

**GAO**

Report to the Chairman, Subcommittee  
on Transportation, Committee on  
Appropriations, House of  
Representatives

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March 1997

# AIR TRAFFIC CONTROL

## Immature Software Acquisition Processes Increase FAA System Acquisition Risks



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United States  
General Accounting Office  
Washington, D.C. 20548

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**Accounting and Information  
Management Division**

B-271531

March 21, 1997

The Honorable Frank R. Wolf  
Chairman, Subcommittee on  
Transportation  
Committee on Appropriations  
House of Representatives

Dear Mr. Chairman:

This report responds to your request that we review the Federal Aviation Administration's (FAA) air traffic control modernization software acquisition maturity and improvement activities. FAA plans to spend billions of dollars replacing its existing air traffic control systems, but has a history of performing poorly when acquiring these software-intensive systems. We found that FAA's software acquisition processes are immature, and are making recommendations to the Secretary of Transportation for strengthening them.

We are sending copies of this report to the Secretary of Transportation, the Director of the Office of Management and Budget, the Administrator of the Federal Aviation Administration, and other congressional committees. We will also make copies available to other interested parties upon request. If you have questions or wish to discuss the issues in this report, please contact me at (202) 512-6412. Major contributors to this report are listed in appendix II.

Sincerely yours,

A handwritten signature in black ink that reads 'Rona B. Stillman'.

Dr. Rona B. Stillman  
Chief Scientist for Computers  
and Telecommunications

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# Executive Summary

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## Purpose

The Federal Aviation Administration (FAA) is modernizing the air traffic control (ATC) systems upon which it will rely to ensure safe, orderly, and efficient air travel well into the 21st century. Since software is the most expensive and complex component of these systems, FAA must use defined and disciplined processes when it acquires software.

Recognizing software's growing importance and prevalence in ATC systems, the Chairman, Subcommittee on Transportation and Related Agencies, House Committee on Appropriations, asked GAO to determine (1) the maturity of FAA's ATC modernization software acquisition processes, and (2) the steps/actions FAA has underway or planned to improve these processes, including any obstacles that may impede FAA's progress.

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## Background

To accommodate forecasted growth in air traffic and replace aging equipment, FAA embarked on an ambitious ATC modernization program in 1981. FAA estimates that it will spend about \$20 billion to replace and modernize software-intensive ATC systems between 1982 and 2003. Our work over the years has chronicled many FAA failures in meeting ATC projects' cost, schedule, and performance goals, largely because of software-related problems. As a result of these failures as well as the tremendous cost, complexity, and mission criticality of FAA's ATC modernization program, we designated the program as a high-risk information technology initiative in our 1995 and 1997 report series on high-risk programs.<sup>1</sup>

Software quality is governed largely by the quality of the processes involved in developing or acquiring, and maintaining it. Carnegie Mellon University's Software Engineering Institute (SEI), recognized for its expertise in software processes, has developed models and methods that define and determine organizations' software process maturity. Together, they provide a logical framework for baselining an organization's current process capabilities (i.e., strengths and weaknesses) and providing a structured plan for incremental process improvement.

Using SEI's software acquisition capability maturity model (SA-CMM),<sup>2</sup> SEI's software capability evaluation method, and SA-CMM authors as consultants,

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<sup>1</sup>High-Risk Series: An Overview (GAO/HR-95-1, Feb. 1995); High-Risk Series: Information Management and Technology (GAO/HR-97-9, Feb. 1997).

<sup>2</sup>We used a draft version of the model for our evaluation (version 00.03, dated April 1996). The first published version of the model was released on October 1996, after we performed our evaluation. According to the model's authors, the published version differed only editorially from the draft we used.

GAO staff trained at SEI evaluated FAA's ATC modernization software acquisition maturity in the seven key process areas (KPA) necessary to attain a "repeatable" level of process capability, and one KPA associated with the "defined" level of process maturity.<sup>3</sup> Repeatability ensures that an organization has the necessary process discipline in place to repeat earlier successes on projects in similar domains. Repeatable processes are at the second level on SEI's five-level scale of process maturity. Organizations that do not satisfy the requirements for the "repeatable" level are by default judged to be at the "initial" level of maturity, meaning that their processes are ad hoc, sometimes even chaotic, with few of the processes defined and success dependent mainly on the heroic efforts of individuals. The one KPA associated with the third level of process maturity, which is called the "defined" level, is acquisition risk management. It was included because many software experts consider it to be a very important process area.

As part of its evaluation, GAO examined five ongoing ATC modernization projects selected by FAA.<sup>4</sup> These were the Automated Radar Terminal System, Display System Replacement, National Airspace System Infrastructure Management System, Voice Switching and Control System, and the Weather and Radar Processor. (See chapter 1 of this report for more detailed information on GAO's evaluation scope and methodology.)

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## Results in Brief

Because of the number and severity of FAA ATC modernization software acquisition process weaknesses, FAA did not fully satisfy any of the seven KPAs necessary to achieve the "repeatable" level of process maturity. As a result, its processes for acquiring software, the most costly and complex component of ATC systems, are ad hoc, sometimes chaotic, and not repeatable across projects. In addition, serious process weaknesses prevented FAA from satisfying the one KPA specified under SEI's "defined" maturity level. While FAA showed process strengths, primarily in the solicitation and evaluation (i.e., testing) KPAs,<sup>5</sup> GAO found extensive weaknesses in these and the remaining six KPAs (i.e., software acquisition

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<sup>3</sup>The seven KPAs relating to the repeatable level are software acquisition planning, solicitation, requirements development and management, project office management, contract tracking and oversight, evaluation, and transition and support.

<sup>4</sup>GAO asked FAA to choose five projects that are: (1) major efforts with large software acquisition components, (2) managed by different FAA product teams, (3) at different life cycle stages, and (4) among FAA's best managed.

<sup>5</sup>According to the SA-CMM, solicitation is the process of ensuring that award is made to the contractor most capable of satisfying the specified requirements, and evaluation is the process of determining that acquired software products and services satisfy contract requirements prior to acceptance.

planning, requirements development and management, project office management, contract tracking and oversight, transition and support, and acquisition risk management).<sup>6</sup> Some of these weaknesses were systemic, recurring in each of the KPAs. For example, no software project teams measured or reported to management on the status of activities performed, and management never verified that critical activities were being done. These types of problems are some of the reasons for FAA's frequent failures to deliver promised ATC system capabilities on time and within budget.

FAA has stated its commitment to increasing ATC modernization process maturity. However, despite 4 years of activity in this area, FAA lacks an effective management approach for improving software acquisition processes. Currently, the Software Engineering Process Group (SEPG) is responsible for process improvement; but the SEPG has neither organizational nor budgetary authority over the product teams that acquire software, and, therefore, cannot effectively implement or enforce process change. Instead, it can only recommend and encourage change. Additionally, FAA does not have an effective plan to correctly target and prioritize improvements and measure improvement progress. In the absence of this plan, it has initiated a "hodge podge" of software acquisition improvement efforts without any analytical justification. As a result, FAA's process improvement activities have yet to produce more repeatable, better defined, more disciplined software acquisition processes.

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## Principal Findings

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### ATC Modernization Software Acquisition Processes Are Immature

To attain a given SEI-defined maturity level, an organization must satisfy the key practices for the KPAs associated with that level. FAA's ATC modernization organization had too many weaknesses to satisfy any of the "repeatable" KPAs (i.e., software acquisition planning, solicitation, requirements development and management, project office management,

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<sup>6</sup>According to the SA-CMM, software acquisition planning is the process for ensuring that reasonable planning for all elements of the software acquisition occur; requirements development and management is the process for establishing an unambiguous and agreed upon set of software requirements; project office management is the process for effective and efficient management of project office activities; contract tracking and oversight is the process of ensuring that contractor activities, products, and services satisfy contract requirements; transition and support is the process of transferring acquired software products to the eventual support organization; and acquisition risk management is the process of identifying software risks early and adjusting the acquisition strategy to mitigate those risks.

contract tracking and oversight, evaluation, and transition and support), nor does it satisfy the acquisition risk management KPA from the “defined” or third maturity level.

For FAA to satisfy any of these eight KPAs, it must eliminate the key practice weaknesses identified in this report.<sup>7</sup> Each practice that is performed effectively constitutes a strength, and each practice not performed or performed poorly constitutes a weakness. While FAA’s ATC modernization has some strengths, it has more weaknesses. Table 1 tallies these strengths on the five projects that GAO evaluated. In summary, of the total number of KPA practices rated, 38 percent constituted strengths, 50 percent were weaknesses, and 12 percent were observations. An observation indicates that the evidence was inconclusive and did not clearly support a determination of either strength or weakness.

**Table 1: Collective Number of KPA Strengths, Weaknesses, and Observations on the Five Projects**

Key Process Area	Number of strengths	Number of weaknesses	Number of observations
Software acquisition planning	16	37	7
Solicitation	36	28	14
Requirements development and management	17	35	6
Project office management	26	35	6
Contract tracking and oversight	26	32	6
Evaluation	43	21	8
Transition and support	27	32	8
Acquisition risk management	16	46	7
<b>Totals</b>	<b>207</b>	<b>266</b>	<b>62</b>

Additionally, GAO found that while the five projects varied as to practice strengths, weaknesses, and observations under three of the five “common features” or practice groupings (commitment to perform, ability to perform, and activities performed), the projects were consistently weak in all practices under the remaining two groupings (measurement and analysis and verifying implementation). As a result, software project teams and FAA management consistently lack reliable information on project team performance.

<sup>7</sup>SEI groups each of its KPA practices into one of five “common features” or practice categories. These are “commitment to perform, ability to perform, activities performed, measurement and analysis, and verifying implementation.”

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## FAA's Approach for Improving ATC Modernization Software Acquisition Processes Is Not Effective

To be effective, the FAA organization responsible for software acquisition process improvement must have (1) organizational and/or budgetary authority over the ATC modernization units acquiring the software; and (2) an effective plan to guide improvement efforts and measure progress on each. The FAA organizational entity currently responsible for ATC modernization software acquisition process improvement, the SEPG, has neither. As a result, little progress has been made over the last 4 years in instituting definition and discipline into ATC modernization software acquisition processes.

The SEPG is a multilevel committee structure chaired by a member of FAA's Chief Information Officer's (CIO) staff. The SEPG is directed by the Software Engineering Executive Committee, which is chaired by the head of the ATC modernization program. The SEPG has no authority to implement and enforce process change. Consequently, it can only attempt to encourage and persuade software acquirers to establish and follow defined and disciplined software acquisition processes.

The SEPG and its predecessors have advocated and initiated a collection of efforts intended to strengthen ATC modernization software-related processes, including software acquisition processes. However, there is no analytical basis for the focus, content, timing, and interrelationships of these efforts. Specifically, the efforts (1) are not based on any assessment of current software acquisition process strengths and weaknesses; and (2) are not detailed in a formal plan that specifies measurable goals, objectives, milestones, and needed resources, prioritizes efforts, fixes responsibility and accountability, and defines metrics for measuring progress. Instead, these efforts were undertaken with no sound analytical basis and, rather than being part of a comprehensive plan, are discussed in general terms without detail and specificity in briefing documents, minutes of meetings, and working group recommendations. While the SEPG is now taking steps to establish the analytical basis needed to formulate a comprehensive software process improvement plan, that plan does not yet exist, and no schedule has been established for completing it.

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## Recommendations

Given the importance and the magnitude of information technology at FAA, GAO reiterates its earlier recommendation that a CIO management structure similar to the department-level CIOs as prescribed in the Clinger-Cohen Act of 1996 be established for FAA.<sup>8</sup>

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<sup>8</sup>Air Traffic Control: Complete and Enforced Architecture Needed for FAA Systems Modernization (GAO/AIMD-97-30, February 3, 1997).



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To improve FAA's software acquisition capability for its ATC modernization, GAO recommends that the Secretary of Transportation direct the FAA Administrator to:

- assign responsibility for software acquisition process improvement to FAA's CIO;
- provide FAA's CIO with the authority needed to implement and enforce ATC modernization software acquisition process improvement;
- require the CIO to develop and implement a formal plan for ATC modernization software acquisition process improvement that is based on the software capability evaluation results contained in this report and specifies measurable goals and time frames, prioritizes initiatives, estimates resource requirements, and assigns roles and responsibilities;
- allocate adequate resources to ensure that planned initiatives are implemented and enforced; and
- require that, before being approved, every ATC modernization acquisition project have software acquisition processes that satisfy at least SA-CMM level 2 requirements.

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## Agency Comments and GAO's Evaluation

In its written comments on a draft of this report, the Department of Transportation recognized the importance of mature software acquisition processes, agreed that FAA's processes are insufficiently mature, acknowledged that FAA process improvement activities have yet to produce greater software acquisition process discipline, and reaffirmed FAA's commitment to improving its software acquisition capabilities using the SA-CMM. However, the Department did not state what, if any, specific action it would take on GAO's recommendations. Additionally, it took the positions that (1) the SA-CMM by itself is inadequate to evaluate ATC system acquisition capabilities, is too new to use as an authoritative source of guidance, and "may" have been misapplied by GAO, (2) the report does not sufficiently recognize FAA's process improvement organization and progress nor the difficulties and time required to affect process improvement change, (3) the SEPG, which is FAA's designated agent for software acquisition process change, is organized as the Department "understands" other SEPGs to be organized, and (4) the report "leads the reader to erroneously conclude that the five programs reviewed are in trouble" relative to attainment of cost and schedule goals.

None of these positions are valid. First, the SA-CMM, like the SW-CMM (another SEI software-specific capability maturity model), focuses on software because it is widely recognized as the most difficult and costly

component of modern computer systems; the one most frequently associated with late deliveries, cost overruns, and performance shortfalls; and the one in greatest need of special management attention. Further, while the SA-CMM is relatively new, the processes it requires are well established, experience-based tenets of effective software acquisition that are widely supported throughout industry and government. Moreover, GAO applied the SA-CMM at FAA properly and with extraordinary diligence: Every member of the evaluation team was trained at SEI; the team leader was certified by SEI as a lead evaluator; and three SEI professionals, including two authors of the SA-CMM, participated in the evaluation and concurred with every practice determination (e.g., strength, weakness).

Second, FAA's many software acquisition process improvement activities were undertaken without assessing current software acquisition process strengths and weaknesses, and were not part of a comprehensive plan for process improvement. Therefore, FAA had no analytical basis for deciding what improvement activities to initiate, or what priorities to assign them. Further, although FAA began drafting a plan during the course of GAO's evaluation, it has no schedule for completing it. In describing FAA's progress to date in improving its processes, the report delineates a wide array of FAA process improvement activities, but distinguishes these activities from actual progress. In fact, after 4 years of activity, FAA could not point to a single case in which it had instituted a more disciplined software acquisition process. Since SEI published statistics show that the median time to improve from software development CMM level 1 to level 2 is 26 months, and from level 2 to level 3 is 17 months, it is entirely reasonable to expect FAA to be able to demonstrate some improvement in its processes after 4 years.

Third, the issue is not whether FAA's SEPG is organized as the Department "understands" other SEPGs to be organized, but whether the SEPG, or any FAA organizational entity responsible for implementing and enforcing software acquisition process change, has the authority needed to accomplish the task. Currently, no organizational entity in FAA has the requisite authority.

Last, the report addresses the maturity of FAA's software acquisition processes and concludes that these processes are ad hoc and undisciplined, reducing the probability that software-intense ATC modernization projects will consistently perform as intended and be delivered on schedule and within budget. The report does not address the overall status of the projects covered by GAO's review, and, therefore,

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provides no basis for drawing conclusions about the projects' overall cost or schedule performance.

The Department's comments and GAO's evaluation of them are presented in greater detail in chapter 11 of this report.

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**Abbreviations**

AAR	Office of Aviation Research
AAS	Advanced Automation System
ACT	William J. Hughes Technical Center
AIMD	Accounting and Information Management Division
AIT	Office of Information Technology
AND	Office of Communication, Navigation, and Surveillance Systems
ARA	Associate Administrator for Research and Acquisitions
ARINC	Aeronautical Radio Incorporated
ARTS	Automated Radar Terminal System
ASD	Office of System Architecture and Investment Analysis
ASU	Office of Acquisitions
ATC	air traffic control
ATCSCC	Air Traffic Control System Command Center
ATS	Associate Administrator for Air Traffic Services
AUA	Office of Air Traffic Systems Development
CIO	Chief Information Officer
CMM	Capability Maturity Model
COTS	commercial, off-the-shelf
DSR	Display System Replacement
FAA	Federal Aviation Administration
GAO	General Accounting Office
IPT	Integrated Product Team
ISSS	Initial Sector Suite System
KPA	key process area
NAS	National Airspace System
NDI	non-development item
NIMS	NAS Infrastructure Management System
SA-CMM	Software Acquisition Capability Maturity Model
SE-CMM	Systems Engineering Capability Maturity Model
SCE	Software Capability Evaluation
SEEC	Software Engineering Executive Committee
SEI	Software Engineering Institute
SEPG	Software Engineering Process Group
SW-CMM	Capability Maturity Model for Software
TRACON	Terminal Radar Approach Control
VSCS	Voice Switching and Control System
WARP	Weather and Radar Processor



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# Introduction

The Federal Aviation Administration's (FAA) primary mission is to ensure safe, orderly, and efficient air travel in the national airspace. FAA's ability to fulfill this mission depends on the adequacy and reliability of the nation's air traffic control (ATC) system, a vast network of computer hardware, software, and communications equipment.<sup>1</sup> The ATC system, however, is being strained by aging equipment, much of which is 1960's technology, and growing air traffic. This growth should continue as the number of passengers traveling on U.S. airlines is expected to increase by 38 percent between 1995 and 2003, from about 580 million to nearly 800 million.

To accommodate the forecasted growth in air traffic and to relieve the problems of the aging ATC system, FAA embarked on an ambitious ATC modernization program in 1981. FAA estimates that it will spend about \$20 billion to replace and modernize software-intensive ATC systems between 1982 and 2003. Our work over the years has chronicled many FAA failures in meeting ATC projects' cost, schedule, and performance goals.<sup>2</sup> As a result of these failures as well as the tremendous cost, complexity, and mission criticality of FAA's ATC modernization program, we designated the program as a high-risk information technology initiative in our 1995 and 1997 report series on high-risk programs.<sup>3</sup>

## Overview of ATC

Automated information processing and display, communication, navigation, surveillance, and weather resources permit air traffic controllers to view key information, such as aircraft location, aircraft flight plans, and prevailing weather conditions, and to communicate with pilots. These resources reside at, or are associated with, several ATC facilities—air traffic control towers, terminal radar approach control (TRACON) facilities, air route traffic control centers (en route centers), flight service stations, and the Air Traffic Control System Command Center (ATCSCC). These facilities' ATC functions are described below.

- Airport towers control aircraft on the ground and before landing and after take-off when they are within about 5 nautical miles of the airport, and up to 3,000 feet above the airport. Air traffic controllers rely on a combination

<sup>1</sup>The ATC system is a major component of the National Airspace System (NAS).

<sup>2</sup>Air Traffic Control: Status of FAA's Modernization Program (GAO/RCED-95-175FS, May 26, 1995); Air Traffic Control: Status of FAA's Modernization Program (GAO/RCED-94-167FS, Apr. 15, 1994); Air Traffic Control: Status of FAA's Modernization Program (GAO/RCED-93-121FS, Apr. 16, 1993).

<sup>3</sup>High-Risk Series: An Overview (GAO/HR-95-1, Feb. 1995); High-Risk Series: Information Management and Technology (GAO/HR-97-9, Feb. 1997).

of technology and visual surveillance to direct aircraft departures and approaches, maintain safe distances between aircraft, and communicate weather-related information, clearances, and other instructions to pilots and other personnel.

- Approximately 180 TRACONS sequence and separate aircraft as they approach and leave busy airports, beginning about 5 nautical miles and ending about 50 nautical miles from the airport, and generally up to 10,000 feet above the airport, where en route centers' control begins.
- Twenty en route centers control planes over the continental United States in transit and during approaches to some airports. Each en route center handles a different region of airspace, passing control from one to another as respective borders are reached until the aircraft reaches TRACON airspace. En route center controlled airspace usually extends above 18,000 feet for commercial aircraft. En route centers also handle lower altitudes when dealing directly with a tower, or when agreed upon with a TRACON.
- Two en route centers—Oakland and New York—also control aircraft over the ocean. Controlling aircraft over oceans is radically different from controlling aircraft over land because radar surveillance only extends 175 to 225 miles offshore. Beyond the radars' sight, controllers must rely on periodic radio communications through a third party—Aeronautical Radio Incorporated (ARINC), a private organization funded by the airlines and FAA to operate radio stations—to determine aircraft locations.
- About 90 flight service stations provide pre-flight and in-flight services, such as flight plan filing and weather report updates, primarily for general aviation aircraft.

See figure 1.1 for a visual summary of air traffic control over the continental United States and oceans.



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## The ATC Modernization Program Is Complex, Costly, and Historically Problematic

FAA faced two problems in continuing to fulfill its mission to ensure safe, orderly, and efficient air travel in the national airspace. First, the ATC system of the late 1970s was a blend of several generations of automated and manual equipment, much of it labor-intensive and obsolete. Second, air traffic was projected to increase dramatically as a result of airline deregulations of the late 1970s. FAA recognized that it could increase ATC operating efficiency by increasing automation. It also anticipated that meeting the demand safely and efficiently would require improved and expanded services, additional facilities and equipment, improved work force productivity, and the orderly replacement of aging equipment. Accordingly, in December 1981, FAA initiated its plan to modernize, automate, and consolidate its enormous ATC system infrastructure by the year 2000. In doing so, it chose to acquire new ATC systems by contracting for systems development services from vendors rather than building new ATC systems in-house.

This ambitious modernization program includes the acquisition of new surveillance, data processing, navigation, and communication equipment in addition to new facilities and support equipment. Totalling over 200 separate projects, the modernization is estimated to cost over \$34 billion through the year 2003. Software-intensive ATC systems make up a large portion of this total, accounting for 169 projects costing \$20.7 billion. The Congress will have provided FAA with approximately \$14.7 billion of the \$20.7 billion through fiscal year 1997. Many of these projects, for example the Display System Replacement and the Voice Switching and Control System, each involve the acquisition of over a million lines of code. Moreover, because the software must operate in a real-time environment in which human life is at stake, it must be fault tolerant, meaning that it must be able to monitor its own execution and recover from failures without losing any data.

Over the past 15 years, FAA's modernization projects have experienced substantial cost overruns, lengthy schedule delays, and significant performance shortfalls. To illustrate, the long-time centerpiece of this modernization program—the Advanced Automation System (AAS)—was restructured in 1994 after estimated costs tripled from \$2.5 billion to \$7.6 billion and delays in putting significantly less-than-promised system capabilities into operation were expected to run 8 years or more over original estimates. Similarly, increases in costs for three other ATC projects<sup>4</sup> have ranged from 51 to 511 percent, and schedule delays have averaged

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<sup>4</sup>The three projects and their respective percentage increase in unit costs are the Voice Switching and Control System (511 percent), the Integrated Terminal Weather System (129 percent), and the Aviation Weather Observing System (51 percent).

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almost 4 years. For example, the per-unit cost estimate for the Voice Switching and Control System increased 511 percent, and the first site implementation was delayed 6 years from the original estimate.

AAS and other ATC projects have also experienced shortfalls in performance. For example, the critical Initial Sector Suite System component of AAS, which was intended to replace controllers' workstations at en route centers, faced so many technical problems that its functionality was severely scaled back. In addition, difficulties in developing the Air Route Surveillance Radar-4 software and integrating it with other ATC systems delayed its implementation for years.

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## ATC Modernization Now Proceeding Under a New Acquisition Management System

Because of FAA's contention that many of its modernization problems were rooted in the Federal Acquisition System, the Congress enacted legislation in October 1995 that exempted FAA from most federal procurement and personnel laws and regulations and directed FAA to develop and implement a new acquisition system that would address the unique needs of the agency.<sup>5</sup> At a minimum, the system was to provide for more timely and cost-effective acquisitions. On April 1, 1996, in response to the Act, the FAA Administrator began implementation of a new acquisition management system.

The new system is intended to reduce the time and cost to field new products and services by introducing a new investment management system that spans the investments' entire life cycles, a new procurement system that provides flexibility in selecting and managing contractors, and organizational learning and cultural reform that supports the new investment management and procurement systems.

This high-level policy promulgated by the new acquisition management system is intended to be supplemented by guidelines in three areas: software/systems acquisition, facilities acquisition, and services acquisition. These guidelines will be available to FAA staff via the Internet and were scheduled to be online by October 1, 1996. As of February 1, 1997, these guidelines were still in draft form and not available to FAA staff.

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<sup>5</sup>Department of Transportation and Related Agencies Appropriations Act 1996, P.L. No. 104-50, sec. 348, 109 Stat. 436, 460 (1995).

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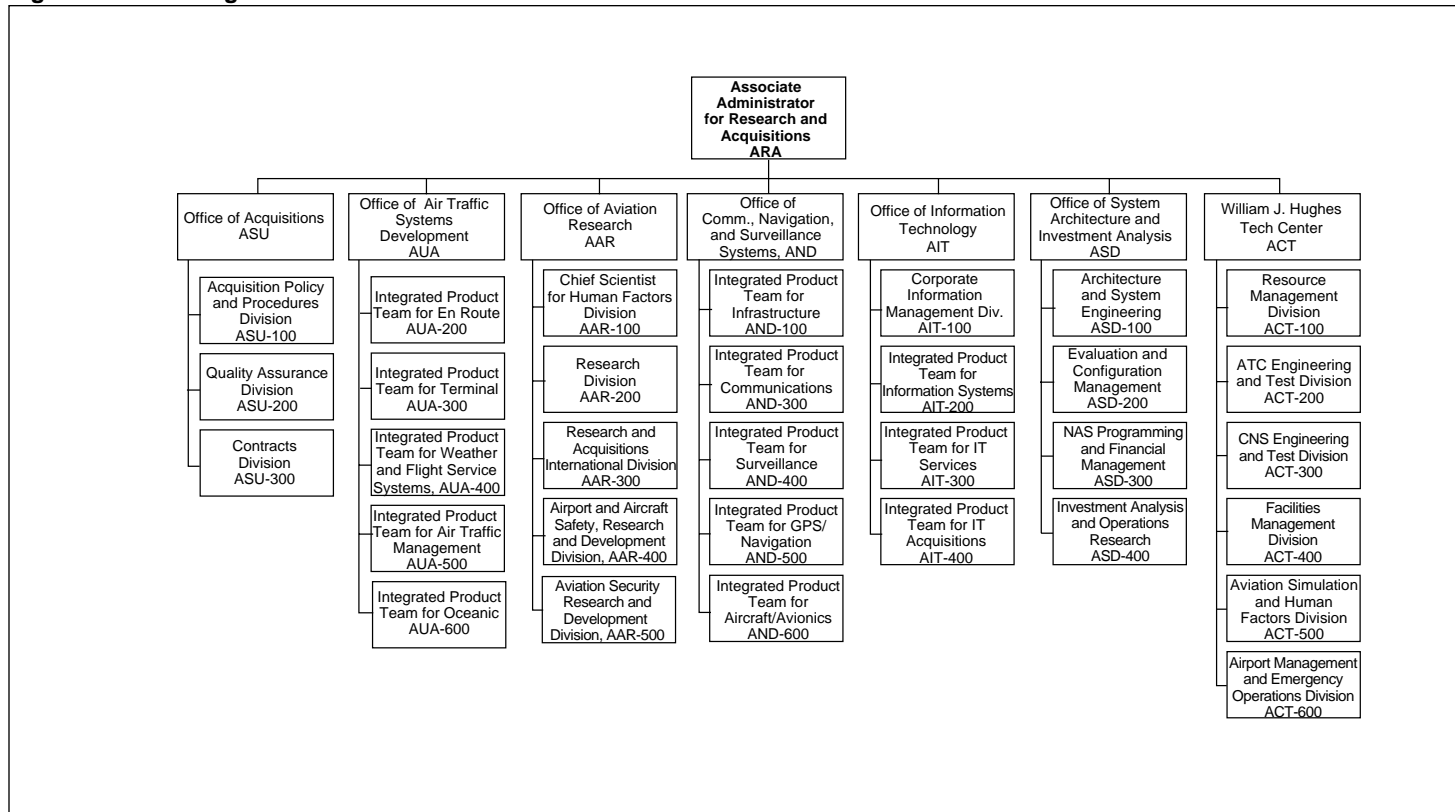
## FAA Organizations Responsible for ATC Systems Acquisition and Maintenance

Two major FAA organizations play key roles in the modernization of ATC systems—the Office of the Associate Administrator for Research and Acquisitions (ARA) and the Office of the Associate Administrator for Air Traffic Services (ATS). Briefly, ARA is responsible for acquiring ATC systems, while ATS is responsible for operating and maintaining ATC systems. Cross-functional integrated product teams (IPT) residing in ARA are responsible for specific ATC system acquisition projects.

ARA manages ATC modernization research and development and acquisition activities. According to the Associate Administrator for ARA, only about one-half of the total ATC systems development budget is spent by ARA, while the other one-half is spent by ATS implementing system enhancements. Within ARA, two groups are responsible for acquiring systems, while other groups handle cross-cutting management functions, such as budget formulation and program evaluation. These two groups are the Office of Air Traffic Systems Development (AUA) and the Office of Communication, Navigation, and Surveillance Systems (AND).

Five IPTs reside in AUA and are organized by ATC business areas (i.e., en route, terminal, weather and flight service, air traffic management, oceanic), and five IPTs reside in AND and are organized by ATC functional areas (i.e., infrastructure, communications, surveillance, Global Positioning System/navigation, aircraft/avionics). IPTs are responsible for research, development, and acquisition as well as for ensuring that new equipment is delivered, installed, and working properly. For example, the en route IPT comprises product teams for the Display Channel Complex Rehost, the Display System Replacement, the Voice Switching and Control System, and several other en route systems. Each IPT includes systems and specialty engineers, logistics personnel, testing personnel, contract personnel, and lawyers as well as representatives from the organizations responsible for operating and maintaining the ATC equipment. The organization chart below shows the structure of the ARA organization.

Figure 1.2: ARA Organization Chart



## Objectives, Scope, and Methodology

The Chairman, Subcommittee on Transportation and Related Agencies, House Committee on Appropriations, requested that we review FAA’s ability to acquire software for ATC systems. Our objectives were to determine (1) the maturity of FAA’s ATC modernization software acquisition processes; and (2) the steps/actions FAA has underway or planned to improve these processes, and any obstacles that may impede FAA’s improvement actions.

To determine FAA’s software acquisition process maturity, we applied the Software Engineering Institute’s Software Acquisition Capability Maturity Model (SA-CMM)<sup>6</sup> and its Software Capability Evaluation (SCE) method. SEI’s expertise in software process assessment is accepted throughout the industry. Our evaluators were all SEI-trained software specialists. In

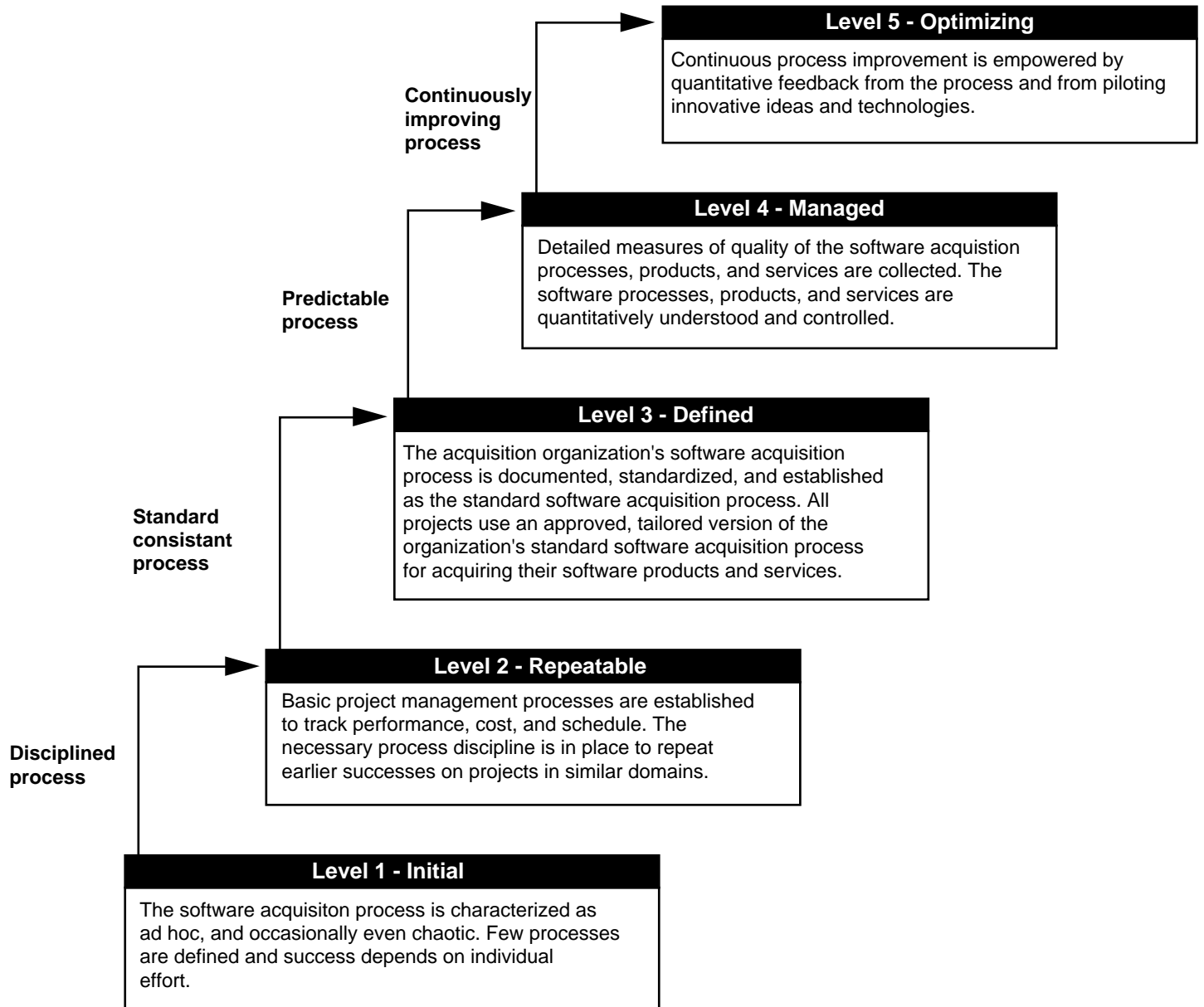
<sup>6</sup>We used a draft version of the model for our evaluation (version 00.03, dated April 1996). The first published version of the model was released in October 1996, after we performed our evaluation. According to the model’s authors, the published version differed only editorially from the draft we used.



addition, we employed SEI consultants, two of whom are authors of the model, as advisors to ensure proper application of the model.

The SA-CMM ranks organizational maturity according to five levels (see figure 1.3). Maturity levels 2 through 5 require the verifiable existence and use of certain software acquisition processes, known as key process areas (KPA). According to the SEI, an agency that has these acquisition processes in place is in a much better position to successfully acquire software than an organization that does not have these processes in place. We evaluated FAA's software acquisition processes against all level 2 KPAs and one level 3 KPA (see table 1.1). We included one level 3 KPA—acquisition risk management—because it is considered by software experts to be a very important process area.

Figure 1.3: SA-CMM Levels and Descriptions



**Table 1.1: SA-CMM KPAs Used to Assess FAA Software Acquisition Maturity**

<b>SA-CMM Level 2 Key process areas</b>	
	<b>Description</b>
Software acquisition planning	Ensuring that reasonable planning for the software acquisition is conducted and that all elements of the project are included.
Solicitation	Ensuring that award is made to the contractor most capable of satisfying the specified requirements.
Requirements development and management	Establishing a common and unambiguous definition of software acquisition requirements understood by the acquisition team, system user, and the contractor.
Project office management	Managing the activities of the project office and supporting contractor(s) to ensure a timely, efficient, and effective software acquisition.
Contract tracking and oversight	Ensuring that the software activities under contract are being performed in accordance with contract requirements, and that products and services will satisfy contract requirements.
Evaluation	Determining that the acquired software products and services satisfy contract requirements prior to acceptance and transition to support.
Transition and support	Providing for the transition of the software products being acquired to their eventual support organization.
<b>CMM Level 3 Key process area</b>	
	<b>Description</b>
Acquisition risk management	Identifying risks as early as possible, adjusting acquisition strategy to mitigate those risks, and developing and implementing a risk management process as an integral part of the acquisition process.

As established by the model, each KPA contains five common attributes that indicate whether the implementation and institutionalization of a KPA can be effective, repeatable, and lasting. The five common features are:

- **Commitment to perform.** Commitment to perform describes the actions that the organization must take to establish the process and ensure that it can endure. Commitment to perform typically involves establishing organizational policies and sponsorship.
- **Ability to perform.** Ability to perform describes the preconditions that must exist in the project or organization to implement the software acquisition process competently. Ability to perform typically involves resources, organizational structures, and training.
- **Activities performed.** Activities performed describes the roles and procedures necessary to implement a KPA. Activities performed typically involve establishing plans and procedures, performing the work, tracking it, and taking appropriate management actions.

- Measurement and analysis. Measurement and analysis describes activities performed to measure the process and analyze the measurements. Measurement and analysis typically includes defining the measurements to be taken and the analyses to be conducted to determine the status and effectiveness of the activities performed.
- Verifying implementation. Verifying implementation describes the steps to ensure that the activities are performed in compliance with the process that has been established. Verification typically encompasses reviews by management.

In accordance with SEI's SCE method, for each KPA in level 2 and the one KPA in level 3 (risk management), we evaluated institutional FAA policies and practices and compared project-specific guidance and practices against the five common attributes. This project-specific comparison can result in one of four possible outcomes: (1) project strength—an effective implementation of the key practice; (2) project weakness—ineffective implementation of a key practice or failure to implement a key practice; (3) project observation—key practice evaluated but evidence inconclusive and cannot be characterized as either strength or weakness; and (4) not rated—key practice not currently relevant to project, therefore not evaluated.

We performed the project-specific evaluations on five ongoing ATC modernization projects, each of which is described below. We asked FAA to choose these projects using the following criteria: (1) the projects are major efforts with large software acquisition components; (2) the projects are managed by different integrated product teams, (3) the projects are in different stages of their life cycles, and (4) the projects are among FAA's best-managed acquisitions. The projects that FAA selected for our evaluation are:

- Automated Radar Terminal System (ARTS) IIIE: ARTS gathers information from surveillance sensors, processes it, and sends it to air traffic controllers in terminal radar approach control facilities and control towers at airports. A series of improvements to ARTS have provided increased processor capacity and the ability to support a greater number of controller displays. The ARTS IIIE improvements provide for more controller positions and surveillance sensor inputs at selected large facilities. ARTS IIIE is operational at New York, Chicago, and Dallas/Fort Worth with additional systems planned for Southern California and Denver. FAA estimates that the enhancement will cost \$383.8 million to develop and deploy.

- Display System Replacement (DSR): DSR is intended to replace air traffic controllers' display-related systems in each of the en route centers. DSR consists of controller work stations connected via a local area network to three interfacing systems (Host Computer System, Enhanced Direct Access Radar Channel, and Weather and Radar Processor). FAA plans to deploy DSR to all 20 en route centers in the continental United States, as well as ATC facilities in Anchorage and potentially in Honolulu. FAA is now conducting system acceptance testing. FAA estimates that DSR will cost \$1,055.3 million to develop and deploy.
- National Airspace System (NAS) Infrastructure Management System (NIMS): NIMS is intended to provide the system infrastructure, including data architecture and network communications, to permit remote ATC system operational monitoring and maintenance. This program will provide a three-tiered architecture consisting of a national control center, 4 to 10 operational control centers, and over 300 local work centers. NIMS is in the pre-solicitation phase, and FAA estimates that it will cost about \$500 million to develop and deploy.
- Voice Switching and Control System (VSCS): VSCS is intended to provide air-to-ground and ground-to-ground communications between en route centers and aircraft. The VSCS is to replace the aging ground-to-ground switching equipment and the air-to-ground circuits with a single integrated, computer-controlled, digital voice switching system. The development of VSCS is completed and all systems are operational. FAA estimates that VSCS will cost about \$1.5 billion to develop and deploy.
- Weather and Radar Processor (WARP): WARP is a next generation weather and radar processing and display system that is intended to permit consolidation of weather data from several sources into a single, integrated display for controllers. Currently, the weather information provided to controllers in the en route centers comes from long-range aircraft surveillance radars, which are not well-suited for this purpose. Next generation weather radars are to replace the surveillance radars as the source of weather information. WARP is to collect, process, and disseminate this and other weather data to controllers, traffic management specialists, pilots, and meteorologists. WARP is currently under development, and FAA estimates that it will cost \$124.6 million to develop and deploy.

To address our second objective (what steps/actions FAA has underway or planned to improve its software acquisition processes and what obstacles, if any, may impede FAA's progress), we interviewed FAA's Chief Scientist for Software Engineering and his staff to determine: (1) process improvements that are planned and underway; (2) the rationale for each

initiative; (3) the relative priority of each; (4) progress made on each initiative; and (5) obstacles, if any, impeding progress. We also analyzed process improvement plans, meeting minutes, and related documentation to further address these areas. Finally, we interviewed representatives from the ATC modernization product teams and the SEPG to obtain their perspectives in assessing process improvement support, activities, progress, and obstacles.

The Department of Transportation provided written comments on a draft of this report. These comments are presented and evaluated in chapter 11, and are reprinted in appendix I. We performed our work at FAA headquarters offices in Washington, D.C. between March 1996 and February 1997, in accordance with generally accepted government auditing standards.

# Software Acquisition Planning

The purpose of software acquisition planning is to ensure that reasonable planning for the software acquisition is conducted and that all aspects of the total software acquisition effort are included in these plans. According to the SA-CMM, a repeatable software acquisition planning process, among other things, includes (1) addressing software life cycle support in acquisition plans, (2) preparing life cycle software cost estimates, (3) having a written software acquisition policy, (4) measuring and reporting on the status of software acquisition planning activities, and (5) having guidance on software training and experience requirements for project personnel.

## FAA's Software Acquisition Planning Process Is Not Effective





All five projects have some ability and/or activity strengths in this KPA. For example, every project addresses software life cycle support in planning documents and software life cycle cost estimates were prepared for four of the projects. However, we found many more process weaknesses than strengths. For example, FAA has a systems acquisition policy, but the policy does not specifically address or provide guidance on software acquisition. Therefore, FAA management has not formally recognized the importance and uniqueness of software acquisition issues in the system acquisition process, and has not formally committed to managing software acquisition in a disciplined manner. Also, the product teams do not measure or report on the status of software acquisition planning activities. As a result, management is not always aware of problems in project performance, and cannot always take corrective action expeditiously. Additionally, none of the five projects has specific guidance on software training or experience requirements for project participation. As a result, software training is ad hoc, and decisions about project personnel assignments are subjective.

Figure 2.1 provides a comprehensive listing of the five projects' strengths, weaknesses, and observations for the software acquisition planning KPA. The specific findings supporting the practice ratings cited in figure 2.1 are in tables 2.1 through 2.5.

**Chapter 2  
Software Acquisition Planning**

**Figure 2.1: Software Acquisition Planning**

	<b>Key Practice</b>	<b>ARTSIIE</b>	<b>DSR</b>	<b>NIMS</b>	<b>VSCS</b>	<b>WARP</b>
Commitment 1	The acquisition organization has a written policy for planning the software acquisition.	Weakness	Weakness	Weakness	Weakness	Weakness
Ability 1	Personnel are assigned the responsibility for performing software acquisition planning.	Weakness	Strength	Strength	Strength	Observation
Ability 2	The acquisition organization has experienced software acquisition management personnel.	Observation	Observation	Observation	Observation	Observation
Ability 3	Software acquisition management personnel are experienced in the domain of the project.	Weakness	Weakness	Weakness	Weakness	Weakness
Activity 1	Software acquisition planning personnel are involved in system acquisition planning.	Weakness	Strength	Strength	Strength	Weakness
Activity 2	The project's software acquisition planning is documented and the planning documentation is maintained over the life of the project.	Weakness	Weakness	Observation	Weakness	Weakness
Activity 3	The software acquisition strategy for the project is developed.	Weakness	Weakness	Strength	Weakness	Weakness
Activity 4	Software acquisition planning includes provisions for ensuring that the life cycle support of the system is included in planning documentation.	Strength	Strength	Strength	Strength	Strength
Activity 5	A life cycle cost estimate for the software activity is prepared and independently verified.	Weakness	Strength	Strength	Strength	Strength
Measurement 1	Measurements are made and used to determine the status of the software acquisition planning activities.	Weakness	Weakness	Weakness	Weakness	Weakness
Verification 1	The activities for software acquisition planning are reviewed by acquisition organization management on a periodic basis.	Weakness	Weakness	Weakness	Weakness	Weakness
Verification 2	The activities for software acquisition planning are reviewed by the project manager on both a periodic and event-driven basis.	Weakness	Weakness	Weakness	Weakness	Weakness

-  = **Weakness** Key practice not implemented
-  = **Strength** Key practice effectively implemented
-  = **Observation** Key practice evaluated but evidence inconclusive. Cannot characterize as either strength or weakness
-  = **Not rated** Key practice not currently relevant to project, therefore not evaluated



**Chapter 2**  
**Software Acquisition Planning**

**Table 2.1: Software Acquisition Planning Findings for ARTSIIIE**

**Automated Radar Terminal System IIIE**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for planning the software acquisition.	The system acquisition policy does not adequately address software, e.g., it does not address items that should be included in software planning such as contract tracking and oversight, requirements development, evaluation, and risk management.	Weakness
Ability 1	Personnel are assigned the responsibility for performing software acquisition planning.	No personnel are assigned the responsibility for software acquisition planning.	Weakness
Ability 2	The acquisition organization has experienced software acquisition management personnel.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Ability 3	Software acquisition management personnel are experienced in the domain of the project.	There are no guidelines that define domain knowledge or experience.	Weakness
Activity 1	Software acquisition planning personnel are involved in system acquisition planning.	No one on the product team is specifically assigned responsibility for software acquisition.	Weakness
Activity 2	The project's software acquisition planning is documented and the planning documentation is maintained over the life of the project.	There is no documented software acquisition plan.	Weakness
Activity 3	The software acquisition strategy for the project is developed.	There is no software acquisition strategy.	Weakness
Activity 4	Software acquisition planning includes provisions for ensuring that the life cycle support of the system is included in planning documentation.	The product team ensures that life cycle support is included in planning documentation.	Strength
Activity 5	A life cycle cost estimate for the software activity is prepared and independently verified.	The life cycle cost estimate was prepared but not independently verified.	Weakness
Measurement 1	Measurements are made and used to determine the status of the software acquisition planning activities.	No internal process measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness
Verification 1	The activities for software acquisition planning are reviewed by acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for software acquisition planning are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

**Chapter 2  
Software Acquisition Planning**

**Table 2.2: Software Acquisition Planning Findings for DSR**

**Display System Replacement**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for planning the software acquisition.	The system acquisition policy does not adequately address software, e.g., it does not address items that should be included in software planning such as contract tracking and oversight, requirements development, evaluation, and risk management.	Weakness
Ability 1	Personnel are assigned the responsibility for performing software acquisition planning.	Personnel are assigned the responsibility for performing software acquisition planning.	Strength
Ability 2	The acquisition organization has experienced software acquisition management personnel.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Ability 3	Software acquisition management personnel are experienced in the domain of the project.	There are no guidelines that define domain knowledge or experience.	Weakness
Activity 1	Software acquisition planning personnel are involved in system acquisition planning.	Software acquisition personnel are involved in system acquisition planning.	Strength
Activity 2	The project's software acquisition planning is documented and the planning documentation is maintained over the life of the project.	There is no software acquisition planning documentation.	Weakness
Activity 3	The software acquisition strategy for the project is developed.	Officials stated that the software acquisition strategy is developed, however, the documents provided did not address such things as objectives, technologies, and schedule.	Weakness
Activity 4	Software acquisition planning includes provisions for ensuring that the life cycle support of the system is included in planning documentation.	Software acquisition planning includes life cycle support planning.	Strength
Activity 5	A life cycle cost estimate for the software activity is prepared and independently verified.	A life cycle cost estimate is prepared and independently verified.	Strength
Measurement 1	Measurements are made and used to determine the status of the software acquisition planning activities.	No internal process measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness
Verification 1	The activities for software acquisition planning are reviewed by acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for software acquisition planning are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

**Chapter 2  
Software Acquisition Planning**

**Table 2.3: Software Acquisition Planning Findings for NIMS**

<b>NAS Infrastructure Management System</b>			
	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for planning the software acquisition.	The system acquisition policy does not adequately address software, e.g., it does not address items that should be included in software planning such as contract tracking and oversight, requirements development, evaluation, and risk management.	Weakness
Ability 1	Personnel are assigned the responsibility for performing software acquisition planning.	The team members are assigned the responsibility for software acquisition planning.	Strength
Ability 2	The acquisition organization has experienced software acquisition management personnel.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Ability 3	Software acquisition management personnel are experienced in the domain of the project.	There are no guidelines that define domain knowledge or experience.	Weakness
Activity 1	Software acquisition planning personnel are involved in system acquisition planning.	The team members for software acquisition are assigned collective responsibility and are actively involved in system acquisition planning.	Strength
Activity 2	The project's software acquisition planning is documented and the planning documentation is maintained over the life of the project.	At this early stage in the program, the software acquisition planning documentation is being written but is not complete.	Observation
Activity 3	The software acquisition strategy for the project is developed.	Officials stated that the software acquisition strategy will be contained within the acquisition plan.	Strength
Activity 4	Software acquisition planning includes provisions for ensuring that the life cycle support of the system is included in planning documentation.	Software acquisition planning includes provisions for ensuring that life cycle support is included in planning documentation.	Strength
Activity 5	A life cycle cost estimate for the software activity is prepared and independently verified.	A life cycle cost estimate for software has been prepared and independently verified.	Strength
Measurement 1	Measurements are made and used to determine the status of the software acquisition planning activities.	No internal process measurements are taken to determine the status of activities for any of the key process areas.	Weakness
Verification 1	The activities for software acquisition planning are reviewed by acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

(continued)

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**Chapter 2**  
**Software Acquisition Planning**

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**NAS Infrastructure Management System**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Verification 2	The activities for software acquisition planning are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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**Chapter 2  
Software Acquisition Planning**

**Table 2.4: Software Acquisition Planning Findings for VSCS**

**Voice Switching and Control System**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for planning the software acquisition.	The system acquisition policy does not adequately address software, e.g., it does not address items that should be included in software planning such as contract tracking and oversight, requirements development, evaluation, and risk management.	Weakness
Ability 1	Personnel are assigned the responsibility for performing software acquisition planning.	Personnel are assigned the responsibility for performing software acquisition planning.	Strength
Ability 2	The acquisition organization has experienced software acquisition management personnel.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Ability 3	Software acquisition management personnel are experienced in the domain of the project.	There are no guidelines that define domain knowledge or experience.	Weakness
Activity 1	Software acquisition planning personnel are involved in system acquisition planning.	Software acquisition personnel are involved in system acquisition planning.	Strength
Activity 2	The project's software acquisition planning is documented and the planning documentation is maintained over the life of the project.	The project's software acquisition planning is not documented.	Weakness
Activity 3	The software acquisition strategy for the project is developed.	No software acquisition strategy exists. The system acquisition strategy does not address software.	Weakness
Activity 4	Software acquisition planning includes provisions for ensuring that the life cycle support of the system is included in planning documentation.	The life cycle support of the system is included in the acquisition planning documentation.	Strength
Activity 5	A life cycle cost estimate for the software activity is prepared and independently verified.	The life cycle cost estimate has been prepared and independently verified.	Strength
Measurement 1	Measurements are made and used to determine the status of the software acquisition planning activities.	No internal process measurements are taken or used to determine the status of activities for any of the key process areas.	Weakness
Verification 1	The activities for software acquisition planning are reviewed by acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for software acquisition planning are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

**Chapter 2  
Software Acquisition Planning**

**Table 2.5: Software Acquisition Planning Findings for WARP**

<b>Weather and Radar Processor</b>			
	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for planning the software acquisition.	The system acquisition policy does not adequately address software, e.g., it does not address items that should be included in software planning such as contract tracking and oversight, requirements development, evaluation, and risk management.	Weakness
Ability 1	Personnel are assigned the responsibility for performing software acquisition planning.	Although the product team stated that they are assigned collective responsibility for systems acquisition, they could not provide documentation to show a specific assignment for software acquisition.	Observation
Ability 2	The acquisition organization has experienced software acquisition management personnel.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Ability 3	Software acquisition management personnel are experienced in the domain of the project.	There are no guidelines that define domain knowledge or experience.	Weakness
Activity 1	Software acquisition planning personnel are involved in system acquisition planning.	Although the product team is responsible for systems acquisition, there is no one specifically assigned for software nor does any document expressly state that software is part of systems acquisition.	Weakness
Activity 2	The project's software acquisition planning is documented and the planning documentation is maintained over the life of the project.	There is no software acquisition plan.	Weakness
Activity 3	The software acquisition strategy for the project is developed.	There is no software acquisition strategy for the project. The system acquisition strategy covers only software enhancements.	Weakness
Activity 4	Software acquisition planning includes provisions for ensuring that the life cycle support of the system is included in planning documentation.	The acquisition plan includes provisions for ensuring that life cycle support is included.	Strength
Activity 5	A life cycle cost estimate for the software activity is prepared and independently verified.	The life cycle cost estimate is prepared and independently verified.	Strength
Measurement 1	Measurements are made and used to determine the status of the software acquisition planning activities.	No internal process measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness
Verification 1	The activities for software acquisition planning are reviewed by acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

(continued)

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**Weather and Radar Processor**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Verification 2	The activities for software acquisition planning are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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## **Conclusions**

**Effective planning is the cornerstone of successful software acquisition. While FAA showed some strengths in this KPA, its many weaknesses render the software acquisition planning capability ad hoc and chaotic. Therefore, it is unlikely that projects are effectively measuring and monitoring software acquisition progress and taking corrective actions expeditiously.**

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**Chapter 2**  
**Software Acquisition Planning**

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# Solicitation

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The purpose of solicitation is to prepare a request for proposal that delineates a project's software-related requirements, and select a contractor that can most cost-effectively satisfy these requirements, while complying with relevant solicitation laws and regulations. According to the SA-CMM, specific requirements for a repeatable solicitation process include, among other things, (1) having and following a solicitation plan, (2) assigning responsibility and ensuring sufficient resources for coordinating and conducting solicitation activities, (3) preparing and reviewing cost and schedule estimates for the software products and services being acquired, and (4) periodically measuring solicitation work completed and effort and funds expended, comparing these measures to plans, and reporting the results to management.

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## Product Teams Performing Many Solicitation Practices

All five projects have strengths in many of the practices required by this KPA. For example, most projects have written solicitation plans, assign responsibility for coordinating and conducting the solicitation activities, and prepare and review contract-related software cost and schedule estimates.

However, the projects are weak in several areas. For example, even though most projects had a written solicitation plan, not all projects followed their plans. Also, none of the projects adequately identified the resources needed to conduct solicitation activities. While FAA personnel stated that they had adequate solicitation resources, they provided no evidence of either a mechanism for identifying required resources or for ensuring that required resources are provided. These weaknesses increase the risk of FAA not adequately evaluating the offerors' proposals, and making a suboptimal selection. Additionally, none of the five measured or reported on the status of product team solicitation activities. As a result, management cannot identify solicitation problems early and resolve them expeditiously.

Figure 3.1 provides a comprehensive listing of the five projects' strengths, weaknesses, and observations for the solicitation KPA. The specific findings supporting the practice ratings cited in figure 3.1 are in tables 3.1 through 3.5.





**Chapter 3  
Solicitation**

**Figure 3.1: Solicitation Summary**

	<b>Key Practice</b>	<b>ARTSIIE</b>	<b>DSR</b>	<b>NIMS</b>	<b>VSCS</b>	<b>WARP</b>
Commitment 1	The acquisition organization has a written policy for the conduct of the solicitation.	<b>Strength</b>	<b>Strength</b>	<b>Strength</b>	<b>Strength</b>	<b>Strength</b>
Commitment 2	Responsibility for the software portion of the solicitation is designated.	<b>Weakness</b>	<b>Observation</b>	<b>Strength</b>	<b>Weakness</b>	<b>Strength</b>
Commitment 3	A selection official has been designated to be responsible for the selection process and the decision.	<b>Strength</b>	<b>Not rated</b>	<b>Strength</b>	<b>Strength</b>	<b>Not rated</b>
Ability 1	A group that is responsible for coordinating and conducting the solicitation activities exists.	<b>Strength</b>	<b>Strength</b>	<b>Strength</b>	<b>Not rated</b>	<b>Strength</b>
Ability 2	Adequate resources are provided for the solicitation activities.	<b>Weakness</b>	<b>Weakness</b>	<b>Weakness</b>	<b>Weakness</b>	<b>Weakness</b>
Ability 3	Individuals performing the solicitation activities have experience or receive training.	<b>Observation</b>	<b>Observation</b>	<b>Observation</b>	<b>Observation</b>	<b>Observation</b>
Activity 1	The project team documents its plans for solicitation activities.	<b>Strength</b>	<b>Not rated</b>	<b>Strength</b>	<b>Observation</b>	<b>Strength</b>
Activity 2	The project's solicitation activities are performed in accordance with its plans.	<b>Observation</b>	<b>Not rated</b>	<b>Strength</b>	<b>Weakness</b>	<b>Strength</b>
Activity 3	The project team documents its plans for proposal evaluation activities.	<b>Weakness</b>	<b>Strength</b>	<b>Strength</b>	<b>Observation</b>	<b>Strength</b>
Activity 4	The project team's proposal evaluation activities are performed in accordance with its plans.	<b>Weakness</b>	<b>Not rated</b>	<b>Strength</b>	<b>Weakness</b>	<b>Strength</b>
Activity 5	A cost estimate and schedule for the software activity being sought are prepared.	<b>Strength</b>	<b>Strength</b>	<b>Strength</b>	<b>Strength</b>	<b>Strength</b>
Activity 6	The software cost estimate and schedule are independently reviewed for comprehensiveness and realism.	<b>Strength</b>	<b>Observation</b>	<b>Strength</b>	<b>Strength</b>	<b>Strength</b>
Activity 7	The groups supporting the solicitation (e.g., end user, systems engineering, support organization, and application domain experts) receive orientation on the solicitation's objectives and procedures.	<b>Weakness</b>	<b>Not rated</b>	<b>Strength</b>	<b>Weakness</b>	<b>Observation</b>
Activity 8	The project team and the offeror review the project's software requirements during negotiations to ensure mutual understanding.	<b>Observation</b>	<b>Strength</b>	<b>Not rated</b>	<b>Observation</b>	<b>Strength</b>
Measurement 1	Measurements are made and used to determine the status of the solicitation activities.	<b>Weakness</b>	<b>Weakness</b>	<b>Weakness</b>	<b>Weakness</b>	<b>Weakness</b>

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Solicitation**

	<b>Key Practice</b>	<b>ARTSIIE</b>	<b>DSR</b>	<b>NIMS</b>	<b>VSCS</b>	<b>WARP</b>
Verification 1	The activities for solicitation are reviewed by the designated selection official or acquisition organization management on a periodic basis.	Weakness	Weakness	Weakness	Weakness	Weakness
Verification 2	The activities for solicitation are reviewed by the project manager on both a periodic and event-driven basis.	Weakness	Weakness	Weakness	Weakness	Weakness

-  = **Weakness** Key practice not implemented
-  = **Strength** Key practice effectively implemented
-  = **Observation** Key practice evaluated but evidence inconclusive. Cannot characterize as either strength or weakness
-  = **Not rated** Key practice not currently relevant to project, therefore not evaluated

**Chapter 3  
Solicitation**

**Table 3.1: Solicitation Findings for ARTSIIE**

<b>Automated Radar Terminal System IIE</b>			
	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for the conduct of the solicitation.	FAA Order 1810.1F is the written policy.	Strength
Commitment 2	Responsibility for the software portion of the solicitation is designated.	Officials gave conflicting answers as to who is responsible for the software portion of the solicitation, and could not provide a document that formally designates responsibility.	Weakness
Commitment 3	A selection official has been designated to be responsible for the selection process and the decision.	The Administrator was the selection official for the sole-source contract.	Strength
Ability 1	A group that is responsible for coordinating and conducting the solicitation activities exists.	A group (matrix team) is responsible for coordinating and conducting the solicitation activities.	Strength
Ability 2	Adequate resources are provided for the solicitation activities.	No mechanism exists for identifying resources required and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	Individuals performing the solicitation activities have experience or receive training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	The project team documents its plans for solicitation activities.	The team documents its plans for solicitation activities.	Strength
Activity 2	The project's solicitation activities are performed in accordance with its plans.	While officials stated that solicitation activities are performed in accordance with its plans, they could not provide documentation to support this.	Observation
Activity 3	The project team documents its plans for proposal evaluation activities.	The team does not document its plans for proposal evaluation activities.	Weakness
Activity 4	The project team's proposal evaluation activities are performed in accordance with its plans.	No evaluation plan exists, therefore, the team could not perform in accordance with its plan.	Weakness
Activity 5	A cost estimate and schedule for the software activity being sought are prepared.	A cost estimate and schedule were prepared.	Strength
Activity 6	The software cost estimate and schedule are independently reviewed for comprehensiveness and realism.	The cost estimate and schedule were independently reviewed.	Strength
Activity 7	The groups supporting the solicitation (e.g., end user, systems engineering, support organization, and application domain experts) receive orientation on the solicitation's objectives and procedures.	No orientation briefing occurred.	Weakness

(continued)

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Solicitation**

**Automated Radar Terminal System IIIE**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Activity 8	The project team and the offeror review the project's software requirements during negotiations to ensure mutual understanding.	Officials stated that meetings were held with the contractor to ensure mutual understanding, however, they could not provide documents to support this.	Observation
Measurement 1	Measurements are made and used to determine the status of the solicitation activities.	No internal process measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness
Verification 1	The activities for solicitation are reviewed by the designated selection official or acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the various key process areas.	Weakness
Verification 2	The activities for solicitation are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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Solicitation**

**Table 3.2: Solicitation Findings for DSR**

<b>Display System Replacement</b>			
	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for the conduct of the solicitation.	There is an FAA policy that addresses solicitation conduct.	Strength
Commitment 2	Responsibility for the software portion of the solicitation is designated.	Officials stated that responsibility for the software portion of the solicitation has been assigned, however, they could not provide documents to support this.	Observation
Commitment 3	A selection official has been designated to be responsible for the selection process and the decision.	Not applicable. DSR was a change order from an existing larger contract that went through the acquisition phase in 1984. Current team members joined the team after the change order was negotiated and, therefore, could not address this key practice.	Not rated
Ability 1	A group that is responsible for coordinating and conducting the solicitation activities exists.	A group responsible for the solicitation exists.	Strength
Ability 2	Adequate resources are provided for the solicitation activities.	No mechanism exists for identifying resources required and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	Individuals performing the solicitation activities have experience or receive training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	The project team documents its plans for solicitation activities.	Not applicable. DSR was a change order from an existing larger contract that went through the acquisition phase in 1984. Current team members joined the team after the change order was negotiated and, therefore, could not address this key practice.	Not rated
Activity 2	The project's solicitation activities are performed in accordance with its plans.	Not applicable. DSR was a change order from an existing larger contract that went through the acquisition phase in 1984. Current team members joined the team after the change order was negotiated and, therefore, could not address this key practice.	Not rated
Activity 3	The project team documents its plans for proposal evaluation activities.	The product team uses a change order evaluation plan to document plans for proposal evaluation activities.	Strength

(continued)

**Chapter 3  
Solicitation**

**Display System Replacement**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Activity 4	The project team's proposal evaluation activities are performed in accordance with its plans.	Not applicable. DSR was a change order from an existing larger contract that went through the acquisition phase in 1984. Current team members joined the team after the change order was negotiated and, therefore, could not address this key practice.	Not rated
Activity 5	A cost estimate and schedule for the software activity being sought are prepared.	A cost estimate and schedule were generated.	Strength
Activity 6	The software cost estimate and schedule are independently reviewed for comprehensiveness and realism.	Officials could not produce documentation that supported their statement that the software cost estimate and schedule were independently reviewed.	Observation
Activity 7	The groups supporting the solicitation (e.g., end user, systems engineering, support organization, and application domain experts) receive orientation on the solicitation's objectives and procedures.	Not applicable. DSR was a change order from an existing larger contract that went through the acquisition phase in 1984. Current team members joined the team after the change order was negotiated and, therefore, could not address this key practice.	Not rated
Activity 8	The project team and the offeror review the project's software requirements during negotiations to ensure mutual understanding.	A series of scheduled meetings were held to ensure mutual understanding of requirements.	Strength
Measurement 1	Measurements are made and used to determine the status of the solicitation activities.	No internal process measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness
Verification 1	The activities for solicitation are reviewed by the designated selection official or acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for solicitation are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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Solicitation**

**Table 3.3: Solicitation Findings for NIMS**

<b>NAS Infrastructure Management System</b>			
	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for the conduct of the solicitation.	The Acquisition Management System is the written policy.	Strength
Commitment 2	Responsibility for the software portion of the solicitation is designated.	Responsibility for the software portion of the solicitation has been designated to software experts on the team.	Strength
Commitment 3	A selection official has been designated to be responsible for the selection process and the decision.	A selection official has been designated to be responsible for the selection process and decision.	Strength
Ability 1	A group that is responsible for coordinating and conducting the solicitation activities exists.	The contracting officer, support staff, and the parent ASU organization are responsible for coordinating and conducting the solicitation activities.	Strength
Ability 2	Adequate resources are provided for the solicitation activities.	No mechanism exists for identifying resources required and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	Individuals performing the solicitation activities have experience or receive training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	The project team documents its plans for solicitation activities.	The product team documents its plans for solicitation activities.	Strength
Activity 2	The project's solicitation activities are performed in accordance with its plans.	Officials stated that solicitation activities will be performed in accordance with its plans. NIMS is in the presolicitation phase.	Strength
Activity 3	The project team documents its plans for proposal evaluation activities.	The project team has documented its plans for proposal evaluation activities.	Strength
Activity 4	The project team's proposal evaluation activities are performed in accordance with its plans.	In accordance with the plan, prequalification was completed and vendors were down-selected from it.	Strength
Activity 5	A cost estimate and schedule for the software activity being sought are prepared.	The Acquisition Program Baseline includes a cost estimate and schedule for the software acquisition.	Strength
Activity 6	The software cost estimate and schedule are independently reviewed for comprehensiveness and realism.	An independent assessment was done.	Strength
Activity 7	The groups supporting the solicitation (e.g., end user, systems engineering, support organization, and application domain experts) receive orientation on the solicitation's objectives and procedures.	Solicitation activities orientation was conducted for NIMS personnel.	Strength
Activity 8	The project team and the offeror review the project's software requirements during negotiations to ensure mutual understanding.	The NIMS project has not yet reached this stage, therefore, this activity was not rated.	Not rated

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**Chapter 3  
Solicitation**

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**NAS Infrastructure Management System**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Measurement 1	Measurements are made and used to determine the status of the solicitation activities.	No internal process measurements are taken to determine the status of activities for any of the key process areas.	Weakness
Verification 1	The activities for solicitation are reviewed by the designated selection official or acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for solicitation are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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**Chapter 3  
Solicitation**

**Table 3.4: Solicitation Findings for VSCS**

**Voice Switching and Control System**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for the conduct of the solicitation.	FAA Order 1810.1F is the written policy.	Strength
Commitment 2	Responsibility for the software portion of the solicitation is designated.	Officials gave conflicting answers as to who is responsible for software acquisition, and could not provide documentation that formally designates responsibility.	Weakness
Commitment 3	A selection official has been designated to be responsible for the selection process and the decision.	The Administrator was the selection official.	Strength
Ability 1	A group that is responsible for coordinating and conducting the solicitation activities exists.	Officials stated that a group was responsible for coordinating and conducting solicitation activities; however, they could not provide documentation to support this claim.	Observation
Ability 2	Adequate resources are provided for the solicitation activities.	No mechanism exists for identifying the resources required and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	Individuals performing the solicitation activities have experience or receive training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	The project team documents its plans for solicitation activities.	Officials said that solicitation activities were documented in the Acquisition Plan and Source Evaluation Plan; however, they could not provide these documents.	Observation
Activity 2	The project's solicitation activities are performed in accordance with its plans.	Solicitation activities were not performed in accordance with plans.	Weakness
Activity 3	The project team documents its plans for proposal evaluation activities.	Officials stated that proposal evaluation activities were documented; however, they could not provide the documentation.	Observation
Activity 4	The project team's proposal evaluation activities are performed in accordance with its plans.	Officials could not describe how or if proposal evaluation activities were performed in accordance with plans; additionally, they could not provide documents to support this activity.	Weakness
Activity 5	A cost estimate and schedule for the software activity being sought are prepared.	A cost estimate and schedule for the software activity were developed.	Strength
Activity 6	The software cost estimate and schedule are independently reviewed for comprehensiveness and realism.	The software cost estimate and schedule were independently reviewed for comprehensiveness and realism.	Strength
Activity 7	The groups supporting the solicitation (e.g., end user, systems engineering, support organization, and application domain experts) receive orientation on the solicitation's objectives and procedures.	Officials stated that orientation was held, however, the documentation provided did not indicate that the product team received orientation on the solicitation objectives and procedures.	Weakness

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**Chapter 3  
Solicitation**

**Voice Switching and Control System**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Activity 8	The project team and the offeror review the project's software requirements during negotiations to ensure mutual understanding.	Officials stated that the product team and the offeror reviewed project software requirements during pre-award negotiations, however, they could not provide documentation to support this.	Observation
Measurement 1	Measurements are made and used to determine the status of the solicitation activities.	No internal process measurements are taken or used to determine the status of activities for any of the key process areas.	Weakness
Verification 1	The activities for solicitation are reviewed by the designated selection official or acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for solicitation are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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Solicitation**

**Table 3.5: Solicitation Findings for WARP**

<b>Weather and Radar Processor</b>			
	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for the conduct of the solicitation.	There is a written policy for solicitation.	Strength
Commitment 2	Responsibility for the software portion of the solicitation is designated.	Responsibility for the solicitation has been designated.	Strength
Commitment 3	A selection official has been designated to be responsible for the selection process and the decision.	Because there was only one offeror, this commitment was not rated.	Not rated
Ability 1	A group that is responsible for coordinating and conducting the solicitation activities exists.	A group is responsible for coordinating and conducting the solicitation activities.	Strength
Ability 2	Adequate resources are provided for the solicitation activities.	No mechanism exists for identifying and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	Individuals performing the solicitation activities have experience or receive training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	The project team documents its plans for solicitation activities.	The project team documents its plans for solicitation activities.	Strength
Activity 2	The project's solicitation activities are performed in accordance with its plans.	The project's solicitation activities were performed in accordance with its plans.	Strength
Activity 3	The project team documents its plans for proposal evaluation activities.	The team documented its plans for proposal evaluation activities.	Strength
Activity 4	The project team's proposal evaluation activities are performed in accordance with its plans.	Proposal evaluation activities were performed in accordance with the plan.	Strength
Activity 5	A cost estimate and schedule for the software activity being sought are prepared.	An independent government cost estimate was prepared which included major milestone data.	Strength
Activity 6	The software cost estimate and schedule are independently reviewed for comprehensiveness and realism.	The software cost estimate and schedule were independently reviewed.	Strength
Activity 7	The groups supporting the solicitation (e.g., end user, systems engineering, support organization, and application domain experts) receive orientation on the solicitation's objectives and procedures.	Officials stated that team members received orientation at the beginning of the solicitation, however, they could not provide documentation to support this.	Observation
Activity 8	The project team and the offeror review the project's software requirements during negotiations to ensure mutual understanding.	Numerous negotiation sessions were held.	Strength
Measurement 1	Measurements are made and used to determine the status of the solicitation activities.	No internal process measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness

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**Weather and Radar Processor**

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	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Verification 1	The activities for solicitation are reviewed by the designated selection official or acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for solicitation are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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**Conclusions**

While FAA has many strengths in this KPA, systemic weaknesses in areas including measurement and analysis and management verification of practices, along with other project-specific weaknesses, render this KPA non-repeatable and dependent upon the capabilities and commitment of individual employees.

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# Requirements Development and Management

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The purpose of requirements development and management is to establish and maintain a common and unambiguous definition of software requirements among the acquisition team, the system users, and the software development contractor. This KPA involves two subprocesses: (1) developing a baseline set of software-related contractual requirements, and (2) managing these requirements and changes to these requirements for the duration of the acquisition.

The SA-CMM specifies a number of requirements development and management practices necessary to achieve a repeatable maturity level. These include (1) having a written organizational policy for establishing and managing requirements allocated to software; (2) documenting plans for the development and management of requirements; (3) having documented processes for requirements development, including elicitation, analysis, and verification; (4) measuring and reporting on the status of requirements development and management activities to management; (5) appraising the impact on software of system-level requirements changes; and (6) having a mechanism to ensure that contractor-delivered work products meet specified requirements.

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## Requirements Development and Management Process Is Not Effective

In the past, we have attributed ATC modernization problems, in part, to FAA's failure to effectively manage requirements. For example, we reported in 1994 that FAA did not adequately specify or effectively control changes to the requirements of its Initial Sector Suite System (ISSS) component of the Advanced Automation System.<sup>1</sup>

Our evaluation of FAA's capability relative to this KPA's requirements reiterates our earlier reported concerns in this area and pinpoints specific weaknesses. For example, while FAA has a policy on requirements development and management, this policy does not address establishing and managing software requirements. Further, product teams do not always document their requirements development and management plans, and while two had a defined process for controlling changes to existing, baselined requirements, they did not have a documented process for developing new software requirements, including requirements planning, elicitation, analysis, or verification. Additionally, management does not oversee or verify requirements development and management activities, which means that management has no assurance that specified

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<sup>1</sup>Advanced Automation System: Implications of Problems and Recent Changes (GAO/T-RCED-94-188, Apr. 13, 1994).

requirements are correct and complete, and does not know when management action is warranted.





We also found some practice strengths. For example, most projects (1) are assessing the impact on software requirements of system-level requirements changes and (2) have a mechanism to ensure that contractor-delivered work products and services satisfied specified software requirements.

Figure 4.1 provides a comprehensive listing of the five projects' strengths, weaknesses, and observations for the requirements development and management KPA. The specific findings supporting the practice ratings in figure 4.1 are in tables 4.1 through 4.5.

**Chapter 4  
Requirements Development and  
Management**

**Figure 4.1: Requirements Development and Management Summary**

	<b>Key Practice</b>	<b>ARTSIIE</b>	<b>DSR</b>	<b>NIMS</b>	<b>VSCS</b>	<b>WARP</b>
Commitment 1	The acquisition organization has a written policy for establishing and managing the system requirements allocated to software.	Weakness	Weakness	Weakness	Weakness	Weakness
Ability 1	A group that is responsible for performing requirements development and management activities exists.	Strength	Strength	Strength	Strength	Strength
Ability 2	Adequate resources are provided for requirements development and management activities.	Weakness	Strength	Weakness	Weakness	Weakness
Ability 3	Individuals performing requirements development and management activities have experience or receive training.	Observation	Observation	Observation	Observation	Observation
Activity 1	The project team documents its plans for requirements development and management activities.	Weakness	Weakness	Not rated	Weakness	Weakness
Activity 2	The project's requirements development and management activities are performed in accordance with its plans.	Weakness	Weakness	Not rated	Weakness	Weakness
Activity 3	The project team baselines the software requirements and places them under change control early in the project, but not later than release of the solicitation.	Strength	Weakness	Not rated	Observation	Strength
Activity 4	The project team appraises system requirements change requests for their impact on software.	Strength	Strength	Not rated	Strength	Strength
Activity 5	The project team appraises software requirements changes for their impact on performance, schedule, cost, system capacities, supportability, and architecture.	Strength	Weakness	Not rated	Weakness	Not rated
Activity 6	The project team maintains a requirements mechanism for traceability during the software effort to ensure requirements have been included in the implemented work products and services.	Strength	Strength	Not rated	Strength	Strength
Measurement 1	Measurements are made and used to determine the status of the requirements development and management activities.	Weakness	Weakness	Weakness	Weakness	Weakness
Verification 1	The activities for requirements development and management are reviewed by acquisition organization management (and the contractor) on a periodic basis.	Weakness	Weakness	Weakness	Weakness	Weakness
Verification 2	The activities for requirements development and management are reviewed by the project manager on both a periodic and event-driven basis.	Weakness	Weakness	Weakness	Weakness	Weakness

-  = **Weakness** Key practice not implemented
-  = **Strength** Key practice effectively implemented
-  = **Observation** Key practice evaluated but evidence inconclusive. Cannot characterize as either strength or weakness
-  = **Not rated** Key practice not currently relevant to project, therefore not evaluated



**Chapter 4  
Requirements Development and  
Management**

**Table 4.1: Requirements Development and Management Findings for ARTSIIE**

**Automated Radar Terminal System IIIE**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for establishing and managing the system requirements allocated to software.	Officials stated that FAA Order 1810.1F is the written policy for requirements development and management, however, it does not address software requirements.	Weakness
Ability 1	A group that is responsible for performing requirements development and management activities exists.	A group responsible for requirements development and management exists.	Strength
Ability 2	Adequate resources are provided for requirements development and management activities.	No mechanism exists for identifying and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	Individuals performing requirements development and management activities have experience or receive training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	The project team documents its plans for requirements development and management activities.	The project team does not document its plans for requirements development, planning, elicitation, analysis, and verification.	Weakness
Activity 2	The project's requirements development and management activities are performed in accordance with its plans.	There is no requirements development and management plan, therefore, the activities are not performed in accordance with it.	Weakness
Activity 3	The project team baselines the software requirements and places them under change control early in the project, but not later than release of the solicitation.	A requirements baseline, which is under change control, was established prior to the release of the solicitation.	Strength
Activity 4	The project team appraises system requirements change requests for their impact on software.	The project team's appraisals of the impact of system requirements changes on software are documented.	Strength
Activity 5	The project team appraises software requirements changes for their impact on performance, schedule, cost, system capacities, supportability, and architecture.	The project team's appraisal of software requirements changes' impact on performance, schedule, cost, and system capacities is documented, but not the impact on system supportability or architecture.	Strength
Activity 6	The project team maintains a requirements mechanism for traceability during the software effort to ensure requirements have been included in the implemented work products and services.	There is a mechanism for traceability of software requirements implementation.	Strength
Measurement 1	Measurements are made and used to determine the status of the requirements development and management activities.	No internal process measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness

(continued)

**Chapter 4  
Requirements Development and  
Management**

**Automated Radar Terminal System IIIE**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Verification 1	The activities for requirements development and management are reviewed by acquisition organization management (and the contractor) on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for requirements development and management are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

**Chapter 4  
Requirements Development and  
Management**

**Table 4.2: Requirements Development and Management Findings for DSR**

**Display System Replacement**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for establishing and managing the system requirements allocated to software.	Officials stated that FAA Order 1810.1F is the written policy for requirements development and management, however, it does not address software requirements.	Weakness
Ability 1	A group that is responsible for performing requirements development and management activities exists.	The group responsible for requirements development and management is the product team.	Strength
Ability 2	Adequate resources are provided for requirements development and management activities.	Adequate resources are provided for requirements development and management activities.	Strength
Ability 3	Individuals performing requirements development and management activities have experience or receive training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	The project team documents its plans for requirements development and management activities.	While processes exist for milestone review, these documents do not cover the activities to be performed such as user involvement, elicitation, and requirements development.	Weakness
Activity 2	The project's requirements development and management activities are performed in accordance with its plans.	There is no requirements development and management plan, therefore, the activities are not performed in accordance with it.	Weakness
Activity 3	The project team baselines the software requirements and places them under change control early in the project, but not later than release of the solicitation.	Software requirements are baselined as part of the contract process, but not explicitly prior to solicitation.	Weakness
Activity 4	The project team appraises system requirements change requests for their impact on software.	The product team appraises system requirements changes for their impact on software.	Strength
Activity 5	The project team appraises software requirements changes for their impact on performance, schedule, cost, system capacities, supportability, and architecture.	Software requirements were not appraised for their impact on performance, schedule, cost, system capacities, supportability, and architecture.	Weakness
Activity 6	The project team maintains a requirements mechanism for traceability during the software effort to ensure requirements have been included in the implemented work products and services.	The product team maintains a mechanism for requirements traceability.	Strength
Measurement 1	Measurements are made and used to determine the status of the requirements development and management activities.	No internal measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness
Verification 1	The activities for requirements development and management are reviewed by acquisition organization management (and the contractor) on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for requirements development and management are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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**Table 4.3: Requirements Development and Management Findings for NIMS**

**NAS Infrastructure Management System**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for establishing and managing the system requirements allocated to software.	Officials cited the Acquisition Management System and FAA Order 1810.1F, but these do not address software requirements.	Weakness
Ability 1	A group that is responsible for performing requirements development and management activities exists.	The team members are assigned collective responsibility for the requirements process.	Strength
Ability 2	Adequate resources are provided for requirements development and management activities.	No mechanism exists for identifying resources required and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	Individuals performing requirements development and management activities have experience or receive training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	The project team documents its plans for requirements development and management activities.	The project has not reached the point where these activities are performed.	Not rated
Activity 2	The project's requirements development and management activities are performed in accordance with its plans.	The project has not reached the point where these activities are performed.	Not rated
Activity 3	The project team baselines the software requirements and places them under change control early in the project, but not later than release of the solicitation.	It is too early in the project life to assess: the software requirements have not been developed.	Not rated
Activity 4	The project team appraises system requirements change requests for their impact on software.	It is too early in the project life to assess: no software has been developed or specified.	Not rated
Activity 5	The project team appraises software requirements changes for their impact on performance, schedule, cost, system capacities, supportability, and architecture.	It is too early in the project life to assess: no software requirements have been developed or specified.	Not rated
Activity 6	The project team maintains a requirements mechanism for traceability during the software effort to ensure requirements have been included in the implemented work products and services.	No traceability matrix of software requirements has been developed at this point in the project.	Not rated
Measurement 1	Measurements are made and used to determine the status of the requirements development and management activities.	No internal process measurements are taken to determine the status of activities for any of the key process areas.	Weakness
Verification 1	The activities for requirements development and management are reviewed by acquisition organization management (and the contractor) on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for requirements development and management are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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**Table 4.4: Requirements Development and Management Findings for VSCS**

**Voice Switching and Control System**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for establishing and managing the system requirements allocated to software.	Officials stated that FAA Order 1810.1F is the written policy for requirements development and management, however, it does not address software requirements.	Weakness
Ability 1	A group that is responsible for performing requirements development and management activities exists.	The product team is responsible for requirements development and management planning.	Strength
Ability 2	Adequate resources are provided for requirements development and management activities.	No mechanism exists for identifying the resources required and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	Individuals performing requirements development and management activities have experience or receive training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	The project team documents its plans for requirements development and management activities.	There are no documented plans for requirements development and management activities.	Weakness
Activity 2	The project's requirements development and management activities are performed in accordance with its plans.	There is no requirements development and management plan, therefore, the activities cannot be performed in accordance with it.	Weakness
Activity 3	The project team baselines the software requirements and places them under change control early in the project, but not later than release of the solicitation.	Officials stated that requirements are baselined at contract award, but no documentation was provided to support this statement.	Observation
Activity 4	The project team appraises system requirements change requests for their impact on software.	The project team appraises system requirements change requests for their impact on software.	Strength
Activity 5	The project team appraises software requirements changes for their impact on performance, schedule, cost, system capacities, supportability, and architecture.	The project team appraises software requirements changes for their impact on performance, schedule, cost, and system capacities, but not on system supportability and architecture.	Weakness
Activity 6	The project team maintains a requirements mechanism for traceability during the software effort to ensure requirements have been included in the implemented work products and services.	A mechanism for traceability during the software effort is maintained.	Strength
Measurement 1	Measurements are made and used to determine the status of the requirements development and management activities.	No internal process measurements are taken or used to determine the status of activities for any of the key process areas.	Weakness

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**Voice Switching and Control System**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Verification 1	The activities for requirements development and management are reviewed by acquisition organization management (and the contractor) on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for requirements development and management are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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**Table 4.5: Requirements Development and Management Findings for WARP**

**Weather and Radar Processor**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for establishing and managing the system requirements allocated to software.	Officials stated that FAA Order 1810.1F is the written policy for requirements development and management, however, it does not address software requirements.	Weakness
Ability 1	A group that is responsible for performing requirements development and management activities exists.	The team is responsible for requirements development and measurement activities.	Strength
Ability 2	Adequate resources are provided for requirements development and management activities.	No mechanism exists for identifying and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	Individuals performing requirements development and management activities have experience or receive training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	The project team documents its plans for requirements development and management activities.	While a process for managing requirements changes exists, there is no documented process for requirements development and management.	Weakness
Activity 2	The project's requirements development and management activities are performed in accordance with its plans.	There is no plan, thus, it cannot be followed.	Weakness
Activity 3	The project team baselines the software requirements and places them under change control early in the project, but not later than release of the solicitation.	The product team baselined the software requirements and placed them under change control before the release of the solicitation.	Strength
Activity 4	The project team appraises system requirements change requests for their impact on software.	The product team appraises system requirements change requests for their impact on software.	Strength
Activity 5	The project team appraises software requirements changes for their impact on performance, schedule, cost, system capacities, supportability, and architecture.	WARP has not had a software requirement change yet; therefore, this activity was not rated.	Not rated
Activity 6	The project team maintains a requirements mechanism for traceability during the software effort to ensure requirements have been included in the implemented work products and services.	There is a traceability matrix for tracking software requirements implementation in the system specification.	Strength
Measurement 1	Measurements are made and used to determine the status of the requirements development and management activities.	No internal process measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness
Verification 1	The activities for requirements development and management are reviewed by acquisition organization management (and the contractor) on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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**Weather and Radar Processor**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Verification 2	The activities for requirements development and management are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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**Conclusions**

Requirements management has been a pervasive and longstanding problem with FAA's ATC modernization, and the results of our evaluation point to many software-specific weaknesses in this area. Because of these weaknesses, it is likely that requirements management problems will continue to jeopardize projects' cost, schedule, and performance goals.



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# Project Office Management

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The purpose of project office management is to manage the activities of the project office and supporting contractors to ensure a timely, efficient, and effective software acquisition. According to the SA-CMM, effective project office management requires, among other things, that project teams (1) be organized to accomplish the project's objective, (2) have a written policy for the management of the software project, (3) document its plans for the activities of the project team, (4) have the authority to alter either the project's performance, cost, or schedule baseline while maintaining the other two, and (5) periodically brief management on the status of project office management activities.

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## FAA's Project Office Management Process Area Is Not Effective

ATC modernization teams are organized to accomplish project objectives, with each team including representatives from key functional areas (e.g., software engineering, contracting, test and evaluation, operations and maintenance). However, serious weaknesses in other KPA requirements undermine FAA's project office management capability. For example, most teams lack a written policy for software project management, do not document its plans for software acquisition management activities, and could not identify which team member(s) is responsible for different team activities (e.g., software, support, requirements, testing, and/or reviews). As a result, lines of accountability and decision-making are blurred, increasing the chances of delays and mistakes. Additionally, the product lead cannot adjust either software performance, cost, or schedule baseline while holding the other two constant. This inflexibility limits the teams' ability to effectively and efficiently respond to such events as valid requirements changes and funding changes. Also, project teams do not periodically brief management on the status of project office activities, which means that management may not be able take corrective action when warranted.

Figure 5.1 provides a comprehensive listing of the five projects' strengths, weaknesses, and observations for the project office management KPA. The specific findings supporting the practice ratings cited in figure 5.1 are in tables 5.1 through 5.5.





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**Figure 5.1: Project Office Management Summary**

	<b>Key Practice</b>	<b>ARTSIIE</b>	<b>DSR</b>	<b>NIMS</b>	<b>VSCS</b>	<b>WARP</b>
Commitment 1	The acquisition organization has a written policy for execution of the software project.	Weakness	Weakness	Strength	Weakness	Weakness
Commitment 2	Performance, cost, and schedule baselines are supported.	Strength	Strength	Strength	Weakness	Strength
Ability 1	A project team that is responsible for performing the project's software acquisition management activities exists.	Strength	Strength	Weakness	Strength	Strength
Ability 2	Adequate resources for the project team and matrix support organization(s) are provided for the duration of the software acquisition project.	Weakness	Weakness	Weakness	Weakness	Weakness
Ability 3	The project manager is permitted to alter either the performance, cost, or schedule software acquisition baseline while maintaining the other two constant.	Weakness	Weakness	Observation	Weakness	Weakness
Ability 4	The project team and matrix support individual(s) have experience or receive training in project office software acquisition management activities.	Observation	Observation	Observation	Observation	Observation
Activity 1	The project team documents its plans for software acquisition management activities.	Weakness	Weakness	Weakness	Strength	Strength
Activity 2	The project team is organized to accomplish the project's objectives.	Strength	Strength	Strength	Strength	Strength
Activity 3	The software acquisition activities of the project team are directed to accomplish the project's objectives.	Strength	Strength	Not rated	Weakness	Strength
Activity 4	The software acquisition activities of the project team are controlled.	Strength	Strength	Not rated	Strength	Weakness
Activity 5	Measurements are used to track project status, execution, and funding expenditures.	Strength	Strength	Not rated	Strength	Strength
Measurement 1	Measurements are made and used to determine the status of the project office management activities.	Weakness	Weakness	Weakness	Weakness	Weakness
Verification 1	The activities for project office management are reviewed by acquisition organization management on a periodic basis.	Weakness	Weakness	Weakness	Weakness	Weakness

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	<b>Key Practice</b>	<b>ARTSIIE</b>	<b>DSR</b>	<b>NIMS</b>	<b>VSCS</b>	<b>WARP</b>
Verification 2	The activities for project office management are reviewed by the project manager on both a periodic and event-driven basis.	Weakness	Weakness	Weakness	Weakness	Weakness

-  = **Weakness** Key practice not implemented
-  = **Strength** Key practice effectively implemented
-  = **Observation** Key practice evaluated but evidence inconclusive. Cannot characterize as either strength or weakness
-  = **Not rated** Key practice not currently relevant to project, therefore not evaluated

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**Table 5.1: Project Office Management Findings for ARTSIIE**

**Automated Radar Terminal System IIIE**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for execution of the software project.	FAA Order 1810.1F was cited as the written policy, but it does not contain policy for software project execution.	Weakness
Commitment 2	Performance, cost, and schedule baselines are supported.	Performance, cost, and schedule baselines are supported.	Strength
Ability 1	A project team that is responsible for performing the project's software acquisition management activities exists.	The product team is responsible for performing software acquisition management activities.	Strength
Ability 2	Adequate resources for the project team and matrix support organization(s) are provided for the duration of the software acquisition project.	No mechanism exists for identifying resources required and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	The project manager is permitted to alter either the performance, cost, or schedule software acquisition baseline while maintaining the other two constant.	The acquisition baseline process does not allow the project manager to alter the baseline.	Weakness
Ability 4	The project team and matrix support individual(s) have experience or receive training in project office software acquisition management activities.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	The project team documents its plans for software acquisition management activities.	The project plans do not address software acquisition project management.	Weakness
Activity 2	The project team is organized to accomplish the project's objectives.	The product team is organized to accomplish the project's objectives.	Strength
Activity 3	The software acquisition activities of the project team are directed to accomplish the project's objectives.	The activities of the product team are directed and controlled to accomplish the project's objectives.	Strength
Activity 4	The software acquisition activities of the project team are controlled.	The software activities of the product team are controlled.	Strength
Activity 5	Measurements are used to track project status, execution, and funding expenditures.	Measurements are used to track project status, execution, and funding expenditures.	Strength
Measurement 1	Measurements are made and used to determine the status of the project office management activities.	No internal process measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness
Verification 1	The activities for project office management are reviewed by acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for project office management are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

**Table 5.2: Project Office Management Findings for DSR**

**Display System Replacement**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for execution of the software project.	FAA Order 1810.1F was cited as the written policy, but it does not contain policy for software project execution.	Weakness
Commitment 2	Performance, cost, and schedule baselines are supported.	Performance, cost, and schedule baselines are supported.	Strength
Ability 1	A project team that is responsible for performing the project's software acquisition management activities exists.	The product team is responsible for managing the software acquisition management activities.	Strength
Ability 2	Adequate resources for the project team and matrix support organization(s) are provided for the duration of the software acquisition project.	No mechanism exists for identifying resources required and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	The project manager is permitted to alter either the performance, cost, or schedule software acquisition baseline while maintaining the other two constant.	The product team leader cannot alter the performance, cost, or schedule software acquisition baseline.	Weakness
Ability 4	The project team and matrix support individual(s) have experience or receive training in project office software acquisition management activities.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	The project team documents its plans for software acquisition management activities.	Plans for software acquisition management activities are not documented.	Weakness
Activity 2	The project team is organized to accomplish the project's objectives.	The product team is organized to achieve the project's objectives.	Strength
Activity 3	The software acquisition activities of the project team are directed to accomplish the project's objectives.	The software acquisition activities of the product team are directed to accomplish the project's objectives.	Strength
Activity 4	The software acquisition activities of the project team are controlled.	The software acquisition activities of the product team are controlled by the Integrated Product Team leader.	Strength
Activity 5	Measurements are used to track project status, execution, and funding expenditures.	The product team is using measurements to track product status, execution, and funding expenditures.	Strength
Measurement 1	Measurements are made and used to determine the status of the project office management activities.	No internal process measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness
Verification 1	The activities for project office management are reviewed by acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for project office management are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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**Table 5.3: Project Office Management Findings for NIMS**

<b>NAS Infrastructure Management System</b>			
	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for execution of the software project.	The policy for project office management is contained in the Acquisition Management System.	Strength
Commitment 2	Performance, cost, and schedule baselines are supported.	Performance, cost, and schedule baselines were developed and are being reviewed through the Acquisition Program Baseline process.	Strength
Ability 1	A project team that is responsible for performing the project's software acquisition management activities exists.	The product team is assigned the responsibility for acquisition management activities. However, no one is assigned responsibility for software acquisition management activities.	Weakness
Ability 2	Adequate resources for the project team and matrix support organization(s) are provided for the duration of the software acquisition project.	No mechanism exists for identifying resources required and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	The project manager is permitted to alter either the performance, cost, or schedule software acquisition baseline while maintaining the other two constant.	Officials said they could change the cost, performance, or schedule baseline, but could not provide documentation to support this.	Observation
Ability 4	The project team and matrix support individual(s) have experience or receive training in project office software acquisition management activities.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	The project team documents its plans for software acquisition management activities.	The Integrated Program Plan and the Product Team Plan provide plans for acquisition management, but these do not address software acquisition management activities.	Weakness
Activity 2	The project team is organized to accomplish the project's objectives.	The product team is being organized to accomplish the project's objectives.	Strength
Activity 3	The software acquisition activities of the project team are directed to accomplish the project's objectives.	Too early in project life to assess: no software acquisition activities performed.	Not rated
Activity 4	The software acquisition activities of the project team are controlled.	Too early in project life to assess: no software acquisition activities performed.	Not rated
Activity 5	Measurements are used to track project status, execution, and funding expenditures.	The project has not reached a stage where this activity applies.	Not rated
Measurement 1	Measurements are made and used to determine the status of the project office management activities.	No internal process measurements are taken to determine the status of activities for any of the key process areas.	Weakness

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**NAS Infrastructure Management System**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Verification 1	The activities for project office management are reviewed by acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for project office management are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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**Table 5.4: Project Office Management Findings for VSCS**

<b>Voice Switching and Control System</b>			
	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for execution of the software project.	FAA Order 1810.1F was cited as the written policy, but it does not contain policy for software project execution.	Weakness
Commitment 2	Performance, cost, and schedule baselines are supported.	Performance, cost, and schedule baselines are not supported.	Weakness
Ability 1	A project team that is responsible for performing the project's software acquisition management activities exists.	The product team is responsible for performing software acquisition management activities.	Strength
Ability 2	Adequate resources for the project team and matrix support organization(s) are provided for the duration of the software acquisition project.	No mechanism exists for identifying the resources required and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	The project manager is permitted to alter either the performance, cost, or schedule software acquisition baseline while maintaining the other two constant.	The product team leader does not have the flexibility to alter cost, performance, or schedule while maintaining the other two.	Weakness
Ability 4	The project team and matrix support individual(s) have experience or receive training in project office software acquisition management activities.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	The project team documents its plans for software acquisition management activities.	The Product Team Plan and the Contract Management Plan document acquisition activities.	Strength
Activity 2	The project team is organized to accomplish the project's objectives.	The product team is organized to accomplish the project's objectives.	Strength
Activity 3	The software acquisition activities of the project team are directed to accomplish the project's objectives.	While officials stated that software activities of the team are directed to accomplish the project's objectives, documents provided do not specify the activities that the team members must accomplish.	Weakness
Activity 4	The software acquisition activities of the project team are controlled.	The software acquisition activities are controlled.	Strength
Activity 5	Measurements are used to track project status, execution, and funding expenditures.	Measurements are used to track project status, execution, and funding expenditures.	Strength
Measurement 1	Measurements are made and used to determine the status of the project office management activities.	No internal process measurements are taken or used to determine the status of activities for any of the key process areas.	Weakness
Verification 1	The activities for project office management are reviewed by acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for project office management are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness



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**Table 5.5: Project Office Management Findings for WARP**

**Weather and Radar Processor**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for execution of the software project.	FAA Order 1810.1F was cited as the written policy, but it does not contain policy for software project execution.	Weakness
Commitment 2	Performance, cost, and schedule baselines are supported.	Performance, cost, and schedule baselines are generated and supported.	Strength
Ability 1	A project team that is responsible for performing the project's software acquisition management activities exists.	The product team is responsible for performing software acquisition management activities.	Strength
Ability 2	Adequate resources for the project team and matrix support organization(s) are provided for the duration of the software acquisition project.	No mechanism exists for identifying and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	The project manager is permitted to alter either the performance, cost, or schedule software acquisition baseline while maintaining the other two constant.	The acquisition baseline process does not allow the project manager to alter the baseline.	Weakness
Ability 4	The project team and matrix support individual(s) have experience or receive training in project office software acquisition management activities.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	The project team documents its plans for software acquisition management activities.	The product team documents its plans for software acquisition management activities.	Strength
Activity 2	The project team is organized to accomplish the project's objectives.	The product team is organized to accomplish the project's objectives.	Strength
Activity 3	The software acquisition activities of the project team are directed to accomplish the project's objectives.	The software acquisition activities of the project team are directed to accomplish the project's objectives.	Strength
Activity 4	The software acquisition activities of the project team are controlled.	No individual is controlling the software acquisition activities of the product team.	Weakness
Activity 5	Measurements are used to track project status, execution, and funding expenditures.	Measurements are used to track project status, execution, and funding status.	Strength
Measurement 1	Measurements are made and used to determine the status of the project office management activities.	No internal process measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness
Verification 1	The activities for project office management are reviewed by acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for project office management are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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## **Conclusions**

Numerous ad hoc project office management practices, including a pervasive lack of measurement, analysis, and verification of project status and progress, are limiting FAA's ability to meet ATC modernization project commitments. More discipline and definition in this KPA is needed before ATC modernization teams can consistently repeat project successes.

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# Contract Tracking and Oversight

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The purpose of contract tracking and oversight is to ensure that (1) the software development contractor performs according to the terms of the contract; (2) needed contract changes are identified, negotiated, and incorporated into the contract; and (3) contractor performance issues are identified early, when they are easier to address. According to the SA-CMM, a repeatable contract tracking and oversight process, among other things, includes (1) having a written organizational policy for contract tracking and oversight, (2) having a documented plan for contract tracking and oversight, (3) conducting tracking and oversight activities in accordance with the plan, and (4) ensuring that individuals performing contract tracking and oversight are suitably experienced or trained.

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## FAA Lacks an Effective Contract Tracking and Oversight Process

Our past work on ATC modernization projects has raised concerns about contract tracking and oversight. For example, in 1994 we reported that FAA did not provide adequate oversight of its contractor during the initial development of the ISSS.<sup>1</sup> As a result, development problems and lack of progress were not always recognized in a timely manner. The results of this software capability evaluation indicate that these problems persist and pinpoint the underlying contract tracking and oversight weaknesses. For example, FAA does not have a written organizational policy for contract tracking and oversight, and most teams have no documented plan for contract tracking and oversight activities. Furthermore, the team that has a plan does not always follow the plan, and none of the teams ensure that persons responsible for managing software contracts have suitable experience or training. As a result, the product teams cannot formulate an independent assessment of contract progress and are forced to rely on data provided by the contractor. Since contractor reports do not always identify problems expeditiously, FAA is not always positioned to correct them promptly.

Figure 6.1 provides a comprehensive listing of the five projects' strengths, weaknesses, and observations for the contractor tracking and oversight KPA. The specific findings supporting the practice ratings cited in figure 6.1 are in tables 6.1 through 6.5.

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<sup>1</sup>Advanced Automation System: Implications of Problems and Recent Changes (GAO/T-RCED-94-188, Apr. 13, 1994).





**Chapter 6  
Contract Tracking and Oversight**

**Figure 6.1: Contract Tracking and Oversight Summary**

	<b>Key Practice</b>	<b>ARTSIIE</b>	<b>DSR</b>	<b>NIMS</b>	<b>VSCS</b>	<b>WARP</b>
Commitment 1	The acquisition organization has a written policy for the contract tracking and oversight of the contracted software effort.	Weakness	Weakness	Not rated	Weakness	Weakness
Commitment 2	Responsibility for the contract tracking and oversight activities is designated.	Strength	Weakness	Not rated	Strength	Strength
Commitment 3	The project team is supported by contracting specialists in the execution of the contract.	Strength	Strength	Not rated	Strength	Strength
Ability 1	A group that is responsible for managing contract tracking and oversight activities exists.	Weakness	Strength	Not rated	Strength	Strength
Ability 2	Adequate resources are provided for contract tracking and oversight activities.	Weakness	Weakness	Not rated	Weakness	Weakness
Ability 3	Individuals performing contract tracking and oversight activities have experience or receive training.	Observation	Observation	Not rated	Observation	Observation
Activity 1	The project team documents its plans for contract tracking and oversight activities.	Weakness	Weakness	Not rated	Strength	Weakness
Activity 2	The project's contract tracking and oversight activities are performed in accordance with its plans.	Weakness	Weakness	Not rated	Weakness	Weakness
Activity 3	The project team reviews required contractor software planning documents which, when satisfactory, are made part of the contractor's baseline.	Observation	Strength	Not rated	Weakness	Strength
Activity 4	The project team, with end user input, conducts periodic reviews and interchanges with the contractor.	Strength	Observation	Not rated	Strength	Strength
Activity 5	The project team tracks the contractor's development of the software engineering environment required to support the software.	Strength	Strength	Not rated	Strength	Strength
Activity 6	Any problems or issues found by the project team during contract tracking and oversight are recorded in the appropriate corrective action system and tracked to closure.	Strength	Strength	Not rated	Strength	Strength
Activity 7	The project team maintains the integrity of the contract throughout the contract performance period.	Weakness	Strength	Not rated	Weakness	Strength

**Chapter 6**  
**Contract Tracking and Oversight**

	<b>Key Practice</b>	<b>ARTSIIE</b>	<b>DSR</b>	<b>NIMS</b>	<b>VSCS</b>	<b>WARP</b>
Measurement 1	Measurements are made and used to determine the status of the contract tracking and oversight activities.	Weakness	Weakness	Not rated	Weakness	Weakness
Verification 1	The activities for contract tracking and oversight are reviewed by acquisition organization management on a periodic basis.	Weakness	Weakness	Not rated	Weakness	Weakness
Verification 2	The activities for contract tracking and oversight are reviewed by the project manager on both a periodic and event-driven basis.	Weakness	Weakness	Not rated	Weakness	Weakness

-  = **Weakness** Key practice not implemented
-  = **Strength** Key practice effectively implemented
-  = **Observation** Key practice evaluated but evidence inconclusive. Cannot characterize as either strength or weakness
-  = **Not rated** Key practice not currently relevant to project, therefore not evaluated

**Chapter 6**  
**Contract Tracking and Oversight**

**Table 6.1: Contract Tracking and Oversight Findings for ARTSIIE**

**Automated Radar Terminal System IIIE**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for the contract tracking and oversight of the contracted software effort.	FAA Order 1810.1F was cited as the written policy, but it does not provide the policy for contract tracking and oversight.	Weakness
Commitment 2	Responsibility for the contract tracking and oversight activities is designated.	Responsibility for contract tracking and oversight is designated.	Strength
Commitment 3	The project team is supported by contracting specialists in the execution of the contract.	Contract specialists are assigned to the product team.	Strength
Ability 1	A group that is responsible for managing contract tracking and oversight activities exists.	Officials gave conflicting statements as to who has the responsibility for contract tracking and oversight activities, and could not provide documentation that formally delegates responsibility.	Weakness
Ability 2	Adequate resources are provided for contract tracking and oversight activities.	No mechanism exists for identifying resources required and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	Individuals performing contract tracking and oversight activities have experience or receive training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	The project team documents its plans for contract tracking and oversight activities.	Contract tracking and oversight plans do not exist.	Weakness
Activity 2	The project's contract tracking and oversight activities are performed in accordance with its plans.	No plan exists, therefore, activities cannot be performed in accordance with it.	Weakness
Activity 3	The project team reviews required contractor software planning documents which, when satisfactory, are made part of the contractor's baseline.	While officials stated that the product team reviews contractor software planning documents, they could not provide documentation to support this.	Observation
Activity 4	The project team, with end user input, conducts periodic reviews and interchanges with the contractor.	Periodic reviews are held.	Strength
Activity 5	The project team tracks the contractor's development of the software engineering environment required to support the software.	The product team tracks the development of the software engineering environment.	Strength
Activity 6	Any problems or issues found by the project team during contract tracking and oversight are recorded in the appropriate corrective action system and tracked to closure.	Issues found during meetings and reviews are documented in minutes and tracked.	Strength

(continued)

**Chapter 6**  
**Contract Tracking and Oversight**

**Automated Radar Terminal System IIIE**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Activity 7	The project team maintains the integrity of the contract throughout the contract performance period.	While product team members (including the contracting officer) stated that the contracting officer is responsible for maintaining the integrity of the contract, they could not provide any documents that support this.	Weakness
Measurement 1	Measurements are made and used to determine the status of the contract tracking and oversight activities.	No internal process measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness
Verification 1	The activities for contract tracking and oversight are reviewed by acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for contract tracking and oversight are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

**Chapter 6**  
**Contract Tracking and Oversight**

**Table 6.2: Contract Tracking and Oversight Findings for DSR**

**Display System Replacement**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for the contract tracking and oversight of the contracted software effort.	FAA Order 1810.1F was cited as the written policy, but it does not provide the policy for contract tracking and oversight.	Weakness
Commitment 2	Responsibility for the contract tracking and oversight activities is designated.	Officials gave conflicting answers on who is responsible for contract tracking and oversight, and they could not provide documentation that formally delegates responsibility.	Weakness
Commitment 3	The project team is supported by contracting specialists in the execution of the contract.	The product team is supported by a contracting specialist in execution of the contract.	Strength
Ability 1	A group that is responsible for managing contract tracking and oversight activities exists.	The product team is responsible for managing contract tracking and oversight activities.	Strength
Ability 2	Adequate resources are provided for contract tracking and oversight activities.	No mechanism exists for identifying resources required and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	Individuals performing contract tracking and oversight activities have experience or receive training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	The project team documents its plans for contract tracking and oversight activities.	There are no written plans for contract tracking and oversight activities.	Weakness
Activity 2	The project's contract tracking and oversight activities are performed in accordance with its plans.	No plan exists, therefore, the product team cannot perform in accordance with it.	Weakness
Activity 3	The project team reviews required contractor software planning documents which, when satisfactory, are made part of the contractor's baseline.	Reviews are used to approve contract planning documents, which, when satisfactory, are made part of the contractor's baseline.	Strength
Activity 4	The project team, with end user input, conducts periodic reviews and interchanges with the contractor.	While it was stated that continuous interactions with the contractor are held, officials could provide no documents to support this.	Observation
Activity 5	The project team tracks the contractor's development of the software engineering environment required to support the software.	The product team tracks the contractor's development of the software engineering environment required to support the software.	Strength
Activity 6	Any problems or issues found by the project team during contract tracking and oversight are recorded in the appropriate corrective action system and tracked to closure.	The product team records problems and issues found during contract tracking and oversight and tracks them to closure.	Strength

(continued)



**Chapter 6**  
**Contract Tracking and Oversight**

**Display System Replacement**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Activity 7	The project team maintains the integrity of the contract throughout the contract performance period.	The product team maintains the integrity of the contract throughout the contract performance period.	Strength
Measurement 1	Measurements are made and used to determine the status of the contract tracking and oversight activities.	No internal process measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness
Verification 1	The activities for contract tracking and oversight are reviewed by acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for contract tracking and oversight are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

**Chapter 6  
Contract Tracking and Oversight**

**Table 6.3: Contract Tracking and Oversight Findings for NIMS**

**NAS Infrastructure Management System**

	<b>Key Practice</b>	<b>Findings</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for the contract tracking and oversight of the contracted software effort.	Since NIMS is not under contract yet, it was not evaluated against this KPA.	Not rated
Commitment 2	Responsibility for the contract tracking and oversight activities is designated.	Too early to assess: the project has not reached a stage where this applies.	Not rated
Commitment 3	The project team is supported by contracting specialists in the execution of the contract.	Too early to assess: the project has not reached a stage where this applies.	Not rated
Ability 1	A group that is responsible for managing contract tracking and oversight activities exists.	Too early to assess: the project has not reached a stage where this applies.	Not rated
Ability 2	Adequate resources are provided for contract tracking and oversight activities.	Too early to assess: the project has not reached a stage where this applies.	Not rated
Ability 3	Individuals performing contract tracking and oversight activities have experience or receive training.	Too early to assess: the project has not reached a stage where this applies.	Not rated
Activity 1	The project team documents its plans for contract tracking and oversight activities.	Too early to assess: the project has not reached a stage where this applies.	Not rated
Activity 2	The project's contract tracking and oversight activities are performed in accordance with its plans.	Too early to assess: the project has not reached a stage where this applies.	Not rated
Activity 3	The project team reviews required contractor software planning documents which, when satisfactory, are made part of the contractor's baseline.	Too early to assess: the project has not reached a stage where this applies.	Not rated
Activity 4	The project team, with end user input, conducts periodic reviews and interchanges with the contractor.	Too early to assess: the project has not reached a stage where this applies.	Not rated
Activity 5	The project team tracks the contractor's development of the software engineering environment required to support the software.	Too early to assess: the project has not reached a stage where this applies.	Not rated
Activity 6	Any problems or issues found by the project team during contract tracking and oversight are recorded in the appropriate corrective action system and tracked to closure.	Too early to assess: the project has not reached a stage where this applies.	Not rated
Activity 7	The project team maintains the integrity of the contract throughout the contract performance period.	Too early to assess: the project has not reached a stage where this applies.	Not rated
Measurement 1	Measurements are made and used to determine the status of the contract tracking and oversight activities.	Too early to assess: the project has not reached a stage where this applies.	Not rated

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**Chapter 6**  
**Contract Tracking and Oversight**

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**NAS Infrastructure Management System**

	<b>Key Practice</b>	<b>Findings</b>	<b>Rating</b>
Verification 1	The activities for contract tracking and oversight are reviewed by acquisition organization management on a periodic basis.	Too early to assess: the project has not reached a stage where this applies.	Not rated
Verification 2	The activities for contract tracking and oversight are reviewed by the project manager on both a periodic and event-driven basis.	Too early to assess: the project has not reached a stage where this applies.	Not rated

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**Chapter 6**  
**Contract Tracking and Oversight**

**Table 6.4: Contract Tracking and Oversight Findings for VSCS**

**Voice Switching and Control System**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for the contract tracking and oversight of the contracted software effort.	There is no policy on contract tracking and oversight.	Weakness
Commitment 2	Responsibility for the contract tracking and oversight activities is designated.	Responsibility for contract tracking and oversight is designated.	Strength
Commitment 3	The project team is supported by contracting specialists in the execution of the contract.	The product team is supported by a contracting specialist.	Strength
Ability 1	A group that is responsible for managing contract tracking and oversight activities exists.	A group exists that is responsible for managing contract tracking and oversight.	Strength
Ability 2	Adequate resources are provided for contract tracking and oversight activities.	No mechanism exists for identifying the resources required and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	Individuals performing contract tracking and oversight activities have experience or receive training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	The project team documents its plans for contract tracking and oversight activities.	The product team has documented its plans.	Strength
Activity 2	The project's contract tracking and oversight activities are performed in accordance with its plans.	The product team could not provide evidence that shows its contracting tracking and oversight activities are performed in accordance with its plans.	Weakness
Activity 3	The project team reviews required contractor software planning documents which, when satisfactory, are made part of the contractor's baseline.	While reviews are conducted, officials could not provide documentation that shows the results are made part of the contractor's baseline.	Weakness
Activity 4	The project team, with end user input, conducts periodic reviews and interchanges with the contractor.	The product team conducts periodic reviews and interchanges with the contractor.	Strength
Activity 5	The project team tracks the contractor's development of the software engineering environment required to support the software.	The contractor is required to provide a list of common tools and support equipment, which the product team uses to track the software engineering environment development.	Strength
Activity 6	Any problems or issues found by the project team during contract tracking and oversight are recorded in the appropriate corrective action system and tracked to closure.	The contractor has an extensive software development environment and problems or issues are tracked to closure.	Strength
Activity 7	The project team maintains the integrity of the contract throughout the contract performance period.	There is no evidence that either the contracting officer or the product team are following the process and maintaining the integrity of the contract.	Weakness

(continued)

**Chapter 6**  
**Contract Tracking and Oversight**

**Voice Switching and Control System**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Measurement 1	Measurements are made and used to determine the status of the contract tracking and oversight activities.	No internal process measurements are taken or used to determine the status of activities for any of the key process areas.	Weakness
Verification 1	The activities for contract tracking and oversight are reviewed by acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for contract tracking and oversight are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

**Chapter 6**  
**Contract Tracking and Oversight**

**Table 6.5: Contract Tracking and Oversight Findings for WARP**

**Weather and Radar Processor**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for the contract tracking and oversight of the contracted software effort.	There is no written policy for contract tracking and oversight activities.	Weakness
Commitment 2	Responsibility for the contract tracking and oversight activities is designated.	The product team is responsible for contract tracking and oversight activities.	Strength
Commitment 3	The project team is supported by contracting specialists in the execution of the contract.	The product team is supported by contracting specialists.	Strength
Ability 1	A group that is responsible for managing contract tracking and oversight activities exists.	The product team is collectively responsible for contract tracking and oversight activities.	Strength
Ability 2	Adequate resources are provided for contract tracking and oversight activities.	No mechanism exists for identifying and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	Individuals performing contract tracking and oversight activities have experience or receive training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	The project team documents its plans for contract tracking and oversight activities.	Plans for contract tracking and oversight activities are not documented.	Weakness
Activity 2	The project's contract tracking and oversight activities are performed in accordance with its plans.	Since there is no contract tracking and oversight plan, there is no way to assess whether activities are being performed in accordance with the plan.	Weakness
Activity 3	The project team reviews required contractor software planning documents which, when satisfactory, are made part of the contractor's baseline.	The product team reviews required contractor software planning documents which, when satisfactory, are made part of the contractor's baseline.	Strength
Activity 4	The project team, with end user input, conducts periodic reviews and interchanges with the contractor.	The product team conducts periodic reviews and interchanges with the contractor.	Strength
Activity 5	The project team tracks the contractor's development of the software engineering environment required to support the software.	As a deliverable, the status of the software support environment development is reviewed and tracked.	Strength
Activity 6	Any problems or issues found by the project team during contract tracking and oversight are recorded in the appropriate corrective action system and tracked to closure.	The contracting officer's technical representative is responsible for managing and tracking action items, and these are recorded in an appropriate correction system.	Strength
Activity 7	The project team maintains the integrity of the contract throughout the contract performance period.	The contracting officer maintains the integrity of the contract and is responsible for doing so throughout the contract performance period.	Strength

(continued)

**Chapter 6**  
**Contract Tracking and Oversight**

**Weather and Radar Processor**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Measurement 1	Measurements are made and used to determine the status of the contract tracking and oversight activities.	No internal process measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness
Verification 1	The activities for contract tracking and oversight are reviewed by acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for contract tracking and oversight are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

**Conclusions**

To effectively and efficiently acquire software, FAA must have a well-defined and enforced process that provides for proactive tracking and oversight of its software development contractors. FAA's current process for ATC modernization contractor tracking and oversight is ad hoc and reactive, thereby increasing the chances of its ATC software acquisitions being late, costing more than expected, and not performing as intended.

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**Chapter 6**  
**Contract Tracking and Oversight**

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# Evaluation

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The purpose of evaluation, or testing, is to determine that the acquired software products and services satisfy contract requirements prior to acceptance. According to the SA-CMM, a repeatable evaluation process includes (1) documenting evaluation plans and conducting evaluation activities in accordance with the plan, (2) developing and managing evaluation requirements in conjunction with developing software technical requirements, (3) incorporating evaluation requirements into the solicitation and the resulting contract, (4) tracking contractor performance of evaluation activities for compliance with the contract, (5) ensuring that adequate resources are provided for evaluation activities, and (6) measuring and reporting on the status of evaluation activities to management.

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## FAA Is Strong in Most but Not All Evaluation KPA Practices

All of the projects were strong in many evaluation practice areas. For example, all rated projects have documented test and evaluation plans and conduct test and evaluation activities in accordance with the plans. In addition, most teams develop evaluation requirements for contractor-conducted software tests concurrent with developing software technical requirements, and all teams incorporate evaluation requirements into the solicitation and resulting contract. Also, most teams track contractor performance of test activities for compliance with the contract.

Despite these many strengths, several weaknesses prevented FAA from meeting this KPA. For example, only one of the teams ensures that adequate resources are provided for evaluation activities. Additionally, none of the teams measure and report on the status of all evaluation activities to management. As a result, management does not have a complete and accurate picture of evaluation status and progress, which could impair decision-making.

Figure 7.1 provides a comprehensive listing of the five projects' strengths, weaknesses, and observations for the evaluation KPA. The specific findings supporting the practice ratings cited in figure 7.1 are in tables 7.1 through 7.5.





**Chapter 7  
Evaluation**

**Figure 7.1: Evaluation Summary**

	<b>Key Practice</b>	<b>ARTSIIE</b>	<b>DSR</b>	<b>NIMS</b>	<b>VSCS</b>	<b>WARP</b>
Commitment 1	The acquisition organization has a written policy for managing the evaluation of the acquired software products and services.	Strength	Strength	Strength	Strength	Strength
Commitment 2	Responsibility for evaluation activities is clearly defined.	Strength	Strength	Observation	Strength	Strength
Ability 1	A group that is responsible for planning, managing, and performing evaluation activities for the project exists.	Strength	Strength	Strength	Strength	Strength
Ability 2	Adequate resources are provided for evaluation activities.	Weakness	Strength	Weakness	Weakness	Weakness
Ability 3	Individuals performing evaluation activities have experience or receive training.	Observation	Observation	Observation	Observation	Observation
Ability 4	Members of the project team and groups supporting the software acquisition receive orientation on the objectives of the evaluation approach.	Weakness	Strength	Weakness	Strength	Observation
Activity 1	The project team documents its plans for evaluation activities.	Strength	Strength	Strength	Strength	Strength
Activity 2	The project's evaluation activities are performed in accordance with its plans.	Strength	Strength	Not rated	Strength	Not rated
Activity 3	Evaluation requirements are developed and managed in conjunction with development of the system or software technical requirements.	Strength	Strength	Observation	Strength	Strength
Activity 4	The evaluation requirements are incorporated into the solicitation and resulting contract.	Strength	Strength	Strength	Strength	Strength
Activity 5	The project team tracks contractor's performance in terms of evaluation requirements for compliance with the contract.	Strength	Strength	Not rated	Strength	Not rated
Activity 6	Planned evaluations are performed on the acquired software products and services prior to acceptance for operational use.	Strength	Strength	Not rated	Strength	Not rated
Activity 7	Results of the evaluations are analyzed and compared to the contract's requirements to establish a basis for acceptance.	Strength	Strength	Not rated	Strength	Not rated
Measurement 1	Measurements are made and used to determine the status of the evaluation activities.	Weakness	Weakness	Weakness	Weakness	Weakness
Verification 1	The activities for evaluation are reviewed with acquisition organization management on a periodic basis.	Weakness	Weakness	Weakness	Weakness	Weakness

**Chapter 7  
Evaluation**

	<b>Key Practice</b>	<b>ARTSIIE</b>	<b>DSR</b>	<b>NIMS</b>	<b>VSCS</b>	<b>WARP</b>
Verification 2	The activities for evaluation are reviewed with the project manager on both a periodic and event-driven basis.	Weakness	Weakness	Weakness	Weakness	Weakness

-  = **Weakness** Key practice not implemented
-  = **Strength** Key practice effectively implemented
-  = **Observation** Key practice evaluated but evidence inconclusive. Cannot characterize as either strength or weakness
-  = **Not rated** Key practice not currently relevant to project, therefore not evaluated

**Chapter 7  
Evaluation**

**Table 7.1: Evaluation Findings for ARTSIIE**

<b>Automated Radar Terminal System IIE</b>			
	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for managing the evaluation of the acquired software products and services.	FAA Order 1810.4B is the written policy.	Strength
Commitment 2	Responsibility for evaluation activities is clearly defined.	Evaluation responsibility is clearly defined.	Strength
Ability 1	A group that is responsible for planning, managing, and performing evaluation activities for the project exists.	The product team is responsible for evaluation activities.	Strength
Ability 2	Adequate resources are provided for evaluation activities.	No mechanism exists for identifying resources required and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	Individuals performing evaluation activities have experience or receive training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Ability 4	Members of the project team and groups supporting the software acquisition receive orientation on the objectives of the evaluation approach.	The product team did not receive orientation on the evaluation approach.	Weakness
Activity 1	The project team documents its plans for evaluation activities.	The Test and Evaluation Master Plan delineates all evaluation activities.	Strength
Activity 2	The project's evaluation activities are performed in accordance with its plans.	Evaluation activities are performed in accordance with plans.	Strength
Activity 3	Evaluation requirements are developed and managed in conjunction with development of the system or software technical requirements.	Evaluation requirements are developed and managed in conjunction with development of the system or software technical requirements.	Strength
Activity 4	The evaluation requirements are incorporated into the solicitation and resulting contract.	Evaluation requirements are part of the contract.	Strength
Activity 5	The project team tracks contractor's performance in terms of evaluation requirements for compliance with the contract.	The evaluation activities performed by the contractor are tracked.	Strength
Activity 6	Planned evaluations are performed on the acquired software products and services prior to acceptance for operational use.	Planned evaluations are performed to ensure that technical and contract requirements are met prior to acceptance.	Strength
Activity 7	Results of the evaluations are analyzed and compared to the contract's requirements to establish a basis for acceptance.	Technical and contract requirements are met prior to acceptance.	Strength
Measurement 1	Measurements are made and used to determine the status of the evaluation activities.	No internal process measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness

(continued)

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**Chapter 7  
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**Automated Radar Terminal System IIIE**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Verification 1	The activities for evaluation are reviewed with acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for evaluation are reviewed with the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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**Table 7.2: Evaluation Findings for DSR**

<b>Display System Replacement</b>			
	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for managing the evaluation of the acquired software products and services.	FAA Order 1810.4B is the written policy.	Strength
Commitment 2	Responsibility for evaluation activities is clearly defined.	The product team leader is responsible for evaluation activities.	Strength
Ability 1	A group that is responsible for planning, managing, and performing evaluation activities for the project exists.	The test and maintenance leader, along with the product team, are responsible for planning, managing, and performing evaluation activities.	Strength
Ability 2	Adequate resources are provided for evaluation activities.	Adequate resources are provided for evaluation activities.	Strength
Ability 3	Individuals performing evaluation activities have experience or receive training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Ability 4	Members of the project team and groups supporting the software acquisition receive orientation on the objectives of the evaluation approach.	Members of the project team received orientation on the evaluation approach.	Strength
Activity 1	The project team documents its plans for evaluation activities.	The product team documents its plans for evaluation activities.	Strength
Activity 2	The project's evaluation activities are performed in accordance with its plans.	The project's evaluation activities are performed in accordance with its plans.	Strength
Activity 3	Evaluation requirements are developed and managed in conjunction with development of the system or software technical requirements.	Evaluation requirements are developed in conjunction with the system requirements.	Strength
Activity 4	The evaluation requirements are incorporated into the solicitation and resulting contract.	The evaluation requirements are incorporated into the contract.	Strength
Activity 5	The project team tracks contractor's performance in terms of evaluation requirements for compliance with the contract.	The product team tracks the contractor's performance, in terms of evaluation requirements, using the A-level and B-level specifications in the contract as criteria.	Strength
Activity 6	Planned evaluations are performed on the acquired software products and services prior to acceptance for operational use.	Planned evaluations are performed on the acquired software products and services prior to acceptance for operational use.	Strength
Activity 7	Results of the evaluations are analyzed and compared to the contract's requirements to establish a basis for acceptance.	Results of evaluations are analyzed and compared to the contract's requirements to establish a basis for acceptance.	Strength
Measurement 1	Measurements are made and used to determine the status of the evaluation activities.	No internal process measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness

(continued)

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**Display System Replacement**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Verification 1	The activities for evaluation are reviewed with acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for evaluation are reviewed with the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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**Table 7.3: Evaluation Findings for NIMS**

<b>NAS Infrastructure Management System</b>			
	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for managing the evaluation of the acquired software products and services.	The Acquisition Management System is the written policy.	Strength
Commitment 2	Responsibility for evaluation activities is clearly defined.	Officials stated that the test leader is responsible for evaluation activities; however, they could not provide documentation to support this.	Observation
Ability 1	A group that is responsible for planning, managing, and performing evaluation activities for the project exists.	The product team has responsibility for planning, managing, and performing evaluation activities.	Strength
Ability 2	Adequate resources are provided for evaluation activities.	No mechanism exists for identifying resources required and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	Individuals performing evaluation activities have experience or receive training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Ability 4	Members of the project team and groups supporting the software acquisition receive orientation on the objectives of the evaluation approach.	Orientation on the objectives of the evaluation approach was not received.	Weakness
Activity 1	The project team documents its plans for evaluation activities.	The project team documents its plans for evaluation activities.	Strength
Activity 2	The project's evaluation activities are performed in accordance with its plans.	NIMS has not yet reached the stage where evaluation activities are being performed.	Not rated
Activity 3	Evaluation requirements are developed and managed in conjunction with development of the system or software technical requirements.	Too early to assess: system software requirements are not developed sufficiently to develop evaluation requirements.	Observation
Activity 4	The evaluation requirements are incorporated into the solicitation and resulting contract.	The evaluation requirements are incorporated into the solicitation through the statement of work, which will be part of the contract.	Strength
Activity 5	The project team tracks contractor's performance in terms of evaluation requirements for compliance with the contract.	NIMS has not yet reached the stage where evaluation activities are being performed.	Not rated
Activity 6	Planned evaluations are performed on the acquired software products and services prior to acceptance for operational use.	NIMS has not yet reached the stage where operational evaluation activities are being performed.	Not rated
Activity 7	Results of the evaluations are analyzed and compared to the contract's requirements to establish a basis for acceptance.	NIMS has not yet reached the stage where evaluation activities are analyzed and compared to the contract.	Not rated

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**NAS Infrastructure Management System**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Measurement 1	Measurements are made and used to determine the status of the evaluation activities.	No internal process measurements are taken to determine the status of activities for any of the key process areas.	Weakness
Verification 1	The activities for evaluation are reviewed with acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for evaluation are reviewed with the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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**Table 7.4: Evaluation Findings for VSCS**

**Voice Switching and Control System**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for managing the evaluation of the acquired software products and services.	FAA Order 1810.4B provides policy guidance.	Strength
Commitment 2	Responsibility for evaluation activities is clearly defined.	The Test and Evaluation Master Plan defines the responsibility for evaluation.	Strength
Ability 1	A group that is responsible for planning, managing, and performing evaluation activities for the project exists.	A group is assigned responsibility for planning, managing, and performing evaluation activities.	Strength
Ability 2	Adequate resources are provided for evaluation activities.	No mechanism exists for identifying the resources required and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	Individuals performing evaluation activities have experience or receive training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Ability 4	Members of the project team and groups supporting the software acquisition receive orientation on the objectives of the evaluation approach.	An orientation was conducted.	Strength
Activity 1	The project team documents its plans for evaluation activities.	Test and evaluation activities are documented.	Strength
Activity 2	The project's evaluation activities are performed in accordance with its plans.	Evaluation activities are performed in accordance with plans.	Strength
Activity 3	Evaluation requirements are developed and managed in conjunction with development of the system or software technical requirements.	Test and evaluation requirements are developed and managed in conjunction with system requirements.	Strength
Activity 4	The evaluation requirements are incorporated into the solicitation and resulting contract.	Evaluation requirements are part of the contract.	Strength
Activity 5	The project team tracks contractor's performance in terms of evaluation requirements for compliance with the contract.	The contractor's performance in terms of evaluation requirements is tracked through weekly meetings.	Strength
Activity 6	Planned evaluations are performed on the acquired software products and services prior to acceptance for operational use.	Evaluation procedures are documented in the Test and Evaluation Master Plan and are performed prior to acceptance.	Strength
Activity 7	Results of the evaluations are analyzed and compared to the contract's requirements to establish a basis for acceptance.	FAA conducts factory acceptance tests and compares results to the contract's requirements.	Strength
Measurement 1	Measurements are made and used to determine the status of the evaluation activities.	No internal process measurements are taken or used to determine the status of activities for any of the key process areas.	Weakness

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**Voice Switching and Control System**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Verification 1	The activities for evaluation are reviewed with acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for evaluation are reviewed with the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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**Table 7.5: Evaluation Findings for WARP**

<b>Weather and Radar Processor</b>			
	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for managing the evaluation of the acquired software products and services.	FAA Order 1810.4B is the written policy.	Strength
Commitment 2	Responsibility for evaluation activities is clearly defined.	Responsibility for evaluation activities has been clearly defined.	Strength
Ability 1	A group that is responsible for planning, managing, and performing evaluation activities for the project exists.	A group is responsible for evaluation activities for the project.	Strength
Ability 2	Adequate resources are provided for evaluation activities.	No mechanism exists for identifying and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	Individuals performing evaluation activities have experience or receive training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Ability 4	Members of the project team and groups supporting the software acquisition receive orientation on the objectives of the evaluation approach.	Orientation was not needed because the test leader and his team were familiar with the evaluation approach.	Observation
Activity 1	The project team documents its plans for evaluation activities.	The Test and Evaluation Master Plan documents the team's plan for evaluation activities.	Strength
Activity 2	The project's evaluation activities are performed in accordance with its plans.	WARP has not reached the stage where evaluation activities are being performed and can be compared to a plan.	Not rated
Activity 3	Evaluation requirements are developed and managed in conjunction with development of the system or software technical requirements.	Evaluation requirements are developed and managed in conjunction with development of system or software technical requirements.	Strength
Activity 4	The evaluation requirements are incorporated into the solicitation and resulting contract.	The evaluation requirements are incorporated into the solicitation and resulting contract.	Strength
Activity 5	The project team tracks contractor's performance in terms of evaluation requirements for compliance with the contract.	WARP has not reached the stage where the contractor is performing evaluation activities that can be tracked for compliance with contract.	Not rated
Activity 6	Planned evaluations are performed on the acquired software products and services prior to acceptance for operational use.	WARP has not yet reached the stage where evaluations are being performed.	Not rated
Activity 7	Results of the evaluations are analyzed and compared to the contract's requirements to establish a basis for acceptance.	WARP has not yet reached the stage where evaluations are being performed.	Not rated
Measurement 1	Measurements are made and used to determine the status of the evaluation activities.	No internal process measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness

(continued)

**Weather and Radar Processor**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Verification 1	The activities for evaluation are reviewed with acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for evaluation are reviewed with the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

**Conclusions**

FAA performs most but not all evaluation KPA practices. To satisfy all evaluation practices and thereby have reasonable assurance that its software acquisition projects will be effectively evaluated and tested on a repeatable basis, FAA must ensure that its product teams identify evaluation resource, training, and experience needs, and that they measure and brief management on the status of all evaluation activities.

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# Transition and Support

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The purpose of transition and support is to provide for the effective and efficient “hand-off” of the acquired software products to the support organization responsible for software maintenance. According to the SA-CMM, repeatable transition and support processes, among other things, include (1) having a written policy for transitioning software products to the support organization, (2) designating a group that is responsible for coordinating transition and support activities, (3) having a complete inventory of all software and related items that are to be transitioned, (4) including members of the support organization in transition and support planning, (5) requiring the support organization to demonstrate its capability to modify and support the software, and (6) measuring and reporting to management on the status of transition and support activities.

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## Transition and Support Not Being Performed Effectively

All of the projects were strong in several transition and support practice areas. For example, FAA has a written policy for transitioning software products to the support organization. Additionally, all five projects have designated a group responsible for transition and support. However, various weaknesses in other practices prevented FAA from satisfying this KPA. In particular, some of the teams lack a complete inventory of all the software and related products to be transitioned, thus jeopardizing the efforts of the support organization to effectively maintain the full software configuration. Additionally, one team did not include the software support organization in planning for transition and support, and some teams do not have plans to require the support organization to demonstrate its capability to maintain the software after transition. As a result, support problems, such as the inability to perform required maintenance, may result. Further, none of the projects are measuring and reporting to management on the status of transition and support activities, precluding management from addressing transition and support problems expeditiously.

Figure 8.1 provides a comprehensive listing of the five projects’ strengths, weaknesses, and observations for the transition and support KPA. The specific findings supporting the practice ratings cited in figure 8.1 are in tables 8.1 through 8.5.

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

**Figure 8.1: Transition and Support Summary**

	<b>Key Practice</b>	<b>ARTSIIE</b>	<b>DSR</b>	<b>NIMS</b>	<b>VSCS</b>	<b>WARP</b>
Commitment 1	The acquisition organization has a written policy for the transitioning of software products to the support organization.	Strength	Strength	Strength	Observation	Strength
Commitment 2	The acquisition organization ensures that the software support organization is involved in planning for transition and support.	Weakness	Strength	Strength	Strength	Strength
Ability 1	A group that is responsible for coordinating the transition and support activities exists.	Strength	Strength	Weakness	Strength	Strength
Ability 2	Responsibility for transition and support activities is designated.	Strength	Strength	Strength	Strength	Strength
Ability 3	Adequate resources are provided for transition and support activities.	Weakness	Weakness	Not rated	Weakness	Weakness
Ability 4	The organization responsible for providing support of the software products is identified no later than release of the solicitation.	Strength	Weakness	Not rated	Strength	Weakness
Ability 5	The software support organization has a complete inventory of all software and related items that are to be transitioned.	Strength	Weakness	Not rated	Weakness	Not rated
Ability 6	Individuals performing transition and support activities have experience or receive training.	Observation	Observation	Not rated	Observation	Observation
Ability 7	The members of organizations interfacing with the transition and support activities receive orientation on the salient aspects of the transition and support activities.	Weakness	Observation	Not rated	Observation	Not rated
Activity 1	The project team documents its plans for transition and support activities.	Strength	Strength	Not rated	Weakness	Strength
Activity 2	The project team's transition and support activities are performed in accordance with its plans.	Strength	Weakness	Not rated	Observation	Not rated
Activity 3	The project team transfers responsibility for the software products only after the support organization demonstrates its capability to modify and support the software products.	Weakness	Strength	Not rated	Weakness	Observation
Activity 4	The project team oversees the configuration control of the software products throughout the transition.	Strength	Strength	Not rated	Weakness	Not rated
Measurement 1	Measurements are made and used to determine the status of the transition and support activities.	Weakness	Weakness	Weakness	Weakness	Weakness
Verification 1	The activities for transition and support are reviewed with acquisition and software support organizations' management on a periodic basis.	Weakness	Weakness	Weakness	Weakness	Weakness



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	<b>Key Practice</b>	<b>ARTSIIE</b>	<b>DSR</b>	<b>NIMS</b>	<b>VSCS</b>	<b>WARP</b>
Verification 2	The activities for transition and support are reviewed with the project manager on both a periodic and event-driven basis.	Weakness	Weakness	Weakness	Weakness	Weakness

-  = **Weakness** Key practice not implemented
-  = **Strength** Key practice effectively implemented
-  = **Observation** Key practice evaluated but evidence inconclusive. Cannot characterize as either strength or weakness
-  = **Not rated** Key practice not currently relevant to project, therefore not evaluated

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**Table 8.1: Transition and Support Findings for ARTSIIIE**

**Automated Radar Terminal System IIIE**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for the transitioning of software products to the support organization.	FAA Order 1800.58 is the written policy.	Strength
Commitment 2	The acquisition organization ensures that the software support organization is involved in planning for transition and support.	The Product Team Plan identifies the organization responsible for software support, but transition is not mentioned.	Weakness
Ability 1	A group that is responsible for coordinating the transition and support activities exists.	A group responsible for coordinating the transition to support activities exists.	Strength
Ability 2	Responsibility for transition and support activities is designated.	Responsibility for transition and support activities is designated.	Strength
Ability 3	Adequate resources are provided for transition and support activities.	No mechanism exists for identifying resources required and for ensuring that the needed resources are provided to the project.	Weakness
Ability 4	The organization responsible for providing support of the software products is identified no later than release of the solicitation.	The Product Team Plan designates responsibility for providing support of the software products before release of the solicitation.	Strength
Ability 5	The software support organization has a complete inventory of all software and related items that are to be transitioned.	The software support organization has a complete inventory of all software and related items that are to be transitioned.	Strength
Ability 6	Individuals performing transition and support activities have experience or receive training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Ability 7	The members of organizations interfacing with the transition and support activities receive orientation on the salient aspects of the transition and support activities.	Orientation was not given.	Weakness
Activity 1	The project team documents its plans for transition and support activities.	The product team documents its plans for transition and support activities.	Strength
Activity 2	The project team's transition and support activities are performed in accordance with its plans.	The product team's activities are being conducted in accordance with its plans.	Strength
Activity 3	The project team transfers responsibility for the software products only after the support organization demonstrates its capability to modify and support the software products.	No certification procedures to test the capability of the support organization was provided.	Weakness
Activity 4	The project team oversees the configuration control of the software products throughout the transition.	The product team oversees the configuration management of the software throughout transition.	Strength
Measurement 1	Measurements are made and used to determine the status of the transition and support activities.	No internal process measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness

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**Automated Radar Terminal System IIIE**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Verification 1	The activities for transition and support are reviewed by acquisition and software support organizations' management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for transition and support are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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Transition and Support**

**Table 8.2: Transition and Support Findings for DSR**

<b>Display System Replacement</b>			
	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for the transitioning of software products to the support organization.	FAA has a written policy for transition and support.	Strength
Commitment 2	The acquisition organization ensures that the software support organization is involved in planning for transition and support.	The Product Team Plan identifies the individual responsible for support planning.	Strength
Ability 1	A group that is responsible for coordinating the transition and support activities exists.	The product team is responsible for transition and support activities.	Strength
Ability 2	Responsibility for transition and support activities is designated.	Responsibility is assigned to the product team for transition and support activities.	Strength
Ability 3	Adequate resources are provided for transition and support activities.	No mechanism exists for identifying resources required and for ensuring that the needed resources are provided to the project.	Weakness
Ability 4	The organization responsible for providing support of the software products is identified no later than release of the solicitation.	Although DSR is in the development stage, the support organization has not been identified.	Weakness
Ability 5	The software support organization has a complete inventory of all software and related items that are to be transitioned.	While documents are planned for configuration audits as part of the transition process, a complete inventory does not exist.	Weakness
Ability 6	Individuals performing transition and support activities have experience or receive training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Ability 7	The members of organizations interfacing with the transition and support activities receive orientation on the salient aspects of the transition and support activities.	While officials stated that orientation had occurred, they could not provide documents to support this.	Observation
Activity 1	The project team documents its plans for transition and support activities.	The Program Implementation Plan contains the plans for transition and support.	Strength
Activity 2	The project team's transition and support activities are performed in accordance with its plans.	Transition planning is being delayed pending a decision on who will provide maintenance.	Weakness
Activity 3	The project team transfers responsibility for the software products only after the support organization demonstrates its capability to modify and support the software products.	There is a plan for the support organization to demonstrate its capabilities prior to transition of responsibilities.	Strength
Activity 4	The project team oversees the configuration control of the software products throughout the transition.	The product team oversees the contractor, who will maintain configuration management throughout the transition.	Strength
Measurement 1	Measurements are made and used to determine the status of the transition and support activities.	No internal process measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness

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**Chapter 8**  
**Transition and Support**

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**Display System Replacement**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Verification 1	The activities for transition and support are reviewed by acquisition and software support organizations' management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for transition and support are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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**Chapter 8  
Transition and Support**

**Table 8.3: Transition and Support Findings for NIMS**

<b>NAS Infrastructure Management System</b>			
	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for the transitioning of software products to the support organization.	The Acquisition Management System is the written policy.	Strength
Commitment 2	The acquisition organization ensures that the software support organization is involved in planning for transition and support.	The software support organization is represented in the product team.	Strength
Ability 1	A group that is responsible for coordinating the transition and support activities exists.	Officials gave conflicting answers as to who is responsible for coordinating the transition and support activities, and they could not provide documentation that formally designates responsibility.	Weakness
Ability 2	Responsibility for transition and support activities is designated.	Responsibility for transition and support activities is designated.	Strength
Ability 3	Adequate resources are provided for transition and support activities.	It is too early in the project's cycle to evaluate this ability.	Not rated
Ability 4	The organization responsible for providing support of the software products is identified no later than release of the solicitation.	It is too early in the project's cycle to evaluate this ability.	Not rated
Ability 5	The software support organization has a complete inventory of all software and related items that are to be transitioned.	It is too early in the project's cycle to evaluate this ability.	Not rated
Ability 6	Individuals performing transition and support activities have experience or receive training.	It is too early in the project's cycle to evaluate this ability.	Not rated
Ability 7	The members of organizations interfacing with the transition and support activities receive orientation on the salient aspects of the transition and support activities.	It is too early in the project's cycle to evaluate this ability.	Not rated
Activity 1	The project team documents its plans for transition and support activities.	It is too early in the project's cycle to evaluate this activity.	Not rated
Activity 2	The project team's transition and support activities are performed in accordance with its plans.	It is too early in the project's cycle to evaluate this activity.	Not rated
Activity 3	The project team transfers responsibility for the software products only after the support organization demonstrates its capability to modify and support the software products.	It is too early in the project's cycle to evaluate this activity.	Not rated
Activity 4	The project team oversees the configuration control of the software products throughout the transition.	It is too early in the project's cycle to evaluate this activity.	Not rated
Measurement 1	Measurements are made and used to determine the status of the transition and support activities.	No internal process measurements are taken to determine the status of activities for any of the key process areas.	Weakness

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**NAS Infrastructure Management System**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Verification 1	The activities for transition and support are reviewed by acquisition and software support organizations' management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for transition and support are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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**Chapter 8**  
**Transition and Support**

**Table 8.4: Transition and Support Findings for VSCS**

**Voice Switching and Control System**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for the transitioning of software products to the support organization.	A written policy for transition exists; however, the officials interviewed did not identify it.	Observation
Commitment 2	The acquisition organization ensures that the software support organization is involved in planning for transition and support.	The acquisition organization ensured that the software support organization was involved in planning for transition and support.	Strength
Ability 1	A group that is responsible for coordinating the transition and support activities exists.	The product team is responsible for coordinating transition and support activities.	Strength
Ability 2	Responsibility for transition and support activities is designated.	Responsibility for transition and support activities is designated.	Strength
Ability 3	Adequate resources are provided for transition and support activities.	No mechanism exists for identifying the resources required and for ensuring that the needed resources are provided to the project.	Weakness
Ability 4	The organization responsible for providing support of the software products is identified no later than release of the solicitation.	The organization responsible was identified before the release of the solicitation.	Strength
Ability 5	The software support organization has a complete inventory of all software and related items that are to be transitioned.	The software support organization does not have a complete inventory of all software and related items that are to be transitioned.	Weakness
Ability 6	Individuals performing transition and support activities have experience or receive training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Ability 7	The members of organizations interfacing with the transition and support activities receive orientation on the salient aspects of the transition and support activities.	While officials said that members of organizations interfacing with the transition and support activities received orientation, they could not provide documentation to support this.	Observation
Activity 1	The project team documents its plans for transition and support activities.	Only a draft plan exists.	Weakness
Activity 2	The project team's transition and support activities are performed in accordance with its plans.	There is no plan for transition and support, therefore, the activity cannot be performed in accordance with it.	Weakness
Activity 3	The project team transfers responsibility for the software products only after the support organization demonstrates its capability to modify and support the software products.	No demonstrations were held for the support organization to demonstrate its capability to support the software products.	Weakness
Activity 4	The project team oversees the configuration control of the software products throughout the transition.	Since there is no transition and support plan, there is no evidence that this activity is being performed.	Weakness

(continued)



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**Chapter 8**  
**Transition and Support**

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**Voice Switching and Control System**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Measurement 1	Measurements are made and used to determine the status of the transition and support activities.	No internal process measurements are taken or used to determine the status of activities for any of the key process areas.	Weakness
Verification 1	The activities for transition and support are reviewed by acquisition and software support organizations' management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key processes.	Weakness
Verification 2	The activities for transition and support are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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**Chapter 8  
Transition and Support**

**Table 8.5: Transition and Support Findings for WARP**

<b>Weather and Radar Processor</b>			
	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for the transitioning of software products to the support organization.	There is a written policy for transition and support.	Strength
Commitment 2	The acquisition organization ensures that the software support organization is involved in planning for transition and support.	The support organization is part of the product team and is involved in planning for transition.	Strength
Ability 1	A group that is responsible for coordinating the transition and support activities exists.	The product team has the responsibility for coordinating the transition and support activities.	Strength
Ability 2	Responsibility for transition and support activities is designated.	Responsibility for transition and support activities is designated to the product team.	Strength
Ability 3	Adequate resources are provided for transition and support activities.	No mechanism exists for identifying and for ensuring that the needed resources are provided to the project.	Weakness
Ability 4	The organization responsible for providing support of the software products is identified no later than release of the solicitation.	The organization responsible for providing support of the software products was not chosen before the release of the solicitation.	Weakness
Ability 5	The software support organization has a complete inventory of all software and related items that are to be transitioned.	It is too early in the project's development for it to have developed an inventory.	Not rated
Ability 6	Individuals performing transition and support activities have experience or receive training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Ability 7	The members of organizations interfacing with the transition and support activities receive orientation on the salient aspects of the transition and support activities.	It is too early in the project's development for it to define support.	Not rated
Activity 1	The project team documents its plans for transition and support activities.	The Product Team Plan documents the initial plans for transition and support activities.	Strength
Activity 2	The project team's transition and support activities are performed in accordance with its plans.	It is too early in the project's development for it to be evaluated against this key practice.	Not rated
Activity 3	The project team transfers responsibility for the software products only after the support organization demonstrates its capability to modify and support the software products.	Officials gave conflicting answers as to whether or not the demonstration has been planned.	Observation
Activity 4	The project team oversees the configuration control of the software products throughout the transition.	It is too early in the project's development for it to be evaluated against this key practice.	Not rated
Measurement 1	Measurements are made and used to determine the status of the transition and support activities.	No internal process measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness

(continued)

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**Chapter 8**  
**Transition and Support**

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**Weather and Radar Processor**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Verification 1	The activities for transition and support are reviewed by acquisition and software support organizations' management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for transition and support are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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**Conclusions**

FAA's transition and support process for its ATC modernization suffers from weaknesses which render it undefined and undisciplined. In light of FAA's enormous investment in ATC-related software and the fact that over 65 percent of the life cycle cost of software is incurred during maintenance, it is essential that these weaknesses be corrected.

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**Chapter 8**  
**Transition and Support**

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# Acquisition Risk Management

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SEI defines risk as the possibility of suffering a loss. The purpose of acquisition risk management is to formally identify risks as early as possible and adjust the acquisition to mitigate those risks. According to the SA-CMM, an effective risk management process, among other things, includes (1) having a written policy on acquisition risk management, (2) developing a software acquisition risk management plan, (3) conducting software risk management activities in accordance with the plan (e.g., identifying risks, taking mitigation actions, and tracking risk mitigation actions to completion), and (4) measuring and reporting on the status of acquisition risk management activities to management.

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## ATC Modernization Software Risk Management Is Ineffective

FAA is not effectively performing ATC modernization software acquisition risk management. Although FAA has a written policy on risk management, it has many weaknesses in this KPA. For example, most teams have no risk management plan, and the one team that has a plan failed to follow it. As a result, the teams are not identifying risks, taking risk mitigation actions, and tracking risk mitigation actions to completion. Moreover, none of the teams measure and report to management on the status of acquisition risk management activities. Consequently, management is not in a position to correct problems promptly.

Figure 9.1 provides a comprehensive listing of the five projects' strengths, weaknesses, and observations for the acquisition risk management KPA. The specific findings supporting the practice ratings in figure 9.1 are in tables 9.1 through 9.5.





**Chapter 9  
Acquisition Risk Management**

**Figure 9.1: Acquisition Risk Management Summary**

	<b>Key Practice</b>	<b>ARTSIIE</b>	<b>DSR</b>	<b>NIMS</b>	<b>VSCS</b>	<b>WARP</b>
Commitment 1	The acquisition organization has a written policy for the management of acquisition risk.	<b>Strength</b>	<b>Strength</b>	<b>Weakness</b>	<b>Strength</b>	<b>Strength</b>
Ability 1	A group that is responsible for coordinating acquisition risk management activities exists.	<b>Weakness</b>	<b>Strength</b>	<b>Strength</b>	<b>Strength</b>	<b>Strength</b>
Ability 2	Adequate resources are provided for acquisition risk management activities.	<b>Weakness</b>	<b>Weakness</b>	<b>Weakness</b>	<b>Weakness</b>	<b>Weakness</b>
Ability 3	Individuals performing acquisition risk management activities have experience or receive required training.	<b>Observation</b>	<b>Observation</b>	<b>Observation</b>	<b>Observation</b>	<b>Observation</b>
Activity 1	Risk identification, analysis, and mitigation activities are integrated into software acquisition planning.	<b>Weakness</b>	<b>Strength</b>	<b>Strength</b>	<b>Weakness</b>	<b>Strength</b>
Activity 2	The Software Risk Management Plan is developed according to the project's defined software acquisition process.	<b>Weakness</b>	<b>Weakness</b>	<b>Weakness</b>	<b>Strength</b>	<b>Weakness</b>
Activity 3	The project's acquisition risk management activities are performed in accordance with its Software Risk Management Plan.	<b>Weakness</b>	<b>Weakness</b>	<b>Weakness</b>	<b>Weakness</b>	<b>Weakness</b>
Activity 4	The project team identifies, analyzes, and takes appropriate software risk mitigation actions during acquisition planning.	<b>Observation</b>	<b>Weakness</b>	<b>Weakness</b>	<b>Weakness</b>	<b>Strength</b>
Activity 5	Risk identification, analysis, and mitigation are conducted as an integral part of the project performance management and contract performance management processes.	<b>Weakness</b>	<b>Strength</b>	<b>Not rated</b>	<b>Weakness</b>	<b>Strength</b>
Activity 6	Software risk mitigation actions are tracked to completion.	<b>Weakness</b>	<b>Weakness</b>	<b>Observation</b>	<b>Weakness</b>	<b>Strength</b>
Measurement 1	Measurements are made and used to determine the status of the acquisition risk management activities.	<b>Weakness</b>	<b>Weakness</b>	<b>Weakness</b>	<b>Weakness</b>	<b>Weakness</b>
Measurement 2	Resources expended for acquisition risk management activities are recorded and tracked.	<b>Weakness</b>	<b>Weakness</b>	<b>Weakness</b>	<b>Weakness</b>	<b>Weakness</b>
Verification 1	The activities for acquisition risk management are reviewed by acquisition organization management on a periodic basis.	<b>Weakness</b>	<b>Weakness</b>	<b>Weakness</b>	<b>Weakness</b>	<b>Weakness</b>

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	<b>Key Practice</b>	<b>ARTSIIE</b>	<b>DSR</b>	<b>NIMS</b>	<b>VSCS</b>	<b>WARP</b>
Verification 2	The activities for acquisition risk management are reviewed by the project manager on both a periodic and event-driven basis.	Weakness	Weakness	Weakness	Weakness	Weakness

-  = **Weakness** Key practice not implemented
-  = **Strength** Key practice effectively implemented
-  = **Observation** Key practice evaluated but evidence inconclusive. Cannot characterize as either strength or weakness
-  = **Not rated** Key practice not currently relevant to project, therefore not evaluated

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**Table 9.1: Acquisition Risk Management Findings for ARTSIIE**

**Automated Radar Terminal System IIIE**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for the management of acquisition risk.	There is a policy for acquisition risk management.	Strength
Ability 1	A group that is responsible for coordinating acquisition risk management activities exists.	No group is assigned acquisition risk management tasks.	Weakness
Ability 2	Adequate resources are provided for acquisition risk management activities.	No mechanism exists for identifying resources required and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	Individuals performing acquisition risk management activities have experience or receive required training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	Risk identification, analysis, and mitigation activities are integrated into software acquisition planning.	No risk identification, analysis, or mitigation activities are integrated into software acquisition planning.	Weakness
Activity 2	The Software Risk Management Plan is developed according to the project's defined software acquisition process.	There is no risk management plan.	Weakness
Activity 3	The project's acquisition risk management activities are performed in accordance with its Software Risk Management Plan.	No software risk management plan exists, therefore, the activities are not performed in accordance with it.	Weakness
Activity 4	The project team identifies, analyzes, and takes appropriate software risk mitigation actions during acquisition planning.	Officials stated that the product team identifies, analyzes, and mitigates risks, but could not provide documents to support this.	Observation
Activity 5	Risk identification, analysis, and mitigation are conducted as an integral part of the project performance management and contract performance management processes.	Officials could provide no evidence of risk identification, analysis, and mitigation being conducted as part of project and contract management.	Weakness
Activity 6	Software risk mitigation actions are tracked to completion.	Risks are not tracked to completion.	Weakness
Measurement 1	Measurements are made and used to determine the status of the acquisition risk management activities.	No internal process measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness
Measurement 2	Resources expended for acquisition risk management activities are recorded and tracked.	FAA does not track resources.	Weakness
Verification 1	The activities for acquisition risk management are reviewed by acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for acquisition risk management are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness



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**Table 9.2: Acquisition Risk Management Findings for DSR**

<b>Display System Replacement</b>			
	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for the management of acquisition risk.	There is a written policy for acquisition risk management.	Strength
Ability 1	A group that is responsible for coordinating acquisition risk management activities exists.	The product team is responsible for acquisition risk management.	Strength
Ability 2	Adequate resources are provided for acquisition risk management activities.	No mechanism exists for identifying resources required and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	Individuals performing acquisition risk management activities have experience or receive required training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	Risk identification, analysis, and mitigation activities are integrated into software acquisition planning.	Risk identification, analysis, and mitigation are integrated into the software acquisition planning.	Strength
Activity 2	The Software Risk Management Plan is developed according to the project's defined software acquisition process.	While there is a risk management plan that addresses software at a high level, there is no software risk management plan.	Weakness
Activity 3	The project's acquisition risk management activities are performed in accordance with its Software Risk Management Plan.	Because there is no software risk management plan, activities are not performed in accordance with it.	Weakness
Activity 4	The project team identifies, analyzes, and takes appropriate software risk mitigation actions during acquisition planning.	The risk identification activities are not well defined. The product team used risk interchangeably with currently identified problems, action items, issues, and schedule tracking.	Weakness
Activity 5	Risk identification, analysis, and mitigation are conducted as an integral part of the project performance management and contract performance management processes.	What the product team considers risks (problems, action items, issues, etc.) are identified, analyzed, and mitigated.	Strength
Activity 6	Software risk mitigation actions are tracked to completion.	Software risk mitigation is not tracked to completion.	Weakness
Measurement 1	Measurements are made and used to determine the status of the acquisition risk management activities.	No internal process measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness
Measurement 2	Resources expended for acquisition risk management activities are recorded and tracked.	FAA does not track resources.	Weakness

(continued)

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**Chapter 9**  
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**Display System Replacement**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Verification 1	The activities for acquisition risk management are reviewed by acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for acquisition risk management are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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**Table 9.3: Acquisition Risk Management Findings for NIMS**

**NAS Infrastructure Management System**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for the management of acquisition risk.	The Acquisition Management System is the written policy for acquisition risk management, but it does not address software.	Weakness
Ability 1	A group that is responsible for coordinating acquisition risk management activities exists.	Both the Integrated Program Plan and the Product Team Plan assign the risk management plan activities to the team.	Strength
Ability 2	Adequate resources are provided for acquisition risk management activities.	No mechanism exists for identifying resources required and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	Individuals performing acquisition risk management activities have experience or receive required training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	Risk identification, analysis, and mitigation activities are integrated into software acquisition planning.	Acquisition risk management is part of acquisition planning as called for in both the Integrated Program Plan and the Product Team Plan.	Strength
Activity 2	The Software Risk Management Plan is developed according to the project's defined software acquisition process.	No software risk management plan exists. The risk management plan does not address software.	Weakness
Activity 3	The project's acquisition risk management activities are performed in accordance with its Software Risk Management Plan.	There is no software risk management plan, therefore, activities cannot be performed in accordance with it.	Weakness
Activity 4	The project team identifies, analyzes, and takes appropriate software risk mitigation actions during acquisition planning.	The project team does not identify, analyze, or mitigate software risks.	Weakness
Activity 5	Risk identification, analysis, and mitigation are conducted as an integral part of the project performance management and contract performance management processes.	While plans call for risk identification, analysis, and mitigation, the project has not reached a stage where this activity applies.	Not rated
Activity 6	Software risk mitigation actions are tracked to completion.	A risk tracking system is being developed as called for in the Integrated Program Plan.	Observation
Measurement 1	Measurements are made and used to determine the status of the acquisition risk management activities.	No internal process measurements are taken to determine the status of activities for any of the key process areas.	Weakness
Measurement 2	Resources expended for acquisition risk management activities are recorded and tracked.	FAA does not track resources.	Weakness

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**NAS Infrastructure Management System**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Verification 1	The activities for acquisition risk management are reviewed by acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for acquisition risk management are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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**Table 9.4: Acquisition Risk Management Findings for VSCS**

**Voice Switching and Control System**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for the management of acquisition risk.	FAA Order 1810.1F is the policy for acquisition risk management.	Strength
Ability 1	A group that is responsible for coordinating acquisition risk management activities exists.	The product team leader is the acquisition risk manager.	Strength
Ability 2	Adequate resources are provided for acquisition risk management activities.	No mechanism exists for identifying the resources required and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	Individuals performing acquisition risk management activities have experience or receive required training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	Risk identification, analysis, and mitigation activities are integrated into software acquisition planning.	The risk management plan does not call for risk activities to be integrated into software acquisition planning.	Weakness
Activity 2	The Software Risk Management Plan is developed according to the project's defined software acquisition process.	There is a software risk management plan.	Strength
Activity 3	The project's acquisition risk management activities are performed in accordance with its Software Risk Management Plan.	Although there is a risk management plan, there is no evidence that acquisition risk management is performed in accordance with the plan.	Weakness
Activity 4	The project team identifies, analyzes, and takes appropriate software risk mitigation actions during acquisition planning.	The project team does not identify, analyze, and take appropriate actions during acquisition planning.	Weakness
Activity 5	Risk identification, analysis, and mitigation are conducted as an integral part of the project performance management and contract performance management processes.	The product team does not ensure that risks are identified, or that analyses and mitigations are conducted as an integral part of project performance management and contract performance management.	Weakness
Activity 6	Software risk mitigation actions are tracked to completion.	There is no evidence that risk mitigation is tracked to completion.	Weakness
Measurement 1	Measurements are made and used to determine the status of the acquisition risk management activities.	No internal process measurements are taken or used to determine the status of activities for any of the key process areas.	Weakness
Measurement 2	Resources expended for acquisition risk management activities are recorded and tracked.	FAA does not track resources.	Weakness
Verification 1	The activities for acquisition risk management are reviewed by acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

(continued)

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**Chapter 9**  
**Acquisition Risk Management**

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**Voice Switching and Control System**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Verification 2	The activities for acquisition risk management are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

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**Chapter 9  
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**Table 9.5: Acquisition Risk Management Findings for WARP**

**Weather and Radar Processor**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The acquisition organization has a written policy for the management of acquisition risk.	FAA Order 1810.1F is the written policy.	Strength
Ability 1	A group that is responsible for coordinating acquisition risk management activities exists.	The product team is responsible for acquisition risk management activities.	Strength
Ability 2	Adequate resources are provided for acquisition risk management activities.	No mechanism exists for identifying and for ensuring that the needed resources are provided to the project.	Weakness
Ability 3	Individuals performing acquisition risk management activities have experience or receive required training.	The acquisition organization has no guidance regarding training or experience requirements for project participation.	Observation
Activity 1	Risk identification, analysis, and mitigation activities are integrated into software acquisition planning.	Risk identification, analysis, and mitigation activities are integrated into software acquisition planning.	Strength
Activity 2	The Software Risk Management Plan is developed according to the project's defined software acquisition process.	Although there is a risk management plan, it incorrectly identifies risks as currently identified problems, action items, issues, etc.	Weakness
Activity 3	The project's acquisition risk management activities are performed in accordance with its Software Risk Management Plan.	While issues are reviewed at team meetings, they are not specifically identified and managed as risks.	Weakness
Activity 4	The project team identifies, analyzes, and takes appropriate software risk mitigation actions during acquisition planning.	The product team identifies and analyzes risks as defined in the risk management plan and takes appropriate actions during acquisition planning.	Strength
Activity 5	Risk identification, analysis, and mitigation are conducted as an integral part of the project performance management and contract performance management processes.	The product team identifies, analyzes, and mitigates risks (as defined in the risk management plan) as part of project and contract performance management.	Strength
Activity 6	Software risk mitigation actions are tracked to completion.	Software risks as defined in the risk management plan are tracked to completion.	Strength
Measurement 1	Measurements are made and used to determine the status of the acquisition risk management activities.	No internal process measurements are taken and used to determine the status of activities for any of the key process areas.	Weakness
Measurement 2	Resources expended for acquisition risk management activities are recorded and tracked.	FAA does not track resources.	Weakness

(continued)

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**Weather and Radar Processor**

	<b>Key Practice</b>	<b>Finding</b>	<b>Rating</b>
Verification 1	The activities for acquisition risk management are reviewed by acquisition organization management on a periodic basis.	While the Integrated Product Team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness
Verification 2	The activities for acquisition risk management are reviewed by the project manager on both a periodic and event-driven basis.	While the product team leader reviews the status of the contract and the contractor's cost and schedule, he does not review the status of the activities that are required to be performed for any of the key process areas.	Weakness

**Conclusions**

FAA's software acquisition risk management process has many weaknesses and is, therefore, undefined and undisciplined. To become an effective acquirer of software, FAA must adopt a more structured, rigorous, and disciplined approach to ATC modernization software acquisition risk management.



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# FAA Lacks an Effective Approach for Improving ATC Modernization Software Acquisition Processes

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In order to be effective, the organization responsible for improving software acquisition processes must have (1) organizational and/or budgetary authority over units acquiring software; and (2) a comprehensive plan to guide software acquisition process improvement efforts and measure progress on each. At FAA, responsibility for ATC software acquisition process maturity and improvement has been assigned to three organizational entities over the last 4 years, and currently is assigned to FAA's Software Engineering Process Group (SEPG), a multilevel committee structure chaired by a member of FAA's Chief Information Officer's (CIO) staff. However, the SEPG, like the entities previously responsible for software acquisition process improvement, has neither organizational nor budgetary authority over the ATC modernization product teams that acquire software. Further, the SEPG does not have a software acquisition process improvement plan to guide its maturation efforts.

As a result, management of FAA's software acquisition process improvement effort is ad hoc and has not instilled software acquisition process discipline into the ATC modernization program. While the SEPG is now taking steps to establish the analytical basis for a defined and comprehensive software process improvement plan, that plan does not yet exist, no schedule has been established for completing it, and the SEPG, like the organizational entities before it that have failed to institute process improvements, has no authority to implement or to enforce process change.

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## FAA Organization Responsible for ATC Software Acquisition Process Improvement Lacks Authority to Affect Change

FAA has been attempting to strengthen its software acquisition processes since 1993. At that time it established the Software Engineering Specialty Group to, among other things, incrementally improve FAA's software acquisition processes, first establishing repeatable processes [SEI maturity level 2], then defined processes [SEI maturity level 3], and eventually managed processes [SEI maturity level 4]. This group was to be FAA's focal point for software process assessment and improvement initiatives through 2002, and it developed a 10-year strategy and implementation plan for doing so. It also produced guidance addressing software acquisition management, software management indicators, and other software-related processes and practices.

In 1995, FAA established the Office of the Chief Scientist for Software Engineering under FAA's CIO to lead FAA's software-related process improvement efforts, including software acquisition. According to FAA officials, this change was made to strengthen software process

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improvement through increased interaction with the ATC modernization project offices. In May 1995, the Chief Scientist reaffirmed SEI's CMM as the basis for all FAA process improvement and set forth three broad "strategies for improving the quality of FAA software."<sup>1</sup> The three strategies were (1) "improve the software acquisition, development, certification, and maintenance processes of the FAA and its suppliers,"<sup>2</sup> (2) "accelerate the adoption of open systems, COTS, NDI,<sup>3</sup> re-engineering, and reuse by FAA programs (without jeopardizing system safety or integrity),"<sup>4</sup> and (3) "promote the use of best software engineering practices throughout the FAA and its supplier community."<sup>5</sup> The Chief Scientist also began about a dozen loosely defined process improvement activities. Examples of these activities include participating in national and international software engineering activities, interacting with governmental and professional software engineering organizations, meeting with FAA suppliers and aviation groups, and assessing software engineering methods, tools, and best practices.

Another of the Chief Scientist's dozen activities was to form the SEPG as FAA's "focal point for initiating, planning, motivating, and facilitating the improvement of 'acquisition life cycle processes' for software intensive systems."<sup>6</sup> Formed in October 1995, the SEPG includes representatives from ATC modernization product teams and their parent organizations as well as other FAA organizations, and it is chaired by the Chief Scientist for Software Engineering. The SEPG is directed by the Software Engineering Executive Committee (SEEC), which is chaired by the Associate Administrator for Research and Acquisition (i.e., the head of the ATC modernization), and is composed of senior FAA executives. The SEEC is responsible for recommending and providing guidance on software engineering issues. Additionally, some of the ATC modernization product teams' parent organizations have SEPGs.

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<sup>1</sup>"Strategies and Tactics for FAA to Improve Software, CIP Steering Committee Meeting," May 16, 1995, page 8.

<sup>2</sup>See footnote 1.

<sup>3</sup>COTS is commercial, off-the-shelf; NDI is non-development item.

<sup>4</sup>See footnote 1.

<sup>5</sup>See footnote 1.

<sup>6</sup>In a document entitled "SEPG Purpose" Nov. 18, 1996, FAA defines a software intensive system as "any system that is entirely software or whose principle (sic) functionality depends on the correct functioning of software."

None of the organizations responsible for ATC modernization software acquisition process improvement over the last 4 years, including the SEPG, have had organizational and/or budgetary authority over the ATC modernization product teams that acquire ATC software. As a result, neither the SEPG nor its predecessor organizations have been positioned to effectively and efficiently implement and enforce process changes. Instead, they can only attempt to encourage and persuade product teams to undertake process improvement activities.

To illustrate the ineffectiveness of this management structure, the Chief Scientist proposed that each product team earmark 5 percent of its software-related budgets to implement approved process improvement initiatives. According to the Chief Scientist, however, the teams refused to spend product team money on the FAA-wide software improvement activities being proposed. One product team leader stated that the teams are understaffed and there is not enough time and resources to support these activities.

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## **FAA Planning for Software Process Improvement Has Not Been Effective**

To properly focus and target software acquisition process improvements, current process strengths and weaknesses (the capability baseline) must be fully identified and assessed, and an effective plan for systematically correcting weaknesses must be developed. At a minimum, this plan should specify measurable goals, objectives, milestones, and needed resources, should clearly assign responsibility and accountability for accomplishing well-defined tasks, and should be documented and approved by FAA leadership.

Despite 4 years of software acquisition process improvement effort, FAA has not effectively baselined FAA's ATC modernization software acquisition processes, and has not developed a comprehensive plan for software acquisition process improvement on the basis of this baseline. In 1995, the Chief Scientist began an effort to assess software acquisition processes, but completion of the effort was delayed 8 months and, because it lacked the requisite depth and scope, it could not be used to produce an effective baseline to guide improvement activities. Subsequent plans to perform more detailed and comprehensive assessments were dropped.

FAA also has no comprehensive plan for software acquisition process improvement. As a proxy, the Chief Scientist claims that a variety of documents produced and activities conducted over the last 2 years collectively form a complete and comprehensive plan. These include (1) a

document containing the “preliminary process improvement recommendations” of a process improvement working group dated September 4, 1996, (2) minutes of SEPG and SEEC meetings, (3) briefings on software process improvement activities, and (4) the business plan for the ATC modernization organization. However, these documents and activities, which only briefly address process improvement initiatives, cite broad strategies, and sometimes mention general schedules and resource needs, do not constitute an effective plan. They do not specify well-defined and measurable goals and milestones, assign responsibility, identify resource needs for each initiative, or define how and when process improvements will actually be implemented and enforced. Further, without a capability maturity baseline, there is no analytical basis for selecting these initiatives. According to product team officials, the modernization effort has no software acquisition process improvement plan.

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## **Improvement Initiatives Have Thus Far Not Instilled Software Process Discipline**

Since 1995, the Chief Scientist has planned or initiated a dozen activities. Some have never been started, some are behind schedule, and several have proceeded according to plan. For example, while the Chief Scientist planned to complete an assessment of ATC modernization software acquisition capabilities using SEI level 2 and level 3 requirements by December 1996 and June 1997, respectively, these efforts were never performed. Other efforts are behind schedule. For example, software engineering policies, guidance, and standards that were to be issued by September 1996 are now scheduled for issuance the third quarter of calendar year 1997; and a software life cycle tool that was to be developed by October 1996 has been postponed indefinitely.

Several efforts have met their milestones and begun to build a foundation for undertaking process improvements. For example, a software engineering training plan was developed in May 1996, 1 month ahead of schedule; product teams have been trained to use the SEI software development CMM and the associated capability evaluation methodology to evaluate contractors’ capabilities to develop software; one product team used the results of a CMM evaluation as part of its source selection criteria; and, according to the Chief Scientist, hundreds of members of various ATC modernization product teams have been trained in software management techniques, such as defining software processes, using software management indicators, estimating software costs, and using standards such as open systems standards.

Other FAA activities relating to software process improvement include establishing an SEPG infrastructure, pilot testing selected software product and process metrics, creating a software quality assurance capability, reengineering configuration management processes, and studying software cost estimation tools. In addition, the SEPG and the Chief Scientist are now taking steps to establish an analytical basis for software acquisition process improvement. For example, the SEPG and the Chief Scientist intend to use the results of this GAO evaluation as the basis for planning future software acquisition process improvement activities. Also, the SEPG has begun to analyze the interrelationships among FAA's various process improvement activities, link the activities to strategic goals and measurable outcomes, and explore ways to manage these activities in a coordinated fashion. Further, the Chief Scientist intends to formalize the results of these steps in a comprehensive plan of action, although no schedule has been set for doing so.

However, none of these activities or steps, either individually or in the aggregate, have yet resulted in more repeatable, better defined, more disciplined ATC modernization software acquisition processes. In interviews, product team and SEPG officials confirmed that the software acquisition processes had not yet been improved. Instead, the activities have begun to lay a foundation for potential process improvements in the future.

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## Conclusions

FAA has neither an effective management structure nor plan of action for improving its software acquisition processes. As a result, software acquisition processes will remain immature and will not support effective, efficient, and economical acquisition of mission-critical software costing billions of dollars. Until responsibility and accountability for software acquisition process improvement is assigned to an FAA organizational entity with the requisite authority to affect process change, and until this organizational entity pursues a plan for change based on a complete and objective assessment of current process strengths and weaknesses, it is unlikely that significant ATC modernization software acquisition process improvements will be made, and ATC software acquisition processes will remain immature.

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# Overall Conclusions and Recommendations

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Leading software acquisition organizations rely on defined and disciplined software acquisition processes to deliver promised software capabilities on time and within budget, first on a project-by-project basis, and later, as the organization's processes become more mature, consistently across the institution. FAA's ATC modernization software acquisition processes are ad hoc and sometimes chaotic, and are not repeatable even on a project-by-project basis. As a result, FAA's success or failure in acquiring ATC software depends largely on specific individuals, rather than on well-defined and disciplined software acquisition management practices. This greatly reduces the probability that software-intense ATC modernization projects will consistently perform as intended and be delivered on schedule and within budget. For FAA to mature beyond this initial level, it must implement basic management controls and instill self-discipline in its software projects.

FAA recognizes the importance of software process maturity and the need to improve its software acquisition processes. However, it lacks an effective management structure for accomplishing this because the FAA organization responsible for process improvement, the SEPG, lacks the authority to implement management controls and instill process discipline within the ATC modernization software acquiring organizations. Additionally, despite 4 years of FAA process improvement activity, no well-targeted, comprehensive, and coordinated plan of action for software acquisition process improvement exists.

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## Recommendations

Given the importance and the magnitude of information technology at FAA, we reiterate our recent recommendation that a CIO organizational structure similar to the department-level CIOs as prescribed in the Clinger-Cohen Act of 1996 be established for FAA.<sup>1</sup>

To improve FAA's software acquisition capability for its ATC modernization and thereby take the first step in institutionalizing mature acquisition processes, we recommend that the Secretary of Transportation direct the FAA Administrator to:

- assign responsibility for software acquisition process improvement to FAA's CIO;
- provide FAA's CIO the authority needed to implement and enforce ATC modernization software acquisition process improvement;

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<sup>1</sup>Air Traffic Control: Complete and Enforced Architecture Needed for FAA Systems Modernization (GAO/AIMD-97-30, Feb. 3, 1997).

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- require the CIO to develop and implement a comprehensive plan for ATC modernization software acquisition process improvement that is based on the software capability evaluation results contained in this report and specifies measurable goals and time frames, prioritizes initiatives, estimates resource requirements, and assigns roles and responsibilities;
  - allocate adequate resources to ensure that these improvement efforts are implemented and enforced; and
  - require that, before being approved, every ATC modernization acquisition project have software acquisition processes that satisfy at least SA-CMM level 2 requirements.

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## Agency Comments and Our Evaluation

In its written comments on a draft of this report, the Department of Transportation recognized the importance of mature software acquisition processes, agreed that FAA's processes are insufficiently mature, acknowledged that FAA process improvement activities have yet to produce greater process discipline, and reaffirmed FAA's commitment to improving its software acquisition capabilities using the SA-CMM. However, the Department did not state what, if any, specific action it would take on our recommendations. Additionally, the Department expressed several concerns, each of which is presented below, along with our rebuttal.

First, the Department stated that FAA does not separately procure software for its ATC systems. Rather, it procures systems that use software as a major component. Therefore, its policies and procedures (i.e., processes) are "geared" to system acquisitions, and evaluating only the software-related aspects of its acquisition processes "is not an adequate approach."

GAO Rebuttal: All major system modernizations, like the ATC modernization, involve the acquisition of hardware, software, and firmware operating interdependently. However, as FAA's own experience with the Advanced Automation System clearly proves, the software component is the source of most system risk, and the component most frequently associated with late deliveries, cost increases, and performance shortfalls. Moreover, there is widespread recognition throughout the computer industry that the billions of dollars being invested in complex, real-time, fault tolerant systems, like FAA ATC systems, are jeopardized by inadequate management attention to software in general, and undisciplined, ill-defined software acquisition and development processes in particular. This is precisely why SEI developed its software-related CMMS, why the CMMS have been endorsed and accepted throughout industry and government, and why the scope of

this evaluation focused on software acquisition processes rather than on broader systems issues. Further, the FAA system acquisition policies and procedures that the Department references do not explicitly or adequately address software issues. For example, they do not address software-specific acquisition planning for such KPAs as contract tracking and oversight, requirements development and management, and risk management. Additionally, they do not provide for measuring and verifying the performance of software-specific acquisition activities.

Second, the Department commented that the SA-CMM “is not widely used, adopted, or validated” and, while it has “significant merit, it is certainly not to be taken as the same authoritative source for process improvement guidance as the SW-CMM,<sup>2</sup> which has been in use worldwide by thousands of organizations for several years.”

GAO Rebuttal: This position is clearly inconsistent with the Department’s and FAA’s stated commitment to using the SA-CMM as the basis for efforts to improve FAA’s software acquisition capabilities. More important however is that this position is without substance. The SA-CMM does not promulgate original or novel concepts of debatable value. Instead, it presents as requisite processes and practices those activities that common sense have validated as essential to effective software acquisition. For example, it requires disciplined requirements development and management, solicitation, contract tracking and oversight, and evaluation. Our evaluations have for years made the same points without rational dispute. The SA-CMM simply provides a coherent framework and standard terminology for these concepts. The findings in this report, which have been corroborated by SEI, are compelling not because of the age of the model used, but because the criticality of the processes and practices examined is undeniable.

Third, the Department claimed that “GAO may have misapplied the model” by (1) giving inadequate consideration to equivalent alternative practices when determining whether SA-CMM specified practices were performed (e.g., DSR system acquisition planning being judged as an insufficient proxy for software acquisition planning specified in the SA-CMM), (2) not effectively tailoring the SA-CMM to focus only on project activities that occurred after the cancellation of the Advanced Automation System, and (3) reporting evaluation results in a way that “does not create an environment conducive to process improvement” (i.e., reporting the

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<sup>2</sup>SW-CMM is SEI’s software development capability maturity model.



results for each project, rather than either aggregating the results or disguising the identity of the projects).

GAO Rebuttal: We applied the model properly and correctly, and SEI has attested to this. Every member of our evaluation team was trained by SEI; the team leader was an SEI designated “lead evaluator” and has been authorized by SEI to submit results for inclusion in SEI studies; three senior SEI professionals, two of whom are authors of the SA-CMM, participated in the evaluation to ensure that the model was properly used; and SEI concurred with each practice determination in the report (e.g., strength, weakness). With respect to each of the Department’s subsidiary points regarding our application of the model:

(1) During the course of extensive interviews with FAA designated officials, no evidence of reasonable alternative practices was provided. If such evidence had been provided, we would have considered it. For example, when FAA provided a system acquisition plan for DSR as evidence of software acquisition planning, we reviewed the document and found that it was not a reasonable alternative practice because it did not adequately address the software component of the acquisition.

(2) As agreed with SEI, those practices that were deemed inapplicable were not rated, and those performed years ago were so designated. Moreover, even if all practices predating the Advance Automation System’s cancellation were ignored, none of our conclusions and recommendations would change.

(3) The model and evaluation method do not specify any reporting format. In particular, they do not address whether results should be reported for each project, or whether the identity of the projects should be disguised or results reported only in the aggregate. Given the mission-critical importance and billion dollar cost of these projects, full disclosure of all relevant facts to the Congress and the public is both warranted and appropriate.

Fourth, concerning FAA’s software acquisition process improvement efforts, the Department stated that the report does not sufficiently appreciate the “progress made to date, the difficulties involved in achieving that progress, and the time that it takes for . . . changes of this . . . magnitude.” Specifically, the many efforts underway are not a “hodge podge” of activities, but are “a very healthy sign of the seriousness and enthusiasm” that FAA assigns to process improvement and are

“organized with respect to specific directorate objectives.” Also, since FAA’s process improvement activities have been underway for less than 2 years, it is too early to expect results.

GAO Rebuttal: The Department’s position that FAA’s many process improvement activities are not a “hodge podge,” but rather are part of an organized and coordinated comprehensive plan of action, is not supported by the facts. While FAA began drafting a plan during the course of our evaluation, it had no schedule for finalizing this plan, and no analytical basis for the software acquisition process improvement activities underway. Just as its software acquisition processes lack maturity and discipline, so do its efforts to improve these processes. Claims that FAA has been engaged in software improvement efforts for less than 2 years, and thus it is too early to evaluate results, are also unsupported. In fact, software acquisition process maturity and improvement efforts began in 1993. Since SEI published statistics show that the median time to improve from SW-CMM level 1 to level 2 is 26 months, and from SW-CMM level 2 to level 3 is 17 months, it is entirely reasonable to expect FAA to be able to demonstrate some improvement in its processes after 4 years.

Fifth, while the report states that the SEPG has neither the organizational nor the budgetary authority to effectively implement process change, the Department stated that its “understanding . . . is that organizations do not normally give their SEPG authority over product teams.” In FAA’s case, the SEPG provides advice and counsel to the Software Engineering Executive Committee, which consists of senior managers who have authority and responsibility to direct process improvement actions. The SEPG is the committee’s agent for implementing these improvements.

GAO Rebuttal: The issue is not whether FAA’s SEPG is organized as the Department “understands” other SEPGs to be organized, but whether the SEPG, or any FAA organizational entity responsible for implementing and enforcing software process change, has the authority needed to accomplish this task. Currently, no organizational entity in FAA has the requisite authority. Accordingly, we have recommended that a CIO organizational structure similar to the department-level CIOs prescribed in the Clinger-Cohen Act of 1996 be established for FAA, and that it be assigned the responsibility and resources needed to affect and enforce software acquisition process improvement.

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Sixth, the Department contends that the report “leads the reader to erroneously conclude that the five programs reviewed are in trouble” relative to their cost and schedule goals.

**GAO Rebuttal:** The report addresses the maturity of FAA’s software acquisition processes and concludes that these processes are ad hoc and undisciplined, reducing the probability that software-intensive ATC modernization projects will consistently perform as intended and be delivered on schedule and within budget. The report does not address the overall status of the projects covered by GAO’s review, and, therefore, provides no basis for drawing conclusions about the projects’ overall cost and schedule performance.

# Comments From the Department of Transportation



**U.S. Department of  
Transportation**

Assistant Secretary  
for Administration

400 Seventh St. S.W.  
Washington, D.C. 20590

March 3, 1997

Dr. Rona B. Stillman  
Chief Scientist for Computers  
and Telecommunications  
U.S. General Accounting Office  
441 G Street, N.W.  
Washington, D.C. 20548

Dear Dr. Stillman:

Enclosed are two copies of the Department of Transportation's comments concerning the U.S. General Accounting Office draft report titled, "Air Traffic Control: Immature Software Acquisition Processes Increase FAA System Acquisition Risks," AIMD-97-47.

Thank you for the opportunity to review the draft report. If you have any questions concerning our reply, please contact Martin Gertel on 366-5145.

Sincerely,

A handwritten signature in cursive script that reads "Melissa Spillenkothen".

Melissa Spillenkothen

Enclosures

**U.S. Department of Transportation  
Comments on the General Accounting Office  
Draft Report  
Air Traffic Control: Immature Software Acquisition Processes  
Increase FAA System Acquisition Risks**

**Overview**

The Department of Transportation through the FAA operates one of the most complex real-time computing systems on this planet as part of the Nation's air traffic control system, and has for some time recognized that continued effective operation of this system requires well planned and executed actions to ensure that the system keeps pace of the state of technology. The subject GAO draft report deals with one aspect of air traffic control (ATC) systems procurement -- the maturity of the processes in place at FAA to acquire ATC software. We agree with the Software Engineering Institute (SEI) that mature processes reduce the risks associated with procuring quality products, and FAA has become a strong advocate of process improvement. FAA agrees that its processes are not as mature as they need to be and has initiated actions that are beginning to address these processes. While we do not dispute the risk reduction benefits to be gained by increasing the maturity of our systems acquisition capabilities, the report leads the reader to erroneously conclude that the five programs reviewed are in trouble, when in fact each is on or ahead of schedule and within budget.

In the relatively short time that FAA has been pursuing efforts to improve its acquisition capabilities for systems that utilize software, much has been achieved. Management has provided leadership through the appointment of a Chief Scientist for Software Engineering and the formation of a Software Engineering Executive Committee (SEEC). Funding is also being provided in support of these efforts. FAA has also identified an approach to a comprehensive framework for improvement through the adoption of the SEI capability maturity models. Yet still, much remains to be done. FAA is working with the SEI to provide a strategic comprehensive approach towards increasing the maturity of our systems acquisition processes by combining the existing capability maturity models into a unified model capable of providing guidance suitable for FAA's specific needs. Once it is sufficiently refined and accepted, further substantial efforts confront us in our efforts to disseminate information on the process throughout the agency, train staff and management in its application, and ensure that it is fully and effectively implemented. It is a challenge that we will meet and surpass.

We have concerns with several aspects of the analysis presented in the draft report, including the limitations on the Software Acquisition Capability Maturity Model (SA-CMM), its stand-alone applicability to FAA ATC modernization efforts, and its application in the GAO draft report. In addition, we maintain that the draft report does not recognize the progress made to date, the difficulties involved in achieving that progress, and the time that it takes for cultural changes of this massive magnitude to take root and reach fruition.

**SA-CMM Not a Sufficient Basis for FAA ATC Systems Acquisition Determinations**

The FAA strongly supports SEI and other organizations' efforts to provide a rational evaluative basis to guide process improvements in the areas of software development and maintenance (SW-CMM), software acquisition (SA-CMM), and systems engineering (SE-CMM). However, we maintain that the application of the SA-CMM as the only arbiter of FAA's ATC systems acquisition efforts is not an adequate approach to critique our acquisition systems capabilities. From the perspective of overall approach, the GAO draft report needs to better recognize that FAA does not separately procure software for the ATC modernization, it procures systems that utilize software. Thus, its policies and practices are geared to system acquisition. As a result, the issue of primary importance to FAA is overall system functionality and operability within the ATC framework. While software is a key element of our systems, it is procured as part of an overall package, much as one would purchase a complete automobile and not its individual component parts.

In regard to the SA-CMM itself, the draft report needs to better recognize that the SA-CMM is not widely used, adopted, or validated. The document used for the GAO draft report was in fact a draft that had only been piloted a limited number of times. According to the SEI, no organization has yet adopted the SA-CMM as their process improvement framework. Moreover, there is not even a method specifically constructed to assess organizations using the SA-CMM. The method applied in the GAO draft report was actually GAO's adaptation of the method used for the SW-CMM. While the SA-CMM has significant merit, it is certainly not to be taken as the same authoritative source for process improvement guidance as the SW-CMM, which has been in use worldwide by thousands of organizations for several years.

We are also concerned that GAO may have misapplied the model. Organizations are scored against the model by evaluating whether they meet the goals of the individual key process areas. The specific activities, measurements, commitments, verification, and abilities called out in the key process areas are intended to be indicative of what an organization might do to meet the goals, not specific prescriptive requirements. Alternative approaches are valid and must be considered in determining whether the goal is met. Based on discussions with GAO's staff, we understand that they considered the practices in the model as essentially prescriptive, and applied a strict

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interpretation of whether they were specifically fulfilled, without analyzing whether any of the goals were achieved through alternative means. For example, the Display System Replacement (DSR) program's software acquisition planning is shown in the GAO draft report as a weakness. The DSR *system* acquisition planning was extensive, covered all aspects of the program—including software—in great detail, and was approved by management throughout FAA and the Department. The draft report's finding was not that the system-level documentation insufficiently covered software, only that a software plan did not exist. It would have been counter-productive to create a software acquisition plan, when that necessity was already fulfilled through the system acquisition plan. Finally, based on industry practices, we understand that process improvement analyses are most effective when the results are consolidated into the key areas in need of improvement, rather than reporting the specific results for each program analyzed. It is widely understood that reporting project specific results, as shown in the GAO draft report, is counterproductive, and does not create an environment conducive to process improvement.

Similarly, it appears that the SA-CMM was not effectively tailored to assess the selected programs. According to the SEI, "the SA-CMM should be tailored to fit the organization; the organization should not be restructured to reflect the SA-CMM." For example, this is reflected in the failure of the assessors to account for the phase of the acquisition life cycle of the project in developing their findings. For example, the ARTS program has been in existence for almost 30 years. Yet, inexplicably, the Solicitation Key Process Area (KPA) was assessed for this program in the draft report. Regardless of the accuracy of the assessment of this phase of the ARTS project, it is difficult to understand the relevance of data on a solicitation conducted during the early 1970's to the current state of FAA's software acquisition processes. We maintain that for the draft report to present conclusions that are relevant to current practices, it must focus on activities that occurred after the cancellation of the Advanced Automation System.

**FAA Working on a Unified Capability Model**

FAA recognized the limitation inherent in attempting to apply the individual capability models to its systems procurement process and has initiated efforts with the SEI to combine the various capabilities models into a single model more directly applicable to FAA. Like many other multiple CMM users, we have identified the potential benefit that can be offered by an integrated reference model that can guide our interrelated systems/software engineering and acquisition process improvement activities. To address this, we have started working with the SEI to develop a merged-CMM that brings together several CMMs relevant to FAA's acquisition of software intensive systems. The establishment of an effective framework for integrating multiple CMMs is now the highest priority of the SEI's process program. A draft of this model already exists and is being refined, enhanced, and tailored.

**FAA Has Initiated Efforts to Improve System Acquisition Capabilities**

The GAO draft report asserts that FAA's process improvement efforts to date are not sufficient in part because the Software Engineering Process Group (SEPG) has neither organizational nor budgetary authority over product teams and thus cannot enforce process change. Our understanding, based on examination of the practices of industry leaders, is that organizations do not normally give their SEPG authority over product teams. That authority normally remains in the hands of the line management team, which endorse and work with the recommendations of the SEPG. The FAA has established a Software Engineering Executive Committee (SEEC), which consists of senior managers, who have the authority and responsibility to direct process improvement actions. The SEPG provides advice and counsel to the SEEC on process improvement, which the SEEC is then responsible for approving. The SEPG then becomes the SEEC's agent to implement those improvements. This practice is consistent with that found throughout industry.

Although the GAO draft report characterizes the breadth of the process improvement activities across the FAA, as a "hodge podge," we maintain that it is a very healthy sign of the seriousness and enthusiasm that the FAA attributes to process improvement. It is true that many improvement efforts are underway across the FAA. Many of these efforts were initiated by directorate level SEPGs; some were initiated prior to the formation of a corporate SEPG; some are corporate initiatives. Several of these efforts relate to different disciplines and domains of the FAA business; for example the SW-CMM is being used to guide software development improvement in the Office of Information Services, software maintenance improvement in Airway Facilities' Operational Support Directorate, and software testing improvement at the William J. Hughes Technical Center; the SE-CMM guides systems engineering improvement in the Office of Systems Architecture and Program Evaluation; and the SA-CMM guides acquisition process improvement in the Office of Air Traffic Services Development and the Office of Communications, Navigation, and Surveillance Systems. At the directorate level, these are not "hodge podge" activities, but are organized with respect to specific directorate objectives.

Finally, we urge that the draft report more fully recognize the time it takes to achieve process improvement. Industrial experience shows that 18-36 months is normal for significant improvements in process maturity to start to become visible. Government organizations, which are encumbered by cultural and legal constraints not imposed on industry, take longer. In fact, another recent GAO report acknowledges the substantial investment of time and effort involved in producing cultural change.<sup>1</sup> In a section of that report titled "FAA Has Begun Efforts to Change its Acquisition Culture," the

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<sup>1</sup> "Aviation Acquisition: A Comprehensive Strategy is Needed for Cultural Change at FAA" GAO/RCED-96-159.



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following is stated: "According to organizational theory and research, large-scale cultural change is a complex and time consuming undertaking that requires a comprehensive strategy to create real improvements." It also states: "Cultural change efforts typically take 5 or more years to fully implement." The FAA has been engaged in concerted process improvement efforts for less than 2 years, with much of the momentum in process improvement occurring in the last 6 to 9 months. The SA-CMM, which is the basis for much of our improvement effort, was just released in final form in December 1996. If the FAA follows a focused path towards process improvement using the merged CMM model described above as the comprehensive strategic basis for that improvement, significant improvements should start to become visible by the end of 1998.

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