Edward H. Phillips, "Lower Costs Called Key to MRO Growth," *Aviation Week & Space Technology*, 21 April 1997, p. 34.

Figure 3-1. Commercial Airline Outsourcing Trend



Recent commercial incidents, accidents, and FAA initiatives have highlighted the fundamental need for high quality contract maintenance support in commercial aviation. The FAA has reacted to a series of these incidents with special studies, changes in oversight processes, and the development of a new system to apply variable amounts of oversight to air carriers, based on a set of factors that will assess the overall risk of the airline operation.[5] The GAO, in turn, has reacted to the FAA studies by pointing out some of the difficulties the Agency faces as it works to make major cultural changes in its oversight processes.[6] This exchange of views serves as a vivid reminder that commercial aviation best practices may be profitably applied within DoD, but the commercial world also has its own set of growing pains to accommodate an increasing level of contract maintenance.

DoD also depends to an increasing extent on contract sources of repair and employs an increasing portion of contractor-supported commercial derivative aircraft in its operations.[7] As the military services restructure to address smaller budgets,

[5] FAA report, *90 Day Safety Review*, 16 September 1996.

[6] GAO Testimony T-RCED-97-90, "Aviation Safety and Security: Challenges to Implementing the Recommendations of the White House Commission on Aviation Safety and Security," 5 March 1997.

[7] The Joint Staff, *Focused Logistics: A Joint Logistics Roadmap*, final report, 1 August 1997, p. 35.

base closures, and organizational realignments, the Department's ability to manage its widespread contracting operations has suffered strains.[8]

NEW POLICY NEEDED REGARDING THE USE OF CONTRACT MAINTENANCE

DoD has focused a great deal of attention on the decision to outsource aircraft maintenance workloads, including the processes for selecting workloads to be outsourced. OSD published a compendium of the policy related to these decisions in 1996.[9] It has also developed a system to determine whether a workload should be contracted at all or retained for performance in-house.[10]

Little OSD policy exists regarding the management of workloads once they are placed on contract. As a result, each military service and contracting entity has developed its own approach to managing aircraft contract maintenance, within the constraints of the Federal Acquisition Regulations (FAR).

Outsourcing of aircraft maintenance requires careful transition planning to avoid workload disruptions.[11] This includes establishment of contract management organizations with adequate resources as well as training the workforce for the new management task.[12] Commercial airlines also have recently been reminded of this requirement in the aftermath of the major accidents that occurred in 1996. DCMC recognized the necessity of advance transition planning for system-level contracts and established the Early CAS program.[13]

A number of operating commands with multiple contracts have centralized certain aspects of contract management and training at the command headquarters level. These commands claim positive effects from the standardization, including better quality of contracting, application of more effective contract incentives, and better training for oversight. For a specific example of this standardization, see the best practices outlined in Appendix C.

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[8] GAO Testimony T-NSIAD/AIMD-97-152, "Defense Depot Maintenance: Challenges Facing DoD in Managing Working Capital Funds," before the Subcommittee on Defense, Committee on Appropriations, U.S. Senate, 7 May 1997.

[9] Office of the Secretary of Defense, *Policy Regarding Performance of Depot-Level Maintenance and Repair*, report to Congress, March 1996.

[10] Defense Depot Maintenance Council Business Plan, FY96–01, 14 January 1997, Chapter 7.

[11] LtCol Mary B. Hamlin, USAF, *Privatization of Aircraft Maintenance: Maximizing Contract Effectiveness*, Air War College Research Report, May 1990.

[12] GAO Testimony T-GGD-97-134, "Privatization and Competition: Comments on S.314, the Freedom From Government Competition Act," 18 June 1997.

[13] "Early CAS Teaming for Acquisition Success," *DCMC Guidebook*, 26 July 1996.

RESOURCES FOR MANAGING CONTRACT MAINTENANCE

Personnel Constraints

Several system-level management organizations we interviewed indicated they were resource constrained by a lack of manpower and funding; all indicated they were straining to some extent to keep up with their contracting responsibilities. The organizations are undergoing a general downsizing due to budget cuts, restructuring due to Base Realignment and Closure initiatives, and an increasing workload due to the DoD emphasis on workload competition and outsourcing. Resource constraints were cited as the reason for decisions by most of these organizations to rely on DCMC for contract oversight.

Base-level contracting activities did not indicate the same level of resource constraints as their system-level counterparts. This relatively robust availability of resources might reflect the somewhat easier ability of operating commands to obtain personnel billets for contract management functions and the relatively higher priority of support for operating systems.

Contracting officer's representatives are typically appointed from within operating units as on-site representatives for unit-level contract operating locations and receive training to work functionally with the contracting officer,[14] who may be located away from the operating site. Unit-level oversight is organizationally separate from system-level oversight; DCMC is not normally chartered to oversee base-level contracts.

The management organizations we interviewed had taken a variety of steps to effectively manage their contract responsibilities despite resource constraints. Examples included career-limiting assignment decisions by military managers to allow them to shepherd their contracts through a full renewal cycle and high levels of overtime for military and civilian personnel.

The military services conduct joint contracting for system-level maintenance of commercial aircraft when they operate common equipment. They also contract for depot maintenance of common equipment on an interservice basis. The predominant user of the equipment is generally designated as the lead contracting agency. However, once the contract has been awarded for commercial aircraft, the services indicated they separate the management of their respective portions of the fleet. The isolation of these contract management activities is magnified by legacy management systems that are not compatible between the military services.

[14] Office of Federal Procurement Policy, "Contracting Officer's Technical Representative," *A Guide to Best Practices for Contract Administration*, October 1994, pp. 4–11.

Training Needs

PRODUCTION VERSUS SERVICE CONTRACTING

Within DoD, aircraft maintenance contracts are uniquely structured: they employ a hybrid of production and service contracting provisions.[15] The contract structure reflects the diverse nature of maintenance tasks, from production-like scheduling and scope to service-like cleaning and parts support, as well as undefinitized "over and above" provisions. The statement of objectives (formerly statement of work) for aircraft maintenance contracts can contain a variety of line items that reflect both types of requirements. The type of contract can also reflect both worlds and contain fixed-price and cost-plus-incentive and award fee provisions in an effort to properly incentivize contract performance.

DoD requirements for sophisticated contract structures are well within the capabilities of system-level contracting organizations but may be beyond (at least initially) the capabilities of unit-level contracting activities. The following illustrates the diversity of a typical contract structure for airframe maintenance:

- Basic aircraft handling, inspections, and servicing are typically contract *services.*
- Input and output scheduling, repairing and overhauling, removing and replacing, checking and testing, local manufacturing, and installating modifications are contract *production.*
- Over and above line items, which address maintenance tasks that are either unpredictable or sporadic in occurrence, are not priced in advance because the scope of a required repair generally cannot be determined prior to discovery. The line item is typically *cost-negotiable* or *cost-reimbursable.*
- *Incentive fees* apply to the contractor's ability to perform as specified in such areas as cost and schedule control and overall fleet performance. Examples include unit-level requirements to maintain a specified number of aircraft in a defined level of operational readiness, generation of a number of sorties per day, and management of the number of aircraft out of service. System-level contracts incorporate measures of spares support effectiveness and fleet-wide status across numerous operating locations.
- *Award fees* apply to the contractor's responsiveness to the customer's priorities. Examples include the identification and establishment of a new repair capability or the development of processes to avoid scrapping items or minimizing the generation of hazardous wastes.

[15] See for an example LTC Larry W. Dandridge, USA, "Aircraft Maintenance Contract," *U.S. Army Aviation Digest*, January/February 1991, p. 14.

Contract structures for engines and components are relatively more simple. Component repair contracts are generally issued by ICPs as fixed-price depot repair contracts. Engine repair contracts may also be fixed price, with special instructions for replacement or repair of expensive components. Engine repair can also be contracted at the unit level as well as depot level.

Within DoD, contract structure has been shown to have a significant effect on contractor behavior and overall fleet performance. For example, a unit-level contract that rewarded flying hours but not equipment status resulted in a fleet that was overdue maintenance and dangerously close to material failure.

Activities that are converting from organic to contract maintenance have the greatest potential to underestimate the need for a hybrid approach because of their lack of experience. Even highly experienced system-level contract management activities refine their approach on each successive iteration of contract renewal.

Operating commands, program offices, and ICPs have realized that standardizing contracting approaches for aircraft maintenance requirements is advantageous. Some operating commands have established central contract management offices to address unit-level contracting at multiple locations. At least one ICP has standardized its approach to CLS contracting through the establishment of a central coordinating office. Senior managers are also avid students of best practices in commercial aviation and apply lessons learned in their own contracting. However, despite increasing resource shortages in contract management activities, little or no structured effort has been made to communicate information across military activities.

Significant benefits can be gained from focused training of contract managers, including communication of information between military and commercial organizations. These benefits will only grow larger in the face of the increasing magnitude of maintenance contracting, as well as DoD's sustained emphasis on the acquisition of commercial equipment. In brief, the benefits include the following:

- *Standardization of terminology.* For example, commercial aviation uses a set of terms in maintenance management foreign to military activities. "Letter check" is the equivalent of a major phased, periodic, or isochronal inspection; "no fault found," the equivalent of "cannot duplicate"; and "aircraft on ground," the equivalent of mission capability. Contract management personnel must understand these differences if they are to relate effectively to the commercial world, as well to other military services.

- *Comparability of performance data.* While it might not be necessary to adopt commercial terminology for concepts that have direct military counterparts, there is a significant gap in the comparability of commercial and military performance data. This gap reinforces the uniqueness of each

management organization when the emphasis might be better applied to a comparison of disparate approaches to similar contract requirements and learning from each other's successes and failures.

- *Common terminology and performance measures.* Within DoD, a common set of terms and metrics would facilitate benchmarking, especially among common systems operated by more than one military service.

- *Standard terminology.* It might be possible to avoid altogether the expense of converting commercial technical information to military technical data.

TRAINING COURSES

Despite the unique aspects of aircraft maintenance contracting, most available training seems to be centered on specific operating commands or unit activities. There are no Defense-level courses on aircraft maintenance or maintenance quality assurance quality control (QA/QC). Military technical training schools include quality processes in their basic training curricula, but few or no advanced courses address the transition to commercial standards.[16]

Aircraft maintenance has been defined as part of the acquisition community, and to the degree maintenance management training is addressed, it is incorporated in Defense-level acquisition courses. There is a dawning awareness that maintenance would benefit from focused courses reflecting the unique nature of maintenance contracting and QA techniques focused on maintenance processes as opposed to contract management.

DAU is a consortium of 15 acquisition-related schools in DoD. DAU coordinates the development of standard training materials for DoD applications.[17] It is well suited to the development of application-specific training through its course development mechanism, which is tailored for such tasks on a joint service basis.[18] The course development process can extend to the consideration of delivery techniques and training locations.

Funding Constraints

Funding availability has become a major workload driver for the management of aircraft maintenance contracts. The depot maintenance structure for workload has historically been based on processing "batches" of reparable parts or end items

[16] See for example DCMC Memorandum No. 96-45, *DLAM 8220.4, Quality Assurance Technical Development Program (QATDP)(INFORMATION)*, 4 September 1996, which mentions a basic quality assurance systems course and commodity courses but no advanced courses addressing maintenance or conversion to commercial standards.

[17] *Defense Acquisition University Catalog for FY97*, Volume V, Chapter 1, ADS-97-01-CG.

[18] Defense Acquisition University, Under Secretary of Defense for Acquisition and Technology, Draft Brochure, *Assignment-Specific Training: Program and Policies*, 12 June 1997.

through the repair process, contract or organic. This "batch mentality" suits the historic method for allocating operations and maintenance funding to the services, which is typically accomplished on a quarterly basis.

In contrast, quarterly funding allocations for COTS aircraft maintenance contracts oblige the management activities to use inefficient contract structures that multiply their workload but are necessary to hedge against funding uncertainties. COTS aircraft incorporate maintenance concepts designed for continuous commercial operations, maximum use of scheduled maintenance requirements, and minimum out-of-service time. Batch concepts are not suited for fleet-wide scheduled maintenance requirements that are specifically known months in advance. Despite the poor fit, contracts with batch funding are in widespread use, with the result that managers do not induct requirements in the most efficient groupings. Management also structures the contracts to avoid the possibility that contractors could seek reimbursement for termination of capability if layoffs were required because the workload is not inducted on schedule.

Managers sometimes cope with such funding uncertainties by structuring unit-by-unit contracts that can be individually funded. This practice is both inefficient and time-consuming. They also expend a large portion (up to 80 percent) of their management resources seeking funding for their next increment of contracting. The net result is a system that can be consumed by administrative issues rather than effective contract management. The impact on managers is expressed in terms of overtime and poor morale, less-than-efficient contract structures, and strained relationships with contractors.

Some commercial airlines also contract by the unit for their major maintenance requirements, but this practice reflects a specific management decision based on the need for focused oversight or some compelling business rationale such as the availability of single-unit capacity at favorable prices. No such criteria were evident in the DoD management organizations we interviewed.

The Need for Cross-Communication

Contract maintenance management activities are naturally predisposed to prefer their own practices and information systems. This attitude, coupled with heavy workloads and significant geographic distances between management activities, results in them viewing other management organizations with disdain. Resource constraints may eventually drive the military services to consider shared management of similar systems. In the meantime, the organizations could benefit from structured opportunities for sharing information, which would allow them to accurately compare their relative performance levels. Commercial airlines routinely compare their performance with selected counterparts; the DoD activities could benefit from the same process.

Opportunities for structured interaction between contract management activities could improve coordination between functions and across services, including improving personnel practices (qualification, selection, training, and career management) involved with aircraft contract maintenance management. Examples of information that could be shared are

- Acquisition strategies
- General contracting approaches
- Incentive and award fee structures
- Fleet performance factors
- Contractor performance history databases
- Source qualification and selection
- Terms and conditions
- Contract types and structures
- Sources of specific expertise, and
- Certifications for quality and other systems.

FINDING AND APPLYING BEST PRACTICES

Within DoD, contract maintenance managers seek information about other successful contracting activities, including best practices. However, this activity is complicated because the metrics used to provide visibility over the total contract maintenance effort and the terms incorporated into those metrics are not standardized and not comparable to commercial aviation measures. Meanwhile, commercial aviation is developing major new information-sharing systems, such as the Global Analysis and Information Network (GAIN), which is designed to facilitate the interchange of safety-related information between operators, manufacturers, and regulatory authorities.[19]

Managers who wish to compare contract structures and performance with their counterparts need to use a set of defined terms and performance parameters. There is evident benefit from such comparison, but there are major differences in terms and analytic techniques between the military services and between DoD and commercial aviation. For example, there is no easy comparison between DoD and commercial accident information, even for the same or similar aircraft. DoD and

[19] Edward H. Phillips, "GAIN Committee Seeks Third Airline Safety Conference," *Aviation Week and Space Technology,* Global Analysis and Information Network, 7 July 1997, p. 53.

the NTSB have developed different definitions for classes of accidents, rendering comparisons difficult. Table 3-1 compares the two sets of definitions.

Table 3-1. Accident Category Definitions

Category	NTSB[a]	DoD[b]
Accident	Person aboard, intent to fly, *and* death or serious injury *or* aircraft substantial damage	—
Class A	—	Fatality *or* permanent total disability *or* more than $1 million property damage *or* hull loss
Class B	—	Permanent partial disability *or* three or more people hospitalized *or* $200,000 to $1 million property damage
Class C	—	Lost work days *or* $10,000 to 200,000 property damage
Class D	—	On-site injury treatment *or* $2,000 to 10,000 property damage
Incident	Occurrence that could affect safety of operations	—

[a] "Reporting an Accident to NTSB," http://www.ntsb.gov/Aviation/report.htm, undated.

[b] Draft DoDI 6055.7, *Accident Reporting and Recording Instructions*, http://www.acq.osd.mil/ens/sh, undated.

SAFETY OF CONTRACT MAINTENANCE

Safety is a fundamental umbrella for maintenance operations in the commercial airlines. During our interviews, airline managers repeatedly cited the overarching role of safety in their operations, reinforced by public, regulatory, and competitive pressures. "Safety czars" have recently been added to airline management to further improve the airlines' focus on the critical subject and to take rapid action to address safety issues, both in their own operations and at contract sources.[20]

Our interviews in DoD indicated safety is also important to management but as one of many priorities that are largely related to measures of operational effectiveness. DoD's overall management structure does react to issues that might affect operational safety. For example, we found that DoD's contract management structure, while heavily segmented, allows for its disparate organizations to assist one another. When one segment encounters difficulty, the management structure is capable of employing another segment to help address the problem. In one instance, contracting responsibility for a large training activity in one military

[20] ICARUS Committee, "The Dollars and Cents of Risk Management and Airline Safety," *Flight Safety Digest*, Flight Safety Foundation, December 1994, p.1.

service was transferred from the operating command to a program office as a means of strengthening the overall contracting approach and oversight mechanism. Commercial airlines do not have the same system of supporting organizations at work in contract maintenance, but they do have additional oversight provided by the FAA.

So long as the contract maintenance management organizations have adequate resources (which, as noted earlier, are generally decreasing along with contract workloads), the organizations appear to be able to react to problems within contractors and operating units, and the overall contract maintenance management system appears to be capable of accommodating increasing levels of outsourcing for aviation maintenance requirements.

MAINTENANCE TO COMMERCIAL AIRWORTHINESS STANDARDS

DoD has a long-standing interest in acquiring commercial equipment that will meet its needs.[21] This interest is reflected in the DoD aircraft fleet, in which commercial derivative aircraft make up approximately 8 percent of the total inventory. These aircraft range from straight off-the shelf varieties, used very much like their commercial counterparts, to heavily modified aircraft that fly operational missions. Many military aircraft share their design heritage with a commercial counterpart, and vice versa. Major examples are highlighted in Table 3-2.

Table 3-2. Shared Military/Commercial Design Heritage

Military designation	Mission	Commercial counterpart
C-130	Cargo, special mission	L-100
KC-10	Tanker, cargo	DC-10
KC-135	Tanker	B-707
OH-58	Observation/scout	Bell 206
P-3	ASW	L-188 Electra
UH-1	Utility	Bell 204/205/212/214

To varying degrees, the military services maintain their commercial derivative aircraft to commercial airworthiness standards. Aircraft maintained under CLS arrangements can be treated as straight commercial aircraft for supply and spare parts management and are frequently inducted into commercial facilities for the heavier maintenance checks as a subcontract to the CLS provider. We found one CLS contract that included government-owned, contractor-operated unit-level

[21] DoD 5000.2-R, *Mandatory Procedures for Major Defense Acquisition Programs (MDAPs) and Major Automated Information system (MAIS) Acquisition Programs*, paragraph 3.3.1.1, "Commercial and Non-Developmental Items," 15 March 1996.

maintenance facilities licensed by the FAA as a repair station, allowing the aircraft to remain commercially certified while in military operation.

There are several advantages to maintaining commercial derivative aircraft to commercial airworthiness standards:

- Parts are generally available on a worldwide basis.
- The stocking of spare parts can reflect their commercial availability.
- The number of qualified repair sources is generally larger and more competitive.
- Operating units can benefit from the worldwide fleet experience for equipment problems and maintenance program requirements.
- Because of their worldwide fleet experience, modifications mandated by the FAA can be much easier to justify within DoD.
- The aircraft can eventually be sold as surplus in the commercial market at substantially higher prices.

A recent effort by a military service to contract for heavy maintenance of a commercial aircraft type with a commercially licensed facility also experienced difficulty. The contractor was obliged to support numerous configuration changes to bring the aircraft up to the latest commercial configuration, with accompanying flow and schedule impacts. While the problems were eventually resolved for the most part, the contractor subsequently requested to be relieved of the contract because of cost accounting issues and impacts on other workloads. These types of growing pains should be anticipated during transitions from Defense to commercial contract structures.

RELIABILITY ANALYSIS TECHNIQUES

Reliability analysis techniques are the analytic processes that allow for the assessment of in-service equipment performance and for adjustments to maintenance programs as a result. Typical actions as a result of reliability analysis include the lengthening of inspection intervals due to a lack of significant inspection findings (a benefit) and the addition of scheduled removals to avoid the expense of catastrophic failure and premature removal (a problem). Only the "problem" half of reliability analysis is in use for contract maintenance.

Unfortunately, resource constraints routinely prevent the use of reliability analysis for contract workloads to identify potential improvements in maintenance programs. Several program managers indicated they collect but do not have the resources to analyze reliability data. As a result, problem areas are identified and

addressed, but opportunities for improvement are missed. In addition, aircraft maintenance contractors have a natural incentive to address repair issues that will increase their repair capability and thereby increase their workload. But they frequently lack similar incentives to seek performance improvements in maintenance programs, which would tend to decrease their workload. As a result, most DoD aircraft supported by contract maintenance typically operate on the manufacturer's original recommended maintenance program.

In contrast, commercial airlines are continually interested in seeking performance enhancements in their maintenance programs because of the potential for resource savings and increased aircraft availability. One major airline estimates that it saves more than $6 million in annual maintenance expenditures as a result of its reliability analysis. An extrapolation of that benefit for DoD's fleet would exceed $250 million annually. See Appendix C for a U. S. Coast Guard approach to reliability improvement using activity-based leasing.

RISK AREAS

There are a number of areas that merit caution as DoD pursues its outsourcing objectives. Organizations being outsourced can wait too long to establish a contract management team and suffer from loss of expertise and lack of resources.[22] Rapid implementation of contract decisions without adequate planning for transition can allow workloads to suffer turmoil as the fledgling management organization works to catch up. Organizations that are obliged to spend an inordinate amount of time on funding issues can misread important shifts in contract performance. Lack of shared information between management organizations can result in more than one activity experiencing the same lesson learned. Finally, over-reliance on customer feedback as a contract's primary quality indicator can miss the potential for identifying problems earlier in the repair cycle and taking action before faulty units are installed on operational aircraft.

On more than one occasion, unit-level contract management oversight has lacked adequate surveillance of the contract effort. Unit-level management activities are well advised to take some basic additional steps to improve surveillance activities and ensure the contractor provides quality aircraft maintenance.[23]

Contracting activities can do a major disservice to aircraft maintenance requirements by attempting to force the contract to look like either a production or services requirement. Contract oversight activities can also oversimplify the type of administration required by presuming that a production quality system is adequate for a maintenance workload. In particular, unit-level management activities may

[22] GAO Testimony T-NSIAD-97-110, "Defense Outsourcing: Challenges Facing DoD as it Attempts to Save Billions in Infrastructure Costs," 12 March 1997, p. 17.

[23] LtCol Beckwith, USAF, "Contracted Transient Aircraft Maintenance—Getting Your Money's Worth," *TIG Brief*, "Crosstalk," January–February 1993, p. 13.

feel these types of pressures and may be constrained from requesting assistance from system-level activities because of organizational hierarchies and a concern that exposure of issues could lead to attempts to centralize the management of the contract.

Part of DCMC's work force already has commercial aircraft maintenance experience, but it can still be obliged by personnel rules to place inexperienced managers in commercial repair facilities. This can place the commercial facility in a de facto training role.

The military services have a long and proud tradition of independence from one another. They prefer to emphasize the uniqueness of each operation and therefore the necessity for uniquely tailored operating procedures. OSD is the only staff activity capable of requiring the degree of cooperation contemplated in this report.

Chapter 4
The Use of Commercial Practices

Application of Commercial Standards

DoD has made significant strides in the acquisition of commercial products and services, and an increasing number of commercial practices are entering DoD's contract maintenance management. Examples include

- incorporation of ISO and ISO-like quality standards and other commercial standards;
- incorporation of commercially derived maintenance processes, such as composite repairs and nondestructive test techniques; and
- commercial certification of enterprises, processes, and technicians to replace the rescinded military specifications and standards.

DoD is also incorporating a variety of commercial support strategies into Defense contracting. Examples include

- the concept of lifetime contract support, even for primary weapon systems;
- expanded use of warranties and extended application of ICS concepts;
- outsourcing of distribution, management activities, and repair cycles, including direct vendor delivery and preferred spares providers; and
- the consolidation of maintenance levels coupled with overnight delivery of spares.

Commercial Substitutes for Military Specifications and Standards

In 1995, OSD embarked on an ambitious program to rescind the bulk of military specifications and standards. The objective was to convert military contracts to the use of commercial standards whenever feasible. OSD formed a Defense Standards Improvement Council to manage the conversion process from the Defense viewpoint. Industry associations serve as counterparts to the council for the identification of alternative commercial standards. Two significant decisions by the council were to provide no guidance as to the transition to commercial standards and to

designate no commercial standards as preferred processes. A specific example of the effects of these decisions is in the area of quality programs.

Quality Control Versus Quality Assurance

Because of the multiple definitions ascribed to key words used in quality programs, some baseline definitions are necessary for further discussion of this area:

- *Quality* has to do with satisfying the total suite of customer requirements.
- *Quality control (QC)* is typically defined as the inspection of finished piece parts and products during production (including maintenance) to determine that the produced item meets the intended specifications for function and appearance. Military maintenance contracts have historically relied on these types of end-of-production inspections for acceptance of repaired items.
- *Quality assurance (QA)* is typically defined in terms of oversight of the processes necessary to yield a product or service that will satisfy customer quality requirements. Commercial aviation is much more process-oriented than end-item oriented. For DoD, process orientation for quality assurance is best identified in DoD 5000.2-R.

The distinctions between QA and QC are at the center of a transition to commercial quality standards for aircraft maintenance. While DoD has rescinded its military quality control standards (e.g., MIL-Q-9858A, MIL-I-45208A), the Department has chosen to allow buying activities considerable flexibility in determining which commercial standards may serve as replacements. We found five distinct types of quality standards now being accepted as a part of aircraft maintenance contracts by system-level contracting activities.[1] In an effort to reduce the confusion and administrative burden of this proliferation of quality systems, DCMC has adopted a single process initiative (SPI). Under this initiative, a single quality practice can be applied to all government contracts at a contract site as long as the practice satisfies the needs of all contracts being performed at the site.

Quality Systems

There are many sources of quality standards applicable to government interests, but they can be narrowed down considerably when focusing on the aviation industry. There is also a variety of quality systems in use in the commercial aviation industry, but the ultimate baseline for all of them is ISO 9001, with supplements

[1] ISO9000/AS9000, MIL-Q/MIL-I, CASE, FAR Part 145, other commercial quality systems.

or gaps in coverage for particular types of workloads. Some of the current quality standards applicable to aviation in both worlds include the following:

- *Military specifications*—MIL-Q-9858A and MIL-I-45208A, although canceled in 1996, are currently in use for a considerable number of existing contracts. Some contracting activities are continuing to allow the use of these specifications when requested by contractors for new contracts.

- *Commercial specifications*—These include the family of international quality standards, ISO 9000. The aviation industry has created a specialized derivative of ISO 9001 for aviation production and maintenance applications. This new specification, AS9000, *Aerospace Basic Quality System Standard*, has been submitted for acceptance as an American National Standard and an ISO-recognized document. The commercial airlines have endorsed this standard.

- *Industry standards*—These include the commercial airlines' *Coordinating Agency for Supplier Evaluation* (CASE), the *Airline Suppliers Association Quality System Standard*, and original equipment manufacture's (OEM's) instructions, such as Boeing's D1-9000 Advanced Quality System.

- *Federal Aviation Regulations from the FAA*—Although these regulations are not generally regarded as quality system specifications, they have been accepted as such in certain maintenance contracts. They include 14 CFR Part 145 (Repair Stations), 14 CFR Part 43 (Maintenance, Preventive Maintenance, Rebuilding, and Alteration), and 14 CFR Part 21 (Certification Procedures for Products and Parts).

- *FAA advisory and guidance documents*—These include FAA Advisory Circular 00-56 (Voluntary Industry Distributor Accreditation Program) and FAA Order 8100.7 (Aircraft Certification Systems Evaluation Program [ACSEP]) for aircraft manufacturers.

- *Internal quality systems*—These are unique quality systems developed by individual companies and accepted for use in the performance of certain DoD contracts. While many of these systems are ISO-like in their basic structure, they are each different in some respect regarding their structure and content.

The ISO 9000 international quality standards are actually a set of five documents, ISO 9000 through ISO 9004. They were originally developed in 1987 and revised in 1994. When these documents are published in the United States, they are published under the joint auspices of the American Society of Quality Control (ASQC) and the American National Standards Institute (ANSI). Appendix B contains a cross-reference of the five ISO standards, their titles, and American

designations and a comparison of the requirements in several of these quality standards.

Although many airlines state that they are not planning to implement ISO, at least in the near term, many of them have joined aircraft manufacturers and suppliers in endorsing AS9000, which supports all ISO 9001 requirements and makes industry-specific additions to it for aerospace applications. Some airlines have begun to apply ISO 9001 internally for competitive purposes. In general, the aviation industry is experiencing a gradual movement toward ISO, and DoD is doing the same. With the elimination of MIL-Q-9858A and MIL-I-45208A, ISO-like systems are increasingly being encouraged and implemented.[2] Since no implementation plan was provided to contracting activities for the transition from military specifications to commercial standards, each activity is applying its own individual methods for accepting ISO and ISO-like quality systems.

By virtue of the ongoing adoption of the ISO 9000 family as the global quality management standard, its requirements have become the baseline against which all other quality management standards are compared. The necessary components of an effective quality management system are addressed in the 20 elements of this ISO standard. The ISO elements span the gulf between the responsibilities of managers and servicing personnel, designers who must exercise control over their designs, and trainers who train people to build and test products properly. These 20 elements comprise the foundation for a universally accepted quality management system. Appendix B provides common language questions to describe each of these 20 elements.

There are a number of considerations that favor the designation of ISO 9000 as a preferred quality standard for DoD:

- No other standard has nearly the same level of acceptance as a global guideline for quality.
- Designation of a preferred quality specification would limit the proliferation of nonstandard quality systems; DoD's adoption of the ISO 9000 series of quality standards would serve to reinforce the standard's acceptance globally.
- The ISO 9000 series quality standards are being tailored for specific applications. In addition to AS9000 mentioned previously, QS-9000, *Quality System Requirements*,[3] is the automotive industry's version of ISO 9000.

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[2] Under Secretary of Defense (Acquisition and Technology) memorandum, subject, *Use of Commercial Quality System Standards in the Department of Defense (DoD)*, 14 February 1994.

[3] Developed by the Automotive Industry Supplier Quality Task Force; QS-9000 is distributed by the Automotive Industry Action Group, Southfield, MI, document number QS9-2, 2nd Edition, February 1995.

- ISO-based standards can provide a common context for sharing and improving quality practices and a new way to converse in standard terms about quality systems and performance.

- DoD can have a voice in the management and update of the ISO 9000 series by participating on the standard's technical management committee.

Aircraft maintenance is populated with an increasing number of experienced ISO-certified contractors; however, early experience with the use of ISO-like quality systems has led to a key lesson learned: *The contracting activity must ensure that the quality certifications for potential contractors actually satisfy the quality requirements for their specific contract.* Failure to check on the applicability and effectiveness of the quality system to the production process can lead to inadvertent degradation of equipment condition.

THE MAINTENANCE WORK FORCE

The military services predominantly recruit high school graduates to become maintenance technicians and basically build their own work force with technical training and on-the-job experience. The military depots enter their local job markets to recruit civilian maintenance technicians and encourage local vocational-technical schools to offer relevant job training for their depot skill requirements. The major commercial airlines prefer to recruit experienced technicians, including hiring from their regional airline affiliates and repair stations. People who are interested in entering the commercial aviation job market may benefit from prior military experience but are responsible for obtaining their own certification training from an FAA-certificated school.[4,5] The airlines and DoD both provide task training to supplement the basic technician training.

Personal accountability is an issue, both commercially and in DoD. The airlines rely on certifications (e.g., aviation maintenance technician, repairman, repair station), and the FAA can take "certificate action" as an ultimate penalty for malfeasance. DoD depends more upon qualifications (e.g., formal aviation maintenance technician training) and must use the Uniform Code of Military Justice or civilian personnel rules for sanctions. There is no direct link between these two approaches. The FAA does not accept maintenance tasks unless they are signed off by certificated technicians (DoD loses the benefit of commercially certificated aircraft because they cannot be maintained to FAA standards without certificated technicians). The possibility of commercial licensing for military maintenance technicians is addressed in the following subsection.

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[4] FAA Order 8300.10, *Airworthiness Inspector's Handbook*, Chapter 22, "Certificate Airframe and/or Powerplant Mechanic/Added Rating," Change 9, 13 August 1995.

[5] Licensed schools under 14 CFR Part 147 train technicians to meet the licensing requirements of 14 CFR Parts 65 and 66 (proposed).

Of course, commercial licensing is not an automatic answer to the issues of technician skill requirements, but the training process can be a fundamental step toward developing well-rounded maintenance technicians for the future. A related topic has to do with the employment of skilled technicians in the process of contract oversight.

Commercial Licensing of Technicians

There is a growing convergence of Defense and commercial contract maintenance practices as DoD increases the portion of commercial derivative aircraft in its inventories and seeks to employ commercial standards on a wholesale basis. Both worlds of aviation maintenance draw from the same technical base for maintenance processes, and both worlds compete for the same maintenance technician resources. The ongoing trend in DoD to increase the amount of contract maintenance places an increased premium on the Department's ability to manage commercial contracts and systems. There is an increasing need for DoD maintenance technicians and managers conversant with commercial practices who can serve in contract maintenance management activities as well as in contract oversight roles and the organic maintenance organizations themselves.

DoD stops short of supporting most of its commercial fleets as fully commercially licensed aircraft. The primary missing element is commercial licensing for the military and DoD civilian personnel who maintain the aircraft. The FAA has an established process, based on military specialty coding, to evaluate military experience and convert it to commercial equivalents. This process is used to give maintenance technicians credit toward the required training for the FAA aviation maintenance technician and repairman licenses. The military services also have procedures in place to grant course credit for military technical training to encourage technicians to obtain associate and higher degrees.

During our interviews, maintenance managers expressed an interest in the use of FAA-licensed technicians to support commercial aircraft in military service. There may already be sufficient duty locations and systems available to allow for a reasonable test program, including career progression of licensed personnel, without the risk of losing their expertise in the military assignment process. Use of a process team and a prototype location may be necessary to develop a workable test program. DoD could encourage maintenance technicians to obtain FAA licenses by gaining authorization for DoD training organizations to grant FAA training credit for their courses. DoD could also explore the conversion of aviation technical training schools to FAA-certified institutions. It might be cost-effective to consider the outsourcing of aviation technical training to FAA-certified schools, at least for personnel who will be assigned to commercial derivative aircraft.

Contract Oversight

Commercial airlines use quality auditors to oversee their maintenance contracts. The ideal individuals for these positions have 8 to 10 years of related experience in the same or similar workloads and good managerial skills. Individuals undergo a year of on-the-job training for audit positions, plus another year to qualify as a CASE auditor. Individual auditors may visit contract sites on a periodic basis or may be assigned to a single site if the workload is large enough to warrant continuous coverage. The auditor may be augmented with other skills (specialists in production and inventory, scheduling, engineering, etc.) as warranted by the workload.

The focus of the auditor's oversight is on production processes as much as it is on output. These individuals typically have authority to approve certain levels of non-routine (analogous to over and above) work requirements to certain cost thresholds, after which the requirement must be approved by the airline's technical operations department. DoD contracting and contract management activities also have contract oversight activities, including some highly experienced quality inspectors. But the entry-level qualifications for quality oversight personnel are somewhat less stringent than in the commercial world, and the authority to approve workload variances is generally reserved at a higher level.

A concept of shared oversight is used by most commercial airlines to mitigate resource requirements and to unify the needs of the user community to their suppliers. The CASE audit program is an example of the type of sharing of audit resources that is authorized by the FAA. A CASE-certified quality auditor from any participating airline may perform a CASE audit, and all participating airlines that use the audited contractor can take credit for the audit's accomplishment. DoD is also a participant in this program by virtue of the audits it conducts on charter operators via the Air Force Air Mobility Command. Other than this CASE participation, auditing and other quality efforts are largely conducted within the military services for their respective unit-level contracting activities or by DCMC for system-level contracting (including contract depot maintenance and the heavy check portion of CLS contracts).

DCMC's recent SPI efforts to consolidate audits and inspections have started to decrease the proliferation of quality systems invoked on single contractors who may have several military customers. There are no direct equivalents of FAA or CASE within DoD, so DCMC is forging new ground. ISO and ISO-like systems are allowed as acceptable alternative quality systems, and third-party quality certification is being encouraged but not required by name.[6]

[6] DCMC Memorandum Number 97-37, subject, *Management Council Reduction of Redundant Supplier Audits*, undated.

INCREASING THE USE OF COMMERCIAL REPAIR SOURCES

DoD already uses a variety of commercial-oriented repair sources, especially for CLS of commercial derivative aircraft. Many of these sources are subcontracted to the prime contractor that provides management for CLS contracts. However, we found only one type of aircraft within DoD, a training helicopter, that was fully maintained as an FAA-certified aircraft.

Many of the largest Defense airframe contractors are also licensed by the FAA as commercial repair stations and are in the process of adapting their maintenance operations to replace rescinded military standards with commercial standards for military-unique workloads. The same contract oversight and management issues apply to military-unique workloads as they do to commercial and commercial derivative aircraft.

Defense contracting activities frequently issue contracts on a sole- or restricted-source basis, typically to specialized Defense contractors or the OEM. A recent GAO report indicated that the portion of depot maintenance contracts awarded on a sole-source basis may range up to 90 percent of the total.[7] Unit-level contracting for aircraft maintenance tends to be more competitive, but awards are made to an increasingly restricted number of contract sources. Table 4-1 identifies the predominant sources for competitive airframe-level maintenance in DoD, which reflect the substantial consolidation that has recently occurred in the Defense industry.

DoD is working to make better use of the commercial source of repair qualification processes, including the acceptance of a variety of commercial quality systems (and third party certification) for Defense contracts. Contracting entities are authorized to consider the past performance and commercial quality certifications of a prospective contractor before award, but, after contract award, there is no effective mechanism for taking action in the event the contractor receives a significant recertification audit or loses those certifications.

[7] GAO/NSIAD-97-152, *Defense Depot Maintenance: Challenges Facing DoD in Managing Working Capital Funds*, 7 May 1997, p. 32.

Table 4-1. List of Major Defense Maintenance Contractors—Over $50 Million, FY96

Contractors	Army	Navy	Air Force
AlliedSignal	—	X	—
Boeing/McDonnell-Douglas/Rockwell	X	X	X
DYNCORP	X	X	X
General Electric/UNC/Greenwich	X	X	X
Lockheed-Martin/Loral/Northrop-Grumman	X	X	X
PEMCO	—	X	X
Raytheon/E-Systems/Chrysler Technology/ServAir	X	X	X
United Technology/Sikorsky	X	X	X

The military services have realized mixed results in their efforts to employ commercially oriented contractors for Defense maintenance workloads. There are apparently procedural and conceptual differences between commercial and Defense contracting techniques that can serve as barriers to successful contract accomplishment. There is no mechanism to assess lessons learned from such experiences and apply the experiences across service boundaries. But there are compelling reasons why DoD should pursue the use of commercial sources for aircraft maintenance, including

- the advantages of a larger competitive base,
- the full application of commercial standards, and
- the opportunity to share in commercial experience for the same or similar aircraft.

Rather than proceed too quickly with commercial contracting on a wholesale basis, DoD might benefit from the application of a limited number of smaller, controlled contract efforts that could be used as prototypes to identify and resolve any differences between commercially oriented and Defense-oriented contracting.

DoD could employ a process team to identify other changes that should be made in statements of objectives or the FAR to better align Defense and commercial maintenance contract processes. The team could identify changes that would allow for better use of standard commercial practices, including qualification and disqualification of repair sources, to address the possibility of terminating a contract in the event a contractor loses commercial certification for either its operating certificate or quality system. A process could also be developed to adopt

commercial practices for notifying the contracting activity of contractor audits by third parties and sharing the results of such audits.

DoD could employ commercial standards for contract oversight of FAA-certified repair stations by obtaining FAA certifications for a portion of its technicians and repair centers. This initiative would be consistent with existing law addressing the use of public DoD aircraft.[8]

RISK AREAS

Long-time observers of the military services have indicated they face three major issues affecting their ability to accomplish their quality goals: loss of experience, environmental compliance/protection, and replacement or loss of military specifications and standards. Specifications have already been addressed in this chapter, and environmental issues are outside the scope of this report. The third issue, experience, has a number of facets related to human resource management.

Experience is a combination of training and job assignment for technicians. While the curriculum for an aviation maintenance technician in commercial aviation is designed to produce a generalist with a wide background in repair techniques and processes, the military services have been working to reduce the amount of maintenance performed by military technicians, and thus their training requirements. When the military depots do not adjust their work scope to reflect this loss of base-level expertise, the result can be abrupt retirement of aircraft for structural deterioration.

Recent successful experience with the use of contractors to provide aviation maintenance in contingency operations indicates there may be few serious drawbacks to their use, up to the point of direct combat operations.[9] In recent contingencies, military and contract personnel easily integrated into single organizations, even on a multinational basis. There is a growing belief that contracting is one of the force multipliers of the future. Procedural limitations may be a greater detriment to contract use than the willingness of contract personnel to deploy into hazardous situations.

[8] 49 USC Part 40102(A)(37).

[9] Personal interview with MG William G. Farmen, USA (Ret), first NATO/USAREUR J-4 in Bosnia, 3 June 1997.

Appendix A
Contributing Organizations

COMMERCIAL ORGANIZATIONS

Industry Associations and Societies

- Aerospace Industries Association
- International Society of Aviation Maintenance Professionals
- National Air Transportation Association
- National Business Aircraft Association
- Regional Airline Association
- Society of Automotive Engineers

Commercial Airlines

- Air Canada
- America West
- American Airlines
- American Trans Air
- Atlantic Southeast
- Atlas Air
- Continental Airlines
- Delta Airlines
- Evergreen International Airlines
- FedEx
- Southwest Airlines

- Trans World Airlines
- United Airlines
- USAirways

DEFENSE ORGANIZATIONS

Headquarters, Defense Contract Management Command

- Aircraft Program Management Office

Army Organizations

- Headquarters, United States Army, Deputy Chief of Staff for Logistics, Aviation Logistics Division
- Headquarters, Aviation and Troop Command
- Special Operations Forces Support Activity
- Directorate of Logistics (DOL)
  - Fort Rucker
  - Fort Campbell
  - Fort Hood

Navy Organizations

- Deputy Chief of Naval Operations (Logistics), Supportability, Maintainability and Modernization Division; and Headquarters
- Aviation Maintenance Programs Branch
- Deputy Chief of Staff for Aviation (Marine Corps), Aviation Logistics Support Branch
- Headquarters, Naval Air Systems Command
- Program Management Activities
  - PMA 225—Training Aircraft

- PMA 227—Commercial Off-the-Shelf
- PMA 273—T-45 Acquisition Program Office

Air Force Organizations

- Headquarters, United States Air Force, Deputy Chief of Staff for Installations and Logistics, Maintenance Management Division
- Installations and Logistics, Maintenance Management Division
- Headquarters, Air Education and Training Command (HQ AETC)
- Oklahoma City Air Logistics Center

OTHER GOVERNMENT ORGANIZATIONS

U.S. Department of Transportation

- Bureau of Transportation Statistics
- Federal Aviation Administration
- United States Coast Guard Headquarters, Office of Aeronautical Engineering

National Transportation Safety Board

Appendix B
Comparison of Selected Aviation Quality Standards, Military Specifications, and FAA Regulations with ISO 9001:1994

This appendix provides a general comparison of selected military and commercial specifications and standards, as well as applicable requirements from the FAA, for establishing and assessing quality programs. The baseline for this comparison is ANSI/ASQC Q9001:1994 (or the international quality standard ISO 9001). This standard was selected as the best baseline for comparison within the aviation industry because of its global acceptance and the scope and framework of its quality system requirements.

The military specifications (both rescinded in 1996 but remaining in use for many existing maintenance contracts) are

- MIL-Q-9858A, *Quality Program Requirements and*
- MIL-I-45208A, *Inspection System Requirements.*

The commercial standards are

- *Coordinating Agency for Supplier Evaluation (CASE), Air Carrier Section, Standard 1A, Component Repair/Overhaul Vendor Quality Program Requirements.*
- ASA 100, *Airline Suppliers Association Quality System Standard.*

The FAA requirements documents include

- FAA Advisory Circular 00-56, *Voluntary Industry Distributor Accreditation Program,*
- 14 CFR 145, FAR Part 145, Repair Stations,
- 14 CFR 43, FAR Part 43, *Maintenance, Preventive Maintenance, Rebuilding, and Alteration*, and
- 14 CFR 21, FAR Part 21, *Certification Procedures for Products and Parts.*

The intent of the appendix is twofold. First, the comparison highlights areas where the various standards, specifications, and regulations overlap in defining quality requirements. For example, all listed documents identify the general requirements for inspection and testing, item 4.10.1. Second, the comparison demonstrates where there are voids in requirements among these same standards, specifications, and regulations. For example, training, item 4.18, where all referenced documents address training except the two military specifications and FAR Part 21. Likewise, only ISO 9001, MIL-Q-9858A, and MIL-I-45208A address corrective actions, item 4.14.2.

Table B-1 contains plain language questions for the 20 major elements of ISO 9000. Table B-2 is a cross-reference of the five ISO 9000 series documents, their titles, and American designations. Table B-3 provides a comparison of the military specifications, commercial standards, and applicable requirements from the FAA.

Table B-4 provides an internal comparison within this baseline established by ISO 9001. This comparison lists the additions to ISO 9001 made by the 1997 Aerospace Standard AS9000. While adopting all elements of ISO 9001:1994, AS9000 is intended to provide increased commonality of requirements based in ISO 9001 while increasing focus on unique requirements of the aerospace industry. AS9000 was recently submitted for recognition as an American National Standard.

Table B-1. Key Questions Related to the 20 Elements of ISO 9001:1994[a]

4.1 Management Responsibility: Who is responsible for product or service quality and supplier quality system effectiveness?	4.2 Quality System: Does the supplier's quality system support that it will deliver what it says, and clarify how it does what it says?
4.3 Contract Review: Does the supplier's quality system ensure that the customer will receive what the marketing and sales sold to the customer?	4.4 Design Control: Does the design of the product ensure that it does what the supplier says and clarify how changes are controlled?
4.5 Document and Data Control: Are key documents controlled in the supplier's quality system throughout design, manufacturing, and service?	4.6 Purchasing: Does the supplier's quality system make sure that bought parts/services are those specified and that its suppliers are reliable?
4.7 Control of Customer-Supplied Product: How does the supplier protect, store, maintain, and fix, if necessary, materials provided by the customer?	4.8 Product Identification and Traceability: How does the supplier ensure that the customer's parts do not get mixed up with the supplier's parts and that the parts are as specified and correct for the customer's project?
4.9 Process Control: What procedures does the supplier have in place to build the customer's product properly?	4.10 Inspection and Testing: How does the supplier ensure that the customer gets what it ordered and that it works as the supplier promised?
4.11 Control of Inspection, Measuring, and Test Equipment: How does the supplier verify that test equipment is accurate?	4.12 Inspection and Test Status: How does the customer know that the product was tested?
4.13 Control of Nonconforming Product: Does the supplier have a procedure for fixing or disposing of products that do not work or fit as required?	4.14 Corrective and Preventive Action: If a problem occurs, how does the supplier ensure that it does not happen again?
4.15 Handling, Storage, Packaging, Preservation, and Delivery: How does the supplier ensure that the customer's product was built correctly and that it will be protected from damage during storage and delivery?	4.16 Control of Quality Records: How are the quality of the customer's product and its input materials documented?
4.17 Internal Quality Audits: How does the supplier check on the effectiveness and correctness of its quality system?	4.18 Training: How does the supplier know that its people who built and tested the customer's product are qualified?
4.19 Servicing: If the supplier told the customer that it provides service for the customer's product, how will the supplier do that, and how will it make sure that servicing personnel are qualified?	4.20 Statistical Techniques: If the supplier is using statistical techniques to ensure the quality of the customer's product, how will the supplier ensure that the techniques are used correctly and that the results are within limits?

[a] John Rabbit and Peter Bergh, *The ISO 9000 Book, A Global Competitor's Guide to Compliance & Certification*, Quality Resources, 1993.

Table B-2. Cross-Reference of ISO 9000 Standards and ANSI/ASQC Equivalents

ISO 9000 series	Title	ANSI/ASQC designation
ISO 9000:1994	*Quality Systems—Management and Quality Assurance Standards: Guidelines for Selection and Use*	ANSI/ISO/ASQC Q9001:1994
ISO 9001:1994	*Quality Systems—Model for Quality Assurance in Design/Development, Production, Installation and Servicing*	ANSI/ISO/ASQC Q9001:1994
ISO 9002:1994	*Quality Systems—Model for Quality Assurance in Production and Installation*	ANSI/ISO/ASQC Q9002:1994
ISO 9003:1994	*Quality Systems—Model for Quality Assurance in Final Inspection and Test*	ANSI/ISO/ASQC Q9003:1994
ISO 9004:1994	*Quality Management and Quality System Elements—Guidelines*	ANSI/ISO/ASQC Q9004:1994

Table B-3. Comparison of Aviation Quality Standards, Military Specifications, and FAA Regulations with ISO 9001:1994

Q (ISO) 9001 (1994)	MIL-Q-9858A (❶) MIL-I-45208A (❷)	CASE (❸) ASA 100 (❹) FAA AC 00-56 (❺)	FAR Part 145 (❻) w/FAR Part 43 (❼) w/FAR Part 21 (❽)
4.1 Management Responsibility			
4.1.1 Quality Policy		❸	
4.1.2 Organization	❶		❻, ❽
4.1.3 Management Review	❶		
4.2 Quality System			
4.2.1 General	❶	❸, ❹	❻, ❽
4.2.2 Quality-System Procedures	❶		❻, ❽
4.2.3 Quality Planning	❶	❺	❻, ❽
4.3 Contract Review			
4.3.1 General	❶		
4.3.2 Review			
4.3.3 Amendment to Contract			
4.3.4 Records			

Table B-4. Comparison of Aviation Quality Standards, Military Specifications, and FAA Regulations with ISO 9001:1994 (Continued)

Q (ISO) 9001 (1994)	MIL-Q-9858 (❶) MIL-I-45208A (❷)	CASE (❸) ASA 100 (❹) FAA AC 00-56 (❺)	FAR Part 145 (❻) w/FAR Part 43 (❼) w/FAR Part 21 (❽)
4.4 Design Control			
4.4.1 General	❶		❽
4.4.2 Design and Development Planning			❽
4.4.3 Organizational and Technical Interfaces			❽
4.4.4 Design Input			❽
4.4.5 Design Output			❽
4.4.6 Design Review			
4.4.7 Design Verification			❽
4.4.8 Design Validation			❻, ❽
4.4.9 Design Changes	❶		❽
4.5 Document and Data Control			
4.5.1 General	❶, ❷	❸, ❹, ❺	❽
4.5.2 Document and Data Approval and Issue			❽
4.5.3 Document and Data Changes			
4.6 Purchasing			
4.6.1 General	❶	❸, ❹	❽
4.6.2 Evaluation of Subcontractors	❶	❸	
4.6.3 Purchasing Data	❶	❸	❽
4.6.4 Verification of Purchased Product		❸	❽
4.7 Control of Customer-Supplied Product	❶, ❷		
4.8 Product Identification and Traceability		❸, ❹, ❺	❽
4.9 Process Control	❶, ❷	❸	❻, ❼, ❽
4.10 Inspection and Testing			
4.10.1 General	❶, ❷	❸, ❹, ❺	❻, ❼, ❽
4.10.2 Receiving Inspection and Testing	❶, ❷	❹	❽
4.10.3 In-process Inspection and Testing	❶		❻, ❽

Table B-4. Comparison of Aviation Quality Standards, Military Specifications, and FAA Regulations with ISO 9001:1994 (Continued)

Q (ISO) 9001 (1994)	MIL-Q-9858 (❶) MIL-I-45208A (❷)	CASE (❸) ASA 100 (❹) FAA AC 00-56 (❺)	FAR Part 145 (❻) w/FAR Part 43 (❼) w/FAR Part 21 (❽)
4.10.4 Final Inspection and Testing	❶	❸	❻, ❼, ❽
4.10.5 Inspection and Test Records	❶, ❷		❻, ❼, ❽
4.11 Control of Inspection, Measuring, and Test Equipment			
4.11.1 General	❶, ❷	❸, ❹	❻
4.11.2 Control Procedure	❶, ❷	❺	
4.12 Inspection and Test Status	❶, ❷		❻, ❼, ❽
4.13 Control of Nonconforming Product			
4.13.1 General	❶, ❷	❹	❻, ❽
4.13.2 Review and Disposition of Nonconforming Product	❶, ❷	❸, ❹, ❺	❻, ❽
4.14 Corrective and Preventive Action			
4.14.1 General			
4.14.2 Corrective Action	❶, ❷		
4.14.3 Preventive Action			
4.15 Handling, Storage, Packaging, Preservation, and Delivery			
4.15.1 General	❶		❻
4.15.2 Handling	❶	❹	❻, ❽
4.15.3 Storage		❸, ❹, ❺	❻, ❽
4.15.4 Packaging		❸, ❹, ❺	❻
4.15.5 Preservation			❻, ❽
4.15.6 Delivery		❸, ❹	
4.16 Control of Quality Records	❶, ❷	❸, ❹	❻, ❽
4.17 Internal Quality Audits	❷	❸, ❺	
4.18 Training		❸, ❹, ❺	❻, ❼
4.19 Servicing		❸	❻, ❽
4.20 Statistical Techniques	❶		
4.20.1 Identification of Need			❽
4.20.2 Procedures	❷		

Table B-5. Additions Made by AS9000 (1997) to ISO 9001:1994

To ISO 9001 requirement	AS9000 adds a requirement for
4.1.2 Organization	4.1.2.4 Documentation for quality assurance activities
4.2.2 Quality-System Procedures	4.2.2.c. Availability of quality system procedures
4.2.3 Quality Planning	4.2.3.b.(1) Design, manufacture, special tooling
4.2.3 Quality Planning	4.2.3.f.(1) Added verification points
4.2.3 Quality Planning	4.2.3.(I) Subcontractor identification and selection
4.2.3 Quality Planning	4.2.3.(j) Process controls and control plans
4.4.9 Design Changes	4.4.9.1 Customer/agency approval
4.5.3 Document and Data Changes	4.5.3.1 Change management
4.6.2 Evaluation of Subcontractors	4.6.2.d. Use customer-approved special process sources
4.6.4 Verification of Purchased Product	4.6.4.3 Right of entry
4.6.4 Verification of Purchased Product	4.6.4.4 Delegations
4.6.4 Verification of Purchased Product	4.6.5 Quality system flowdown
4.9 Process Control	4.9.d.(1) Key characteristics
4.9 Process Control	4.9.h Accountability of controlled conditions
4.9 Process Control	4.9.i Authorized controlled conditions
4.9 Process Control	4.9.j Prevention, detection, and removal of foreign objects
4.9 Process Control	4.9.l Customer approval for special processes
4.9 Process Control	4.9.2 Production tooling
4.10 General Inspection and Testing	4.10.1.1 Control of subcontracted activity
4.10.2 Receiving Inspection and Testing	4.10.2.4 Document certification test reports
4.10.5 Inspection and Test Records	4.10.5.1 First production article process
4.11.1 General Control of Inspection, Measuring, and Test Equipment	4.11.1.1 Tooling and personally owned acceptance equipment
4.11.2 Control Procedure	4.11.2.c.(1) Recall of inspection equipment
4.12 Inspection and Test Status	4.12.1 Controls for acceptance media
4.13.2 Review and Disposition of Nonconforming Product	4.13.2.1 Use of "use-as-is" and "repair" dispositions
4.13.2 Review and Disposition of Nonconforming Product	4.13.2.2 "Regrade" includes change in product's identification
4.13.2 Review and Disposition of Nonconforming Product	4.13.2.3 Marking and disposition of scrap
4.13.2 Review and Disposition of Nonconforming Product	4.13.2.4 Timely reporting of nonconformances
4.16 Control of Quality Records	4.16.1 Records available for review
4.19 Servicing	4.19.1 Service management system
4.20.2 Procedures for Statistical Techniques	4.20.3 Valid sampling inspection system

Appendix C
Best Practices for Aviation Contract Maintenance Management

INTRODUCTION

During our interviews for this report, we identified organizations with innovative management approaches for contract maintenance management. Several of those organizations are highlighted in this appendix. Inclusion of organizations in this list of best practices does not mean they are necessarily unique in their particular innovation; our survey was never intended to be an exhaustive examination of every management organization in DoD, let alone commercial aviation. Instead, this is a list of good ideas that might serve as a starting point for some other organization seeking to make improvements in similar areas for their respective activities.

BEST PRACTICES

Aging aircraft: The Air Force Corrosion Office

Corrosion and structural fatigue cracking are the two most serious issues facing DoD's aging aircraft fleet and directly affect the quality of the fleet for long-term operation. The commercial airlines have similar aging aircraft problems, which led to a major aging aircraft program after a partial structural disintegration of an aircraft in Hawaii in 1988. The Air Force has several special project offices focused on specific aspects of aircraft maintenance and supportability.

In particular, the Air Force Corrosion Office, located at the Warner Robins Air Logistics Center near Macon, GA, is charged with assessing the services' overall equipment condition for environmental deterioration, as well as the technical experience and ability of the work force to respond appropriately to the equipment condition. Over the years, the office has become the ultimate Air Force source of technical expertise on corrosion control for both military and contract maintenance activities and has been instrumental in making changes to maintenance programs and technician training to maximize equipment life. In an era when the maintenance work force is being reduced with the drawdown in force structure, program offices can be a vital reservoir of technical competence and expertise for service maintenance programs.

Aviation safety focus: The DCMC and Fort Campbell Directorate of Logistics (DOL)

The DCMC has established the Aircraft Program Management Office as a special entity to deal with commercial aircraft contract management in the Southern United States. The office is a new approach toward consistent oversight through a central contract administration activity and serves as a clearinghouse for technical expertise for the many aircraft contract maintenance locations in its jurisdiction. The office's emphasis on safety has yielded a steady decline in aircraft incidents at contract facilities.

Along the same lines, the Army Aircraft Logistics Management Division, Director of Logistics, Fort Campbell, KY, has established a Situation Analysis Team to coordinate its various safety efforts, including a contractor-established safety cell for safety surveys and resolution of hazardous situations in its special operations mission. Fort Campbell's safety record reflects its emphasis on safety: in 1996, it had zero accidents and no lost work days for a fleet of helicopters approaching 400 aircraft.

Contract structure: Aircraft Logistics Management Division, DOL, Fort Rucker, AL, and Naval Air Systems Command.

The Army operates its entire aviation training activity at Fort Rucker with a system of competitively awarded contracts, including maintenance. The scope of the operation is massive, with multiple aircraft types, numerous airfields, and more than 550 aircraft making up the Fort Rucker complex. The maintenance contract is largely self-contained, with the contractor operating an extensive (military-oriented) intermediate maintenance capability, as well as depot repair for items that are not repaired in the Army's normal depot repair system. One training helicopter type, a version of the Bell Jet Ranger, is maintained as an FAA-certified aircraft including FAA oversight.

The maintenance contract structure, which is managed by a single program office under the DOL, includes cost-plus-multiple incentive/fee provisions to incentivize the contractor with regard to cost control, aircraft availability, and supply support. The Fort Rucker operation was the largest and most diverse unit-level maintenance operation we visited, with the most sophisticated and effective contract provisions.

The Navy COTS program office exercises a combination of positive and negative incentives tied to objectively derived outcomes for which the contractor is entirely responsible. These incentives (or penalties) can address materiel support, quality, and schedule performance, including flying hour production and equipment readiness. The increasing use of these incentives was made possible by utilizing performance-oriented specifications, accepting commercial practices, partnering with suppliers/contractors, and holding contractors accountable for the effective use of

their management and production systems. In the realm of system-level contracting, these performance incentives appear to be at the leading edge of the processes used in DoD contract maintenance management.

The Navy maintains its COTS fleet to commercial airworthiness standards but without FAA certification. The lack of certification reflects the way the aircraft are supported on the flightline with Navy personnel. However, the aircraft are maintained by FAA-certified repair stations for major airframe inspections and all engine and component repair. Advantages to the service include the application of commercial airworthiness standards; incorporation of the latest service bulletins for safety, as well as reliability, maintainability, and supportability; and the eventual bonus of enhanced resale value on the commercial surplus market.

The program office has a select list of lessons learned for commercial support:[1]

- Acquisition reforms are beneficial—overcome team/customer resistance to change.
- Involve type commanders and headquarters early and often—education customers/team.
- Understand both U.S. Navy requirements/operations and commercial market practices.
- Get lift off commercial operators, OEMs, and suppliers.
- More commercial practices = less $.
- Competition is essential to control costs—package requirements for maximum competition.
- Be careful what you buy and how you pay—use draft solicitations and market research.

Contractor assessment and partnering: Naval Air Systems Command

Two of the program management offices in the Naval Air Systems Command indicated they had particularly strong methods for bridging the gaps between their own organizations, the operating commands, and the contractors for maintenance support. One described a systematic process for assessing contractor performance by obtaining feedback from the operating unit, including both good and bad information. This customer-oriented perspective was in marked contrast to management activities that indicated they were responsive to customer inputs, but basically awaited the receipt of "bad news" before acting. The second program office engages in a dialog with its contractors, somewhat akin to the way

[1] Naval Air Systems Command briefing, *Outsourcing—COTS Aircraft Experiences,* Robert A. Kuzmick, 5 March 1997.

commercial airlines structure contracts, to verbalize desired contractor behavior and
obtain the contractor's commitment to provide an expected level of performance. The program office described this process as a form of partnering because this "meeting of the minds" solidifies the relationships and expected outcomes between the management activity and its commercial source of repair.

Cooperative oversight: Coordinating Agency for Supplier Evaluation (CASE)

The commercial airlines have been authorized by the Federal Aviation Administration to cooperatively share their oversight of contract sources. While the airlines prefer to maintain their own on-site oversight of their airframe repair contracts, they typically visit their component repair contracts on a periodic basis. It is these periodic visits that are shared via the voluntary CASE organization.

CASE has a set of audit standards as well as auditor training guidelines to ensure standardization of the site visits. The advantages to the airlines include the reduced need to perform repetitive audits, especially for contract vendors who are operating without significant production discrepancies. The advantages to the vendor include a significantly reduced number of audits, which might otherwise be looking at the same production process for multiple customers.

The Air Force Air Mobility Command has also joined CASE, and performs audits of the air carriers that provide charter flights to the military. These audits are conducted in exchange for access to the approved vendor database from audits conducted by the commercial airlines. CASE audits only cover a portion of the areas addressed in ISO 9000 but have proven successful as the aviation industry applies the concept. The FAA is considering whether to request a more extensive set of audit requirements for CASE; eventually, the audit requirements may resemble the basic criteria in ISO 9000.

Focused maintenance contract management: Headquarters, Air Education and Training Command (HQ AETC)

The Air Force's HQ AETC is the operating command for the Air Force pilot training wings, each of which can have up to 200 operating aircraft. The wings have been subjected to public/private competition for aircraft maintenance under OMB Circular A-76 beginning in the early 1960s. Three of the wings were subsequently closed by BRAC. Today's wing structure includes two that are maintained by DoD civilian personnel and three by contract.

HQ AETC established a significant centralized management structure at its headquarters devoted to the full range of acquisition and maintenance management issues, serving to standardize the contract management at the wings and to facilitate training for the oversight personnel. The result is a structure that is largely self-contained in terms of contract management and able to cope with the continual

decline in available expertise for contract oversight functions as the former military personnel from the contracted bases are absorbed into other fields of endeavor. Several other commands have established centralized contact management offices as well; the HQ AETC office was particularly noteworthy during our interviews because of the number of large contract management operations they oversaw.

"Power by the Hour" leasing: U.S. Coast Guard

The U.S. Coast Guard pioneered the equipment leasing concept loosely known as "Power by the Hour" to overcome serious reliability shortfalls in one of its aircraft engines. The concept entails the provision of spare engines and repair services at a fixed rate per operating hour. The rate is structured to incentivize the OEM to incorporate continuous reliability improvements in the engine as a way of earning increased profit from the fixed fee. The concept is successful; the Coast Guard is operating significantly more reliable engines than when it began the arrangement. The idea is now being incorporated into commercial airline maintenance concepts for auxiliary power units and aircraft engines.

Shared inventories: Commercial Partnering, International Aircraft Technical Pool (IATP)

The commercial airlines have begun to share expensive spares inventories as a way to avoid substantial investment in spares for new aircraft. Several of the "launch customers" for the Boeing 777 aircraft have established a single parts pool on a worldwide basis. Since components of that aircraft can cost in the millions of dollars, the savings from the pooling arrangement are substantial. At the same time, the airlines also operate an IATP, which is designed to loan serviceable spares to other airlines in a short-term, fee-based arrangement. The pool is particularly useful at international gateways because it allows carriers to serve "long, thin" routes with infrequent flight schedules without the necessity for full spares support at each line location. The OEMs have also begun to enter the serviceable spares market, supported by their own repair stations and parts pools.

Appendix D
Glossary

See *Transportation Expressions*, and *Transportation Acronym Guide*, Bureau of Transportation Statistics, U.S. Department of Transportation.

AMT	aviation maintenance technician, the proposed replacement term for airframe and powerplant mechanics
ANSI	American National Standards Institute
ANSI/ASQC Q9001	ISO 9001 published in the United States
AS9000	ANSI/ASQC Aerospace Basic Quality System Standard, adaptation of ISO 9001
ASQC	American Society of Quality
BTS	DOT Bureau of Transportation Statistics
CAS	contract administration services
CASE	Coordinating Agency for Supplier Evaluation
CFT	contractor field team
CLS	contractor logistics support
COTS	commercial off-the-shelf
D1-9000	Boeing adaptation of ISO 9000
DAU	Defense Acquisition University
DCMC	Defense Contract Management Command
DLA	Defense Logistics Agency
DOL	Directorate of Logistics
DOT	US Department of Transportation
FAA	Federal Aviation Administration
FAR	(DoD) Federal Acquisition Regulations (FAA) Federal Aviation Regulations
GAO	General Accounting Office
GAIN	Global Analysis and Information Network
HQ AETC	Headquarters, Air Education and Training Command
IATP	International Aircraft Technical Pool

ICP	Inventory control point
ICS	Interim contractor support
ISO 9000	International Organization for Standardization, Document Number 9000, *Quality Management and Quality Assurance Standards: Guidelines for Selection and Use.* (See Appendix B for all variants)
MRO	maintenance, repair, and overhaul
NTSB	National Transportation Safety Board
OEM	original equipment manufacturer
QA	Quality assurance
QC	Quality control
QS-9000	automotive industry adaptation of ISO 9000
SPI	single process initiative

TERMS	
Contract maintenance management	Encompasses the full range of activities that are required to generate and execute aircraft maintenance contracts, including requiring/engineering activities, contracting organizations, oversight activities, and supporting organizations
Defense Contract Audit Agency	The auditing arm of the DoD Comptroller
Defense Contract Management Command	The single Defense organization charged with overseeing system-level contracts at contractor facilities
Defense Finance and Accounting Service	The central paying activity for Defense contracts
Inventory control points	The classic organizations charged with the logistics management of in-service systems, including acquisition of contract maintenance support
Program offices	The organizations charged with managing the acquisition and lifetime support of major aircraft types
System-level contracting	Contracting for depot maintenance, contractor logistics support, interim contractor support, and contractor field teams; issued by inventory control points and program offices
Unit-level contracting	All types of base maintenance contracts issued by operating commands and units

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The Logistics Management Institute was tasked to survey the commercial and Defense processes for contract maintenance management. The study focused on two primary areas. The first addresses expanded use of contract maintenance. We found aircraft contract maintenance has proven itself to be a reliable production source within DoD and capable of expanding to accommodate further outsourcing. However, DoD needs to issue guidance to support the increasing use of contracting contemplated in Defense acquisition policy. The second area of study addresses the use of commercial practices. Rescinded military specifications and standards are being replaced by a proliferation of alternative commercial practices. Contract management activities are working to adopt single commercial practices on a site-by-site basis but would benefit from DoD-wide designation of preferred commercial standards. DoD's use of commercial sources would benefit from improved cross-service coordination of market research efforts and sharing of lessons learned. Further changes to acquisition rules may be needed to accept external (third party) certifications and audits of commercial sources of repair.

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