

February 1999

# CUSTOMS SERVICE MODERNIZATION

## Ineffective Software Development Processes Increase Customs System Development Risks



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

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**Accounting and Information  
Management Division**

B-280417

February 11, 1999

The Honorable Ben Nighthorse Campbell  
Chairman, Subcommittee on Treasury,  
General Government, and Civil Service  
Committee on Appropriations  
United States Senate

The Honorable Jim Kolbe  
Chairman, Subcommittee on Treasury,  
Postal, and General Government  
Committee on Appropriations  
House of Representatives

This report responds to your requests that we review the U. S. Customs Service's software development maturity and improvement activities. Customs plans to spend hundreds of millions of dollars developing and maintaining software-intensive systems. We found that Customs' software development processes are immature and are making recommendations to the Commissioner of Customs for strengthening them.

We are sending copies of this report to the Secretary of the Treasury; Commissioner of Customs; Director of the Office of Management and Budget; Ranking Minority Members of the Subcommittee on Treasury and General Government of the Senate Committee on Appropriations and the Subcommittee on Treasury, Postal Service, and General Government of the House Committee on Appropriations; 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) 512-6240. Major contributors to this report are listed in appendix II.

Randolph C. Hite  
Associate Director, Governmentwide  
and Defense Information Systems

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# Executive Summary

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## Purpose

The Customs Service relies extensively on software intensive systems to perform its core missions of enforcing laws governing the flow of goods and persons across U.S. borders, and assessing and collecting billions of dollars annually in duties, taxes, and fees on imported merchandise. Because software is a complex and expensive component of these systems, Customs must use defined and disciplined processes if it expects to develop and maintain software effectively.

Recognizing software's importance to Customs' mission effectiveness, the Chairman, Subcommittee on Treasury and General Government, Senate Committee on Appropriations, and the Chairman, Subcommittee on Treasury, Postal Service and General Government, House Committee on Appropriations, asked GAO to determine (1) the maturity of Customs' software development processes, and (2) whether Customs has an effective software process improvement program.

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## Background

During fiscal year 1997, Customs collected \$22.1 billion in revenue at more than 300 ports of entry, and it processed nearly 450 million passengers who entered the U.S. during the year. Each year Customs also provides trade statistics used in developing trade policy and negotiating trade agreements with various countries. Customs expects its workload to burgeon. Accordingly, Customs plans to spend hundreds of millions of dollars over the next 5 years developing software for new and existing information systems.

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 Capability Maturity Model<sup>SM</sup> (SW-CMM®)<sup>1</sup> and the SEI software capability evaluation method<sup>2</sup>, GAO staff trained at SEI evaluated Customs' software development/maintenance maturity in five of the six key process areas (KPA) that are necessary to attain a "repeatable" level of

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<sup>1</sup>Capability Maturity Model<sup>SM</sup> is the service mark of Carnegie Mellon University, and CMM® is registered in the U.S. Patent and Trademark Office.

<sup>2</sup>We used the latest version (version 1.1) of the software development CMM for our evaluation.

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process maturity.<sup>3</sup> GAO did not evaluate Customs in the sixth repeatable level KPA, software subcontract management, because Customs did not use subcontractors on any of the projects that GAO evaluated.<sup>4</sup> An organization at the repeatable level of process maturity has the necessary process discipline in place to repeat earlier successes on projects in similar applications. The repeatable level of process maturity is the second level on SEI's five-level scale. 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. To aid such organizations in maturing their processes, SEI has also published a software process improvement model called IDEAL<sup>SM5</sup> that defines a systematic, five-phase process improvement approach.<sup>6</sup>

As part of its evaluation, GAO examined three software projects. These were (1) development of the first software release of the National Customs Automation Program (NCAP 0.1), which is the first phase of the Automated Commercial Environment (ACE); (2) software maintenance on the Automated Export System (AES); and (3) software maintenance on the Administrative Security System.<sup>7</sup>

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## Results in Brief

Because of the number and severity of Customs' software development process weaknesses, Customs did not fully satisfy any of the key process

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<sup>3</sup>The five KPAs are requirements management, software project planning, software project tracking and oversight, software quality assurance, and software configuration management. According to the SW-CMM, requirements management is the process for establishing a common understanding between the customer and the software developer of the customer's requirements; software project planning is the process for establishing reasonable plans for engineering the software and managing the software project; software project tracking and oversight is the process of providing adequate visibility into the software project's progress to permit effective action when deviations from plans occur; software quality assurance is the process of verifying for management that software project plans, standards, and procedures are being followed; and software configuration management is the process of establishing and maintaining the integrity of the software products throughout the project's life cycle.

<sup>4</sup>According to the SW-CMM, software subcontract management is the process of selecting a software subcontractor, establishing commitments with the subcontractor, and tracking and reviewing the subcontractor's performance and results.

<sup>5</sup>IDEAL<sup>SM</sup> is a service mark of Carnegie Mellon University.

<sup>6</sup>IDEAL: A User's Guide for Software Process Improvement (CMU/SEI-96-HB-001).

<sup>7</sup>The Subcommittee Chairmen requested that we evaluate ACE, which is the largest and most important system that Customs is developing. The other two projects were selected by Customs on the basis of the following GAO specified criteria: each project should be managed by a different software team, at least one project should involve a legacy system, at least one project should involve Year 2000 software conversion, and each project should be relatively large and important to accomplishing Customs' mission.

areas (KPAS) necessary to achieve the “repeatable” level of process maturity. As a result, its processes for developing software, a complex and expensive component of Customs’ systems, are ad hoc, sometimes chaotic, and not repeatable across projects.

Customs had some practice strengths in all but one of the five KPAS evaluated (i.e., requirements management, software project planning, software project tracking and oversight, software quality assurance, and software configuration management); however, GAO also found extensive and significant weaknesses in each of these KPAS. Some of these weaknesses were systemic, recurring in each of the KPAS. For example, Customs had no written policy for managing or implementing any of the KPAS; and none of the projects had (1) an approved quality assurance plan; (2) documented procedures for determining the project cost, schedule, or effort; or (3) any outside group reviewing or reporting on the project’s compliance with defined processes. These weaknesses are some of the reasons for Customs’ limited success, for example, in delivering promised ACE capabilities on time.

Currently, Customs does not have a software development process improvement program, and it has not taken the basic steps to initiate one. These steps, many of which are described in SEI’s IDEAL<sup>8</sup> model for process improvement, include assigning responsibility and authority for process improvement, establishing a process improvement management structure, defining a plan of action, and committing needed resources. Until Customs establishes an effective process improvement program, its software processes will remain poorly defined and undisciplined, and its software projects are likely to suffer cost, schedule, and performance shortfalls.

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## Principal Findings

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### Customs Software Development Processes Are Immature

GAO evaluated how effectively each of the three Customs software projects implemented five of the six level 2 KPAS: requirements management, software project planning, software project tracking and oversight, software quality assurance, and software configuration management. To attain a level 2 or repeatable maturity rating, Customs would have to effectively implement all of the key practices for all five relevant KPAS.

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<sup>8</sup>IDEAL stands for the five phases of the model—Initiating, Diagnosing, Establishing, Acting, and Leveraging.

GAO found that while Customs had some strengths (i.e., practices that are effectively implemented), it had too many weaknesses (i.e., practices that are ineffectively implemented) to satisfy any of the level 2 KPAs. The strengths and weaknesses for all three projects are tallied in table 1. In summary, of the total number of KPA practices rated, 35 percent constituted strengths, 61 percent were weaknesses, and 4 percent were observations. An observation indicates that the evidence was inconclusive and did not clearly support a determination of either strength or weakness. To reach the repeatable level of maturity, Customs must eliminate the key practice weaknesses identified in this report.<sup>9</sup>

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

Key process area	Number of strengths	Number of weaknesses	Number of observations
Requirements management	23	13	0
Software project planning	32	38	5
Software project tracking and oversight	28	40	4
Software quality assurance	3	46	2
Software configuration management	17	46	0
<b>Total</b>	<b>103</b>	<b>183</b>	<b>11</b>

Also, GAO found that while the three projects varied as to the number of key practice strengths, weaknesses, and observations under each of the five “common features” or practice groupings (commitment to perform, ability to perform, activities performed, measurement and analysis, and verification of implementation), the NCAAP 0.1 project displayed a better strengths to weaknesses ratio across all KPAs (about 1:1) than either AES or the Administrative Security System (about 1:2 and 1:4, respectively). By increasing its software maturity, Customs will reduce both the number of weaknesses on individual projects and the variability in process discipline among projects.

**Customs Does Not Have a Software Process Improvement Program**

SEI’s IDEAL model for software process improvement defines five sequential phases. The phases are (1) initiating the program, including assigning organizational roles and responsibility, establishing a program management structure, developing an action plan, and allocating needed resources; (2) assessing the organization’s current level of process maturity; (3) establishing a plan for addressing the identified process weaknesses; (4) developing and implementing new or improved processes;

<sup>9</sup>SEI groups each of its KPA practices into one of five “common features” or practice attributes. These are “commitment to perform, ability to perform, activities performed, measurement and analysis, and verifying implementation.”

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and (5) learning from process improvement experiences to strengthen the program.

In 1996, Customs initiated efforts to improve its software processes. As part of this effort, Customs had a contractor assess its software development capabilities and develop a process improvement plan. Customs then established process improvement teams for strengthening two level-2 KPAS (software project planning and project tracking and oversight).

In 1997, Customs discontinued its process improvement program, deciding at that time to redirect its process improvement resources to Year 2000 conversion. As a result, Customs' software development capability, which is fundamental to its ability to effectively develop new systems like ACE, and maintain existing systems like AES, remains ad hoc and undisciplined. Customs officials stated their commitment to using the results of GAO's software capability evaluation to baseline its strengths and weaknesses and address its weaknesses, but Customs has not yet established a software process improvement program. In particular, it has not assigned organizational responsibility and authority for process improvement, established a program management structure, defined a plan of action, or committed the necessary resources (trained staff and funding) to execute the plan.

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## Recommendations

GAO recommends that, after ensuring that its mission-critical systems are Year 2000 compliant, but before investing in major software development efforts like ACE, the Commissioner of Customs direct the Customs Chief Information Officer to:

- assign responsibility and authority for software process improvement;
- develop and implement a formal plan for software development 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 (trained staff and funding), and defines a process improvement management structure;
- ensure that every new software development effort in Customs adopts processes that satisfy at least SW-CMM level 2 requirements; and
- ensure that process improvement activities are initiated for all ongoing essential software maintenance projects.



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## Agency Comments and GAO's Evaluation

In its written comments on a draft of this report, Customs acknowledged the importance of software process improvement and maturity. Also, it agreed with GAO's overall findings, including that Customs' software development processes have not attained SW-CMM level 2 maturity.

Customs stated that it has taken the first step toward implementing GAO's recommendations by assigning responsibility and authority for software process improvement as part of a reorganization of the Office of Information and Technology that it plans to implement in early 1999. Customs commented that once the reorganization is implemented, a formal software process improvement program will be established, including definition of an action plan, commitment of resources, and specification of goals for achieving CMM levels 2 and 3. According to Customs, these improvement activities are in their early stages. When they are successfully implemented, they should address many of GAO's recommendations.

Customs also stated that, because its legacy systems are aging and need to be enhanced and replaced, software process improvement must occur in parallel with continued software development investments. History has shown that attempting to modernize without first instituting disciplined software processes has been a characteristic of failed modernization programs.<sup>10</sup> Until it implements disciplined software processes (at least level 2 process maturity), Customs cannot prudently manage major software investments, such as ACE with an estimated life cycle cost exceeding \$1 billion.

In its comments, Customs also asked to meet with GAO to discuss system-specific KPA practice strength and weakness determinations. GAO met with Customs prior to requesting comments on a draft of this report to discuss system-specific determinations, and then again after receiving Customs' comments to ensure that all findings were clear. GAO is prepared to continue assisting Customs as it improves its software processes.

Customs provided other comments on a draft of this report. Each of Customs' comments, along with GAO's responses, is discussed in detail in chapter 8 and appendix I of this report.

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<sup>10</sup>Tax Systems Modernization: Management and Technical Weaknesses Must Be Corrected If Modernization Is To Succeed ([GAO/AIMD-95-156](#), July 26, 1995), Tax Systems Modernization: Actions Underway But IRS Has Not Yet Corrected Management and Technical Weaknesses ([GAO/AIMD-96-106](#), June 7, 1996), and Air Traffic Control: Immature Software Acquisition Processes Increase FAA System Acquisition Risks ([GAO/AIMD-97-47](#), March 21, 1997).

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**Abbreviations**

ACE	Automated Commercial Environment
ACS	Automated Commercial System
AES	Automated Export System
CMM®	Capability Maturity Model <sup>SM</sup>
GAO	General Accounting Office
IDEAL <sup>SM</sup>	Initiating, Diagnosing, Establishing, Acting, Leveraging
KPA	key process area
NAFTA	North American Free Trade Agreement
NCAP	National Customs Automation Program
NCAP/P	National Customs Automation Program Prototype
RM	requirements management
SCE	Software Capability Evaluation
SCM	software configuration management
SDLC	Software Development Life Cycle
SEI	Software Engineering Institute
SEPG	Software Engineering Process Group
SPP	software project planning
SPTO	software project tracking and oversight
SQA	software quality assurance
SW-CMM	Software Capability Maturity Model

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# Introduction

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The mission of the Customs Service is to ensure that all goods and persons entering and exiting the United States do so in compliance with all U.S. laws and regulations. It does this by (1) enforcing the laws governing the flow of goods and persons across the borders of the United States and (2) assessing and collecting duties, taxes, and fees on imported merchandise. During fiscal year 1997, Customs collected \$22.1 billion in revenue<sup>1</sup> at more than 300 ports of entry and reported that it processed nearly 450 million passengers who entered the United States during the year.

To accomplish its mission, Customs is organized into six lines of business—trade compliance, outbound, passenger, finance, human resources, and investigations. Each business area is described below.

- Trade compliance includes enforcement of laws and regulations associated with the importation of goods into the United States. To do so, Customs (1) works with the trade community to promote understanding of applicable laws and regulations, (2) selectively examines cargo to ensure that only eligible goods enter the country, (3) reviews documentation associated with cargo entries to ensure that they are properly valued and classified, (4) collects billions of dollars annually in duties, taxes, and fees associated with imported cargo, (5) assesses fines and penalties for noncompliance with trade laws and regulations, (6) seizes and accounts for illegal cargo, and (7) manages the collection of these moneys to ensure that all trade-related debts due to Customs are paid and properly accounted for.
- Outbound includes Customs enforcement of laws and regulations associated with the movement of merchandise and conveyances from the United States. To do so, Customs (1) selectively inspects cargo at U.S. ports to guard against the exportation of illegal goods, such as protected technologies, stolen vehicles, and illegal currency, (2) collects, disseminates, and uses intelligence to identify high-risk cargo and passengers, (3) seizes and accounts for illegal cargo, (4) assesses and collects fines and penalties associated with the exportation of illegal cargo, and (5) physically examines baggage and cargo at airport facilities for explosive and nuclear materials. In addition, the outbound business includes collecting and disseminating trade data within the federal government. Accurate trade data are crucial to establishing accurate trade statistics on which to base trade policy decisions and negotiate trade agreements with other countries. By the year 2000, Customs estimates that

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<sup>1</sup>Includes tariff duty, user fees, Internal Revenue Service excise taxes, and other assessments.

exports will be valued at \$1.2 trillion, compared to a reported \$696 million in 1994.

- Passenger includes processing all passengers and crew of arriving and departing (1) air and sea conveyances and (2) land vehicles and pedestrians. In fiscal year 1997, Customs reported it processed nearly 450 million travelers and, by the year 2000, expects almost 500 million passengers to arrive in the United States annually. Many of Customs' passenger activities focus on illegal immigration and drug smuggling and are coordinated with other federal agencies, such as the Immigration and Naturalization Service and the Department of Agriculture's Animal and Plant Health Inspection Service. Activities include targeting high-risk passengers, which requires timely and accurate information, and physically inspecting selected passengers, baggage, and vehicles to determine compliance with laws and regulations.
- Finance includes asset and revenue management activities. Asset management consists of activities to (1) formulate Customs' budget, (2) properly allocate and distribute funds, and (3) acquire, manage, and account for personnel, goods, and services. Revenue management encompasses all Customs activities to identify and establish amounts owed Customs, collect these amounts, and accurately report the status of revenue from all sources. Sources of revenue include duties, fees, taxes, other user fees, and forfeited currency and property. The revenue management activities interrelate closely with the revenue collection activities in the trade compliance, outbound, and passenger business areas.
- Human resources is responsible for filling positions, providing employee benefits and services, training employees, facilitating workforce effectiveness, and processing personnel actions for Customs' 18,000 employees and managers.
- Investigations includes activities to detect and eliminate narcotics and money laundering operations. Customs works with other agencies and foreign governments to reduce drug-related activity by interdicting (seizing and destroying) narcotics, investigating organizations involved in drug smuggling, and deterring smuggling efforts through various other methods. Customs also develops and provides information to the trade and carrier communities to assist them in their efforts to prevent smuggling organizations from using cargo containers and commercial conveyances to introduce narcotics into the United States.

To carry out its responsibilities, Customs relies on information systems and processes to assist its staff in (1) documenting, inspecting, and accounting for the movement and disposition of imported goods and

(2) collecting and accounting for the related revenues. Customs expects its reliance on information systems to increase as a result of its burgeoning workload. For 1995 through 2001, Customs estimates that the annual volume of import trade between the United States and other countries will increase from \$761 billion to \$1.1 trillion. This will result in Customs processing an estimated increase of 7.5 million commercial entries—from 13.1 million to 20.6 million annually—during the same period. Recent trade agreements, such as the North American Free Trade Agreement (NAFTA), have also increased the number and complexity of trade provisions that Customs must enforce.

Customs recognizes that its ability to process the growing volume of imports while improving compliance with trade laws depends heavily on successfully modernizing its trade compliance process and its supporting automated systems. To speed the processing of imports and improve compliance with trade laws, the Congress enacted legislation<sup>2</sup> that eliminated certain legislatively mandated paper requirements and required Customs to establish the National Customs Automation Program (NCAP). The legislation also specified certain functions that NCAP must provide, including giving members of the trade community the capability to electronically file import entries at remote locations and enabling Customs to electronically process “drawback” claims.<sup>3</sup> In response to the legislation, Customs began in 1994 to modernize the information systems that support operations.

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## **Current Projects: A Brief Description**

Customs has several projects underway to develop and acquire new software and evolve (i.e., maintain) existing software to support its six business areas. Customs’ fiscal year 1998 budget for information management and technology activities was about \$147 million.

Customs’ major information technology effort is its Automated Commercial Environment (ACE) system. In 1994, Customs began to develop ACE to replace its existing automated import system, the Automated Commercial System (ACS). ACE is intended to provide an integrated, automated information system for collecting, disseminating, and analyzing import-related data and ensuring the proper collection and allocation of revenues, totaling about \$19 billion annually. According to

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<sup>2</sup>North American Free Trade Agreement Implementation Act, Public Law 103-182, 19 U.S.C. 1411 et seq.

<sup>3</sup>Drawbacks are refunds of duties and taxes paid on imported goods that are subsequently exported or destroyed.



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Customs, ACE is planned to automate critical functions that the Congress specified when it established NCAP.

Customs reported that it spent \$47.8 million on ACE as of the end of fiscal year 1997. In November 1997, Customs estimated it would cost \$1.05 billion to develop, operate, and maintain ACE over the 15 years from fiscal year 1994 through fiscal year 2008. Customs plans to deploy ACE to more than 300 ports that handle commercial cargo imports.

Customs plans to develop and deploy ACE in multiple phases. According to Customs, the first phase, known as NCAP, is an ACE prototype. Customs currently plans to deploy NCAP in four releases. The first release was deployed for field evaluation at three locations in May 1998,<sup>4</sup> and the fourth is scheduled for 1999. Customs, however, has not adhered to previous NCAP deployment schedules. Specifically, implementation of the NCAP prototype slipped from January 1997 to August 1997 and then again to a series of four releases beginning in October 1997, with the fourth release starting in June 1998.

Customs also has several other projects underway to modify or enhance existing systems that support its six business areas. For example, in fiscal year 1998, Customs planned to spend about \$3.7 million to enhance its Automated Export System (AES), which supports the outbound business area and is designed to improve Customs' collection and reporting of export statistics and to enforce export regulations. In addition, Customs planned to spend another \$4.6 million to maintain its administrative systems supporting its finance and human resource business areas.

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## Objectives, Scope, and Methodology

The Chairman, Subcommittee on Treasury and General Government, Senate Committee on Appropriations, and the Chairman, Subcommittee on Treasury, Postal Service and General Government, House Committee on Appropriations, requested that we review Customs' ability to develop software for its computer systems. Our objectives were to determine (1) the maturity of Customs' software development processes and (2) the effectiveness of Customs' software process improvement program.

To determine Customs' software development process maturity, we applied the Software Engineering Institute's (SEI) Software Capability

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<sup>4</sup>The first release of the NCAP prototype was deployed to Detroit, Michigan; Laredo, Texas; and Port Huron, Michigan.

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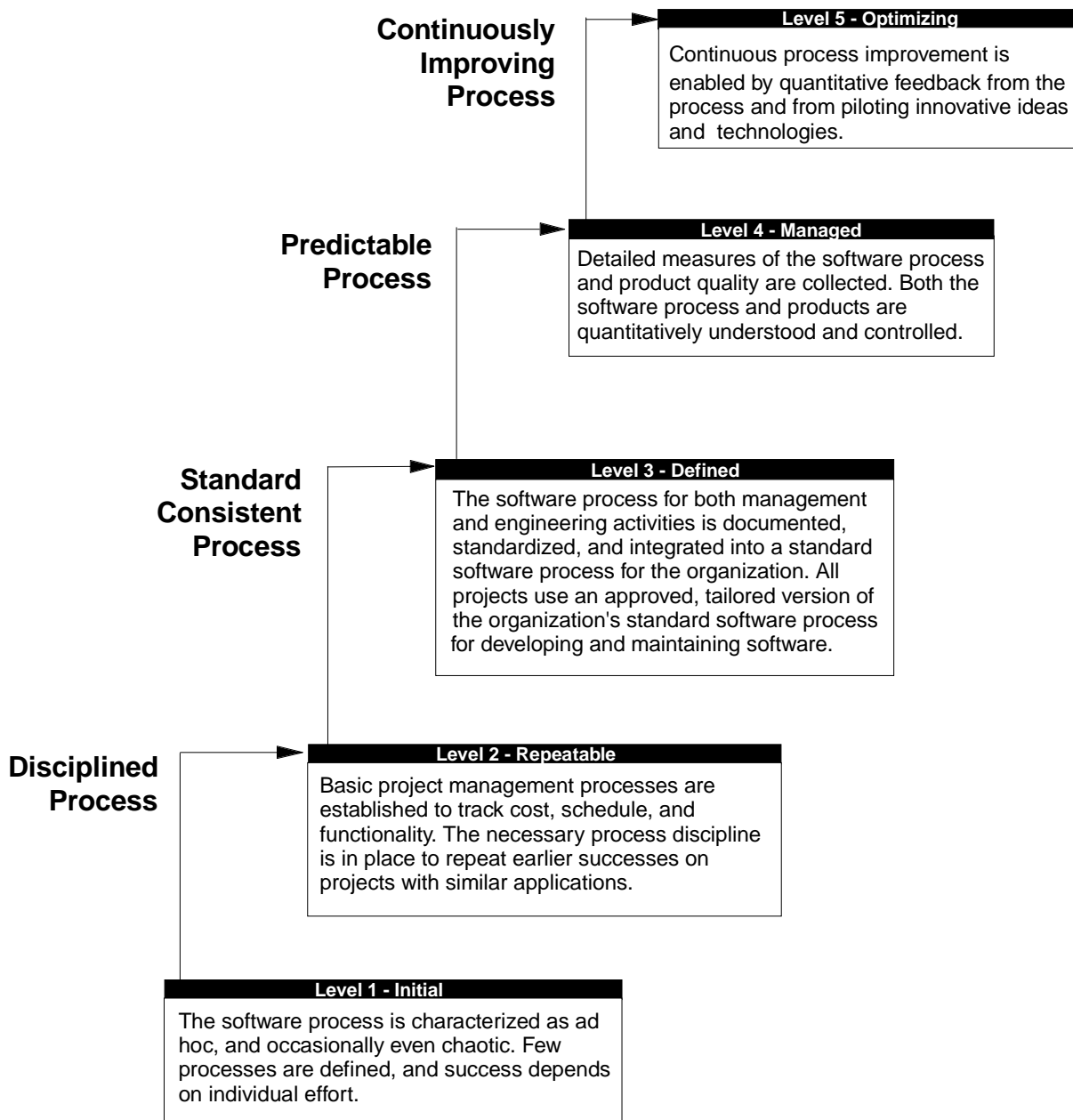
Maturity Model<sup>SM</sup> (SW-CMM®)<sup>5</sup> and its Software Capability Evaluation (SCE) method. SEI's expertise in software process maturity as well as its capability maturity models and evaluation methods are widely accepted throughout the software industry. All our specialists were SEI-trained.

The SW-CMM ranks organizational maturity according to five levels. (See figure 1.1.) Maturity levels 2 through 5 require the verifiable existence and use of certain software development processes, known as key process areas (KPA). According to SEI, an organization that has these processes in place is in a much better position to successfully develop software than an organization that does not have these processes in place. We evaluated Customs' software development processes against five of the six level 2 KPAs.

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<sup>5</sup>Capability Maturity Model<sup>SM</sup> is the service mark of Carnegie Mellon University, and CMM® is registered in the U.S. Patent and Trademark Office.

Figure 1.1: SW-CMM Levels and Descriptions



The sixth level 2 KPA, software subcontract management, was not evaluated because Customs did not use subcontractors on any of the projects that we evaluated. (See table 1.1.)

**Table 1.1: SW-CMM KPAs Used to Assess Customs' Software Development Maturity**

<b>CMM Level 2 KPAs</b>	<b>Summary description</b>
Requirements management	Defining, validating, and prioritizing requirements, such as functions, performance, and delivery dates.
Software project planning	Developing estimates for the work to be performed, establishing the necessary commitments, and defining the plan to perform the work.
Software project tracking and oversight	Tracking and reviewing software accomplishments and results against documented estimates, commitments, and plans and adjusting these based on the actual accomplishments and results.
Software quality assurance	Reviewing and auditing the software products and activities to ensure that they comply with the applicable processes, standards, and procedures and providing the staff and managers with the results of their reviews and audits.
Software configuration management	Selecting project baseline items, such as specifications; systematically controlling these items and changes to them; and recording and reporting status and change activity for these items.

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:** 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 senior management sponsorship.
- **Ability to perform:** The preconditions that must exist in the project or organization to implement the software development process competently. Ability to perform typically involves resources, organizational structures, and training.
- **Activities performed:** 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:** 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:** 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 and, for five of the six KPAs in level 2, we evaluated Customs' institutional 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 three ongoing Customs software development projects, each of which is described below. As requested by the Subcommittee Chairmen, one of the projects evaluated was ACE, which is the largest and most important system that Customs is developing. The other two projects were selected by Customs on the basis of the following GAO specified criteria: (1) each project should be managed by a different software team, (2) at least one project should involve a legacy system, (3) at least one project should involve Year 2000 software conversion, and (4) each project should be relatively large and important to accomplishing Customs' mission. The projects we evaluated are:

- **National Customs Automation Program (NCAP 0.1):** NCAP 0.1 was the first component of the National Customs Automation Program Prototype (NCAP/P). NCAP/P, in turn, is the first phase of the Automated Commercial Environment (ACE). Customs began developing ACE in 1994 to address the new import processing requirements established by the National Customs Automation Program. ACE is also intended to replace the agency's legacy automated import system, the Automated Commercial System (ACS). NCAP 0.1 was installed at three field locations in May 1998.
- **Automated Export System (AES):** AES is an export information gathering and processing system, developed through cooperative efforts by Customs, the Bureau of Census, other federal agencies with export missions, and the export trade community. AES is designed to improve the collection of trade statistics; assist in the creation of a paperless export environment; facilitate the release of exports subject to licensing

requirements; and consolidate export data required by several government agencies, easing the data filing burden for exporters while streamlining the federal data collection process.

Customs installed AES in all U.S. vessel ports in October 1996, and currently it is operational in all ports, including air, rail, and truck transit ports. Customs and Census officials estimate that they spent approximately \$12.9 million to develop and implement AES from fiscal year 1992 to 1997. These costs included, among other things, expenses for contractors, travel, and training. According to Customs' and Census' figures, both agencies estimate that together they will spend an additional \$32.2 million through fiscal year 2002 on AES implementation and maintenance.

- **Administrative Security System:** The Administrative Security System assists users in requesting access to administrative systems. Users' requests are electronically submitted to the appropriate official for approvals. In addition, other portions of the Administrative Security System provide functionality to allow the System Administrators the ability to prepare and maintain user profiles, request logs, and electronic approval and disapproval reports.

To assess the effectiveness of Customs' software process improvement program, we interviewed the Director, Technical Architecture Group, Office of Information and Technology, 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 reviewed past process improvement plans, meeting minutes, and related documentation. Further, we reviewed SEI's model for software process improvement, known as IDEAL<sup>SM</sup>.<sup>6</sup> IDEAL defines five sequential phases of software process improvement that can be used to develop a long range, integrated plan for initiating and managing a software process improvement program.<sup>7</sup>

Customs provided written comments on a draft of this report. These comments are presented and evaluated in chapter 8, and are reprinted in appendix I. We performed our work at Customs' Newington, Virginia, Data Center from February 1998 through November 1998, in accordance with generally accepted government auditing standards.

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<sup>6</sup>IDEAL<sup>SM</sup> is a service mark of Carnegie Mellon University.

<sup>7</sup>IDEAL: A User's Guide for Software Process Improvement (CMU/SEI-96-HB-001).

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# Requirements Management

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The purpose of requirements management is to establish agreement between the customer and the software developers of the customer's requirements that will be implemented by the software developers. This agreement typically is referred to as the "system requirements allocated to the software." The agreement covers both technical and nontechnical (e.g., delivery dates) requirements. The agreement forms the basis for estimating, planning, performing, and tracking the software developer's activities throughout the software life cycle.

According to the SW-CMM, a repeatable requirements management process, among other things, includes (1) documenting the system requirements allocated to software, (2) providing adequate resources and funding for managing the allocated requirements, (3) following a written organizational policy for requirements management, (4) having a quality assurance group that reviews the activities and work products for managing allocated requirements and reports the results, (5) using the allocated requirements as the basis for software plans, work products, and activities, and (6) training members of the software engineering group to perform their requirements management activities.

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## Customs' Requirements Management Process Does Not Satisfy SEI's Criteria

All three projects had practice strengths in this KPA. For example, each project documented the system requirements allocated to software and ensured that adequate resources and funding for managing the allocated requirements were provided. One of the projects, NCAP 0.1, had strengths in all but two practices under this KPA; however, each practice weakness is significant.

Collectively, the projects had many weaknesses in this KPA, and thus Customs' requirements management processes do not meet "repeatable" maturity level criteria. For example, none of the projects had a written organizational policy governing requirements management, and none had a quality assurance group for reviewing and reporting on the activities and work products associated with managing the allocated requirements. In the absence of these two practices, management is missing two means for ensuring that software requirements are managed in a prescribed manner. Also, two of the projects did not use the allocated software requirements as the basis for software plans, work products, and activities, which increases the risk that the software developed will not fully satisfy requirements. Further, members of two projects' software engineering groups were not trained to perform requirements management activities, thus increasing the chances of mismanagement.

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Table 2.1 provides a comprehensive list of the three projects' strengths and weaknesses for the requirements management KPA. The specific findings supporting the practice ratings cited in table 2.1 are in tables 2.2 through 2.4.

**Table 2.1: Requirements Management**

	<b>Key practice</b>	<b>NCAP 0.1</b>	<b>AES</b>	<b>Administrative</b>
Commitment 1	The project follows a written organizational policy for managing the system requirements allocated to software.	Weakness	Weakness	Weakness
Ability 1	For each project, responsibility is established for analyzing the system requirements and allocating them to hardware, software, and other system components.	Strength	Strength	Strength
Ability 2	The allocated requirements are documented.	Strength	Strength	Strength
Ability 3	Adequate resources and funding are provided for managing the allocated requirements.	Strength	Strength	Strength
Ability 4	Members of the software engineering group and other software-related groups are trained to perform their requirements management activities.	Strength	Weakness	Weakness
Activity 1	The software engineering group reviews the allocated requirements before they are incorporated into the software project.	Strength	Strength	Weakness
Activity 2	The software engineering group uses the allocated requirements as the basis for software plans, work products, and activities.	Strength	Weakness	Weakness
Activity 3	Changes to the allocated requirements are reviewed and incorporated into the software project.	Strength	Strength	Weakness
Measurement 1	Measurements are made and used to determine the status of the activities for managing the allocated requirements.	Strength	Strength	Strength
Verification 1	The activities for managing the allocated requirements are reviewed with senior management on a periodic basis.	Strength	Weakness	Strength
Verification 2	The activities for managing the allocated requirements are reviewed with the project manager on both a periodic and event-driven basis.	Strength	Strength	Strength
Verification 3	The software quality assurance group reviews and/or audits the activities and work products for managing the allocated requirements and reports the results.	Weakness	Weakness	Weakness



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**Table 2.2: Requirements Management Findings for NCAP 0.1**

<b>National Customs Automation Program 0.1</b>			
	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The project follows a written organizational policy for managing the system requirements allocated to software.	There is no written organizational policy for managing the system requirements allocated to software.	Weakness
Ability 1	For each project, responsibility is established for analyzing the system requirements and allocating them to hardware, software, and other system components.	The Process Analysis and Requirements Team is responsible for analyzing system requirements and allocating them to hardware, software, and other system components.	Strength
Ability 2	The allocated requirements are documented.	Allocated requirements are documented.	Strength
Ability 3	Adequate resources and funding are provided for managing the allocated requirements.	Adequate resources and funding are provided for managing the allocated requirements.	Strength
Ability 4	Members of the software engineering group and other software-related groups are trained to perform their requirements management activities.	Members of the software engineering group and other software-related groups are trained to perform their requirements management activities.	Strength
Activity 1	The software engineering group reviews the allocated requirements before they are incorporated into the software project.	The software engineering group reviews the allocated requirements before they are incorporated into the software project.	Strength
Activity 2	The software engineering group uses the allocated requirements as the basis for software plans, work products, and activities.	The software engineering group uses the allocated requirements as the basis for software plans, work products, and activities.	Strength
Activity 3	Changes to the allocated requirements are reviewed and incorporated into the software project.	Changes to the allocated requirements are reviewed and incorporated into the software project.	Strength
Measurement 1	Measurements are made and used to determine the status of the activities for managing the allocated requirements.	Measurements are made and used to determine the status of the activities for managing the allocated requirements.	Strength
Verification 1	The activities for managing the allocated requirements are reviewed with senior management on a periodic basis.	Periodic meetings with senior management include reviews of allocated requirements.	Strength
Verification 2	The activities for managing the allocated requirements are reviewed with the project manager on both a periodic and event-driven basis.	The activities for managing the allocated requirements are reviewed with the project manager on both a periodic and event-driven basis.	Strength
Verification 3	The software quality assurance group reviews and/or audits the activities and work products for managing the allocated requirements and reports the results.	There is no software quality assurance group, therefore, no reviews and/or audits are done.	Weakness

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**Table 2.3: Requirements Management Findings for AES**

<b>Automated Export System</b>			
	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The project follows a written organizational policy for managing the system requirements allocated to software.	There is no written organizational policy for managing systems requirements allocated to software.	Weakness
Ability 1	For each project, responsibility is established for analyzing the system requirements and allocating them to hardware, software, and other system components.	The project team established responsibility for analyzing the system requirements and allocating them to hardware, software, and other system components.	Strength
Ability 2	The allocated requirements are documented.	The allocated requirements are documented in the system functional requirements document and in the change requests document.	Strength
Ability 3	Adequate resources and funding are provided for managing the allocated requirements.	Adequate resources and funding are provided for managing allocated requirements.	Strength
Ability 4	Members of the software engineering group and other software-related groups are trained to perform their requirements management activities.	One member of the software engineering group has been trained to perform requirements management activities, but others have not.	Weakness
Activity 1	The software engineering group reviews the allocated requirements before they are incorporated into the software project.	The software engineering group reviews the allocated requirements before they are incorporated into the software project.	Strength
Activity 2	The software engineering group uses the allocated requirements as the basis for software plans, work products, and activities.	The software engineering group does not use the allocated requirements as the basis for software plans, work products, and activities.	Weakness
Activity 3	Changes to the allocated requirements are reviewed and incorporated into the software project.	The Change Request Board reviews and approves all changes made to allocated requirements and incorporates them into the software project.	Strength
Measurement 1	Measurements are made and used to determine the status of the activities for managing the allocated requirements.	Measurements are made and used to track changes to requirements and hours spent on requirements management. A performance measurement plan is available.	Strength
Verification 1	The activities for managing the allocated requirements are reviewed with senior management on a periodic basis.	The activities for managing the allocated requirements are not reviewed with senior management on a periodic basis.	Weakness
Verification 2	The activities for managing the allocated requirements are reviewed with the project manager on both a periodic and event-driven basis.	The activities for managing the allocated requirements are reviewed with the project manager on both a periodic and event-driven basis.	Strength
Verification 3	The software quality assurance group reviews and/or audits the activities and work products for managing the allocated requirements and reports the results.	The individual responsible for software quality assurance did not review and/or audit the activities and work products for managing the allocated requirements.	Weakness

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**Table 2.4: Requirements Management Findings for Administrative Security System**

<b>Administrative Security System</b>			
	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The project follows a written organizational policy for managing the system requirements allocated to software.	There is no written organizational policy on requirements management.	Weakness
Ability 1	For each project, responsibility is established for analyzing the system requirements and allocating them to hardware, software, and other system components.	Project leaders are responsible for analyzing systems requirements and allocating them to software, hardware or other components.	Strength
Ability 2	The allocated requirements are documented.	Allocated requirements for the system are documented.	Strength
Ability 3	Adequate resources and funding are provided for managing the allocated requirements.	Adequate resources and funding are available for managing the allocated requirements.	Strength
Ability 4	Members of the software engineering group and other software-related groups are trained to perform their requirements management activities.	There was no evidence to show that members of the software engineering group received training in requirements management.	Weakness
Activity 1	The software engineering group reviews the allocated requirements before they are incorporated into the software project.	The software engineering group did not review the allocated requirements before they were incorporated into the software project.	Weakness
Activity 2	The software engineering group uses the allocated requirements as the basis for software plans, work products, and activities.	Members of the software engineering group did not use the allocated requirements as the basis for software plans, work products, and activities.	Weakness
Activity 3	Changes to the allocated requirements are reviewed and incorporated into the software project.	Changes to the allocated requirements are not reviewed by the software engineering group and incorporated into the software project.	Weakness
Measurement 1	Measurements are made and used to determine the status of the activities for managing the allocated requirements.	Measurements are made and used to determine the status of the activities for managing the allocated requirements.	Strength
Verification 1	The activities for managing the allocated requirements are reviewed with senior management on a periodic basis.	Requirements management activities are discussed at periodic meetings with senior management.	Strength
Verification 2	The activities for managing the allocated requirements are reviewed with the project manager on both a periodic and event-driven basis.	The activities for managing the allocated requirements are reviewed with the project manager on both a periodic and event-driven basis.	Strength
Verification 3	The software quality assurance group reviews and/or audits the activities and work products for managing the allocated requirements and reports the results.	There is no software quality assurance (SQA) group.	Weakness

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## Conclusions

While Customs' projects had several practice strengths in this KPA, the number and significance of their practice weaknesses mean that Customs' ability to manage software requirements is not repeatable. As a result, Customs is at risk of producing systems that fail to provide promised capabilities, and cost more and take longer than necessary.

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# Software Project Planning

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The purpose of software project planning is to establish reasonable plans for performing the software engineering and for managing the software project. According to the SW-CMM, a repeatable software project planning process, among other things, includes (1) documenting the software project plan, and preparing plans for software engineering facilities and support tools, (2) identifying the work products needed to establish and maintain control of the software project, (3) following a written organizational policy for planning a software project, (4) having a quality assurance group that reviews the activities and work products for software project planning and reports the results, (5) estimating the software project's efforts and costs, and estimating its critical computer resources according to a documented procedure, (6) making and using measurements to determine the status of planning activities, and (7) training personnel in software project planning and estimating.

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## Customs Is Not Performing Software Project Planning Effectively

All of the projects that we evaluated had key practice strengths in this KPA. For example, all had strengths in (1) documenting a software project plan and preparing plans for the software engineering facilities and support tools needed to develop the software and (2) identifying the work products needed to control the software project. NCAP 0.1, in particular, had many additional practice strengths.

However, many significant practice weaknesses were found in all three projects. None of the projects followed an organizational software project planning policy, and none had a quality assurance group conducting reviews and/or audits. As a result, the projects performed these practices differently and inconsistently, and controls were unreliable. For example, while the NCAP 0.1 project followed a documented procedure for estimating the size of software work products (or changes to the size of work products), and made and used measurements to determine the status of software planning activities, neither of the other two projects performed these practices and none of the projects had personnel trained in software project planning and estimating. Such project planning weaknesses mean that management has no assurance that it will get the consistent, complete, and reliable information about the projects' expected costs and schedules needed to make expeditious and informed investment decisions.

Table 3.1 provides a comprehensive list of the three projects' strengths, weaknesses, and observations for the software project planning KPA. The

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specific findings supporting the practice ratings cited in table 3.1 are in tables 3.2 through 3.4.

**Table 3.1: Software Project Planning**

	<b>Key practice</b>	<b>NCAP 0.1</b>	<b>AES</b>	<b>Administrative</b>
Commitment 1	A project software manager is designated to be responsible for negotiating commitments and developing the project's software development plan.	Strength	Strength	Weakness
Commitment 2	The project follows a written organizational policy for planning a software project.	Weakness	Weakness	Weakness
Ability 1	A documented and approved statement of work exists for the software project.	Strength	Observation	Observation
Ability 2	Responsibilities for developing the software development plan are assigned.	Strength	Observation	Strength
Ability 3	Adequate resources and funding are provided for planning the software project.	Strength	Weakness	Strength
Ability 4	The software managers, software engineers, and other individuals involved in the software project planning are trained in the software estimating and planning procedures applicable to their areas of responsibility.	Weakness	Weakness	Weakness
Activity 1	The software engineering group participates on the project proposal team.	Strength	Weakness	Weakness
Activity 2	Software project planning is initiated in the early stages of, and in parallel with, the overall project planning.	Strength	Weakness	Strength
Activity 3	The software engineering group participates with other affected groups in the overall project planning throughout the project's life.	Strength	Weakness	Observation
Activity 4	Software project commitments made to individuals and groups external to the organization are reviewed with senior management according to a documented procedure.	Weakness	Observation	Weakness
Activity 5	A software life cycle with predefined stages of manageable size is identified or defined.	Weakness	Strength	Strength
Activity 6	The project's software development plan is developed according to a documented procedure.	Strength	Strength	Weakness
Activity 7	The plan for the software project is documented.	Strength	Strength	Strength
Activity 8	Software work products that are needed to establish and maintain control of the software project are identified.	Strength	Strength	Strength
Activity 9	Estimates for the size of the software work products (or changes to the size of software work products) are derived according to a documented procedure.	Strength	Weakness	Weakness
Activity 10	Estimates for the software project's effort and costs are derived according to a documented procedure.	Weakness	Weakness	Weakness
Activity 11	Estimates for the project's critical computer resources are derived according to a documented procedure.	Weakness	Weakness	Weakness

(continued)

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	<b>Key practice</b>	<b>NCAP 0.1</b>	<b>AES</b>	<b>Administrative</b>
Activity 12	The project's software schedule is derived according to a documented procedure.	Weakness	Weakness	Weakness
Activity 13	The software risks associated with the cost, resource, schedule, and technical aspects of the project are identified, assessed, and documented.	Strength	Strength	Weakness
Activity 14	Plans for the project's software engineering facilities and support tools are prepared.	Strength	Strength	Strength
Activity 15	Software planning data are recorded.	Strength	Weakness	Weakness
Measurement 1	Measurements are made and used to determine the status of the software planning activities.	Strength	Weakness	Weakness
Verification 1	The activities for software project planning are reviewed with senior management on a periodic basis.	Strength	Weakness	Weakness
Verification 2	The activities for software project planning are reviewed with the project manager on both a periodic and event-driven basis.	Strength	Strength	Weakness
Verification 3	The software quality assurance group reviews and/or audits the activities and work products for software project planning and reports the results.	Weakness	Weakness	Weakness

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**Table 3.2: Software Project Planning Findings for NCAP 0.1**

<b>National Customs Automation Program 0.1</b>			
	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	A project software manager is designated to be responsible for negotiating commitments and developing the project's software development plan.	The NCAP project has a software manager designated to be responsible for negotiating commitments and developing the project's software development plan.	Strength
Commitment 2	The project follows a written organizational policy for planning a software project.	The project does not follow a written organizational policy for planning a software project.	Weakness
Ability 1	A documented and approved statement of work exists for the software project.	The approved project plan meets the requirements for a statement of work for the project.	Strength
Ability 2	Responsibilities for developing the software development plan are assigned.	The project manager has been assigned responsibility for developing the software development plan.	Strength
Ability 3	Adequate resources and funding are provided for planning the software project.	Adequate resources and funding have been provided for planning the software project.	Strength
Ability 4	The software managers, software engineers, and other individuals involved in the software project planning are trained in the software estimating and planning procedures applicable to their areas of responsibility.	Project personnel are not trained in software project planning and estimating procedures.	Weakness
Activity 1	The software engineering group participates on the project proposal team.	The software engineering group participates on the project proposal team.	Strength
Activity 2	Software project planning is initiated in the early stages of, and in parallel with, the overall project planning.	Software project planning is initiated in the early stages of, and in parallel with, the overall project planning.	Strength
Activity 3	The software engineering group participates with other affected groups in the overall project planning throughout the project's life.	The software engineering group participates with other affected groups in the overall project planning throughout the project's life.	Strength
Activity 4	Software project commitments made to individuals and groups external to the organization are reviewed with senior management according to a documented procedure.	Software project commitments made to individuals and groups external to the organization are not reviewed with senior management and there is no documented procedure for such reviews.	Weakness
Activity 5	A software life cycle with predefined stages of manageable size is identified or defined.	There is no documented evidence that a software life cycle was selected for the project.	Weakness
Activity 6	The project's software development plan is developed according to a documented procedure.	The project has a software development plan that is developed according to a documented procedure.	Strength
Activity 7	The plan for the software project is documented.	The plan for the software project is documented in the project plan.	Strength
Activity 8	Software work products that are needed to establish and maintain control of the software project are identified.	Software work products that are needed to establish and maintain control of the software project are identified in the project plan.	Strength

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**National Customs Automation Program 0.1**

	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Activity 9	Estimates for the size of the software work products (or changes to the size of software work products) are derived according to a documented procedure.	Estimates for the size of the software work products (or changes to the size of software work products) are derived according to a documented procedure.	Strength
Activity 10	Estimates for the software project's effort and costs are derived according to a documented procedure.	Estimates for the software project's effort and costs are not derived according to a documented procedure.	Weakness
Activity 11	Estimates for the project's critical computer resources are derived according to a documented procedure.	Estimates for the project's critical computer resources are not derived according to a documented procedure.	Weakness
Activity 12	The project's software schedule is derived according to a documented procedure.	There is no documented procedure for deriving the software schedule.	Weakness
Activity 13	The software risks associated with the cost, resource, schedule, and technical aspects of the project are identified, assessed, and documented.	The software risks associated with the cost, resource, schedule, and technical aspects of the project are identified, assessed, and documented.	Strength
Activity 14	Plans for the project's software engineering facilities and support tools are prepared.	Plans for the project's software engineering facilities and support tools are prepared.	Strength
Activity 15	Software planning data are recorded.	Software planning data are recorded.	Strength
Measurement 1	Measurements are made and used to determine the status of the software planning activities.	Measurements are made and used to determine the status of the software planning activities.	Strength
Verification 1	The activities for software project planning are reviewed with senior management on a periodic basis.	The activities for software project planning are reviewed with senior management, including reports to Treasury and Customs Investment Review Boards (IRB), on a periodic basis.	Strength
Verification 2	The activities for software project planning are reviewed with the project manager on both a periodic and event-driven basis.	The activities for software project planning are reviewed with the project manager on both a periodic and event-driven basis through weekly status reports and meetings.	Strength
Verification 3	The software quality assurance group reviews and/or audits the activities and work products for software project planning and reports the results.	There is no SQA group.	Weakness

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**Table 3.3: Software Project Planning Findings for AES**

<b>Automated Export System</b>			
	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	A project software manager is designated to be responsible for negotiating commitments and developing the project's software development plan.	A project software manager is designated to be responsible for negotiating commitments and developing the project's software development plan.	Strength
Commitment 2	The project follows a written organizational policy for planning a software project.	The project does not follow a written organizational policy for planning a software project.	Weakness
Ability 1	A documented and approved statement of work exists for the software project.	The AES System and Functional Requirements Table documents the statement of work for this project. However, this document is not approved.	Observation
Ability 2	Responsibilities for developing the software development plan are assigned.	Responsibilities for developing the software development plan have not been assigned; however, a plan has been developed.	Observation
Ability 3	Adequate resources and funding are provided for planning the software project.	Adequate resources and funding are not provided for planning the software project.	Weakness
Ability 4	The software managers, software engineers, and other individuals involved in the software project planning are trained in the software estimating and planning procedures applicable to their areas of responsibility.	Individuals involved in the software project planning are not trained in the software estimating and planning procedures.	Weakness
Activity 1	The software engineering group participates on the project proposal team.	The software engineering group does not participate in project proposal preparation.	Weakness
Activity 2	Software project planning is initiated in the early stages of, and in parallel with, the overall project planning.	Software project planning is not initiated in the early stages of, and in parallel with, the overall project planning.	Weakness
Activity 3	The software engineering group participates with other affected groups in the overall project planning throughout the project's life.	The software engineering group does not participate in the overall project planning throughout the project's life cycle.	Weakness
Activity 4	Software project commitments made to individuals and groups external to the organization are reviewed with senior management according to a documented procedure.	Software project commitments made to individuals and groups external to the organization are reviewed with senior management; however, there is no documented procedure for these reviews.	Observation
Activity 5	A software life cycle with predefined stages of manageable size is identified or defined.	The project uses the waterfall model identified in the Customs software development life cycle document.	Strength
Activity 6	The project's software development plan is developed according to a documented procedure.	The project's software development plan was developed according to a documented procedure in the SDLC.	Strength
Activity 7	The plan for the software project is documented.	The plan for the software project is documented.	Strength
Activity 8	Software work products that are needed to establish and maintain control of the software project are identified.	Software work products that are needed to establish and maintain control of the software project have been identified.	Strength

(continued)

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**Software Project Planning**

**Automated Export System**

	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Activity 9	Estimates for the size of the software work products (or changes to the size of software work products) are derived according to a documented procedure.	There is no documented procedure for estimating the size of software work products (or changes to the size of software work products).	Weakness
Activity 10	Estimates for the software project's effort and costs are derived according to a documented procedure.	There is no documented procedure for estimating project effort and cost.	Weakness
Activity 11	Estimates for the project's critical computer resources are derived according to a documented procedure.	There is no documented procedure for estimating the project's computer resources.	Weakness
Activity 12	The project's software schedule is derived according to a documented procedure.	There is no documented procedure for deriving the software schedule.	Weakness
Activity 13	The software risks associated with the cost, resource, schedule, and technical aspects of the project are identified, assessed, and documented.	The software risks associated with the cost, resource, schedule, and technical aspects of the project are identified, assessed, and documented.	Strength
Activity 14	Plans for the project's software engineering facilities and support tools are prepared.	AES is an ongoing project. The software engineering facilities and support tools already exist, and are documented in the software development plan.	Strength
Activity 15	Software planning data are recorded.	Software planning data, such as estimating the project's critical computer resources, are not recorded.	Weakness
Measurement 1	Measurements are made and used to determine the status of the software planning activities.	Measurements are not made and used to determine the status of the software planning activities.	Weakness
Verification 1	The activities for software project planning are reviewed with senior management on a periodic basis.	The activities for software project planning are not reviewed with senior management on a periodic basis.	Weakness
Verification 2	The activities for software project planning are reviewed with the project manager on both a periodic and event-driven basis.	The activities for software project planning are reviewed with the project manager on both a periodic and event-driven basis.	Strength
Verification 3	The software quality assurance group reviews and/or audits the activities and work products for software project planning and reports the results.	The individual performing software quality assurance activities does not conduct reviews and/or audits.	Weakness

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**Table 3.4: Software Project Planning Findings for Administrative Security System**

<b>Administrative Security System</b>			
	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	A project software manager is designated to be responsible for negotiating commitments and developing the project's software development plan.	A project software manager has not been designated to be responsible for negotiating commitments and developing the project's software development plan. The software engineering group was not sure who was responsible for negotiating commitments.	Weakness
Commitment 2	The project follows a written organizational policy for planning a software project.	The project does not follow a written organizational policy for planning a software project.	Weakness
Ability 1	A documented and approved statement of work exists for the software project.	A documented statement of work exists for the software project, but has not been approved.	Observation
Ability 2	Responsibilities for developing the software development plan are assigned.	Responsibilities for developing the software development plan were assigned to a team of seven whose names appear on the document.	Strength
Ability 3	Adequate resources and funding are provided for planning the software project.	Adequate resources and funding are available for planning the software project.	Strength
Ability 4	The software managers, software engineers, and other individuals involved in the software project planning are trained in the software estimating and planning procedures applicable to their areas of responsibility.	The software managers, software engineers, and other individuals involved in the software project planning are not trained in the software estimating and planning procedures applicable to their areas of responsibility.	Weakness
Activity 1	The software engineering group participates on the project proposal team.	The software engineering group did not participate on the project proposal team.	Weakness
Activity 2	Software project planning is initiated in the early stages of, and in parallel with, the overall project planning.	Software project planning is initiated in the early stages of, and in parallel with, the overall project planning.	Strength
Activity 3	The software engineering group participates with other affected groups in the overall project planning throughout the project's life.	The software engineering group occasionally participates with other affected groups in the overall project planning throughout the project's life.	Observation
Activity 4	Software project commitments made to individuals and groups external to the organization are reviewed with senior management according to a documented procedure.	There is no documented procedure to ensure that software project commitments made to individuals and groups external to the organization are reviewed with senior management.	Weakness
Activity 5	A software life cycle with predefined stages of manageable size is identified or defined.	A software life cycle with predefined stages of manageable size has been identified in the SDLC.	Strength
Activity 6	The project's software development plan is developed according to a documented procedure.	The project has a software development plan; but it was not developed according to a documented procedure.	Weakness
Activity 7	The plan for the software project is documented.	The plan for the software project is documented.	Strength

(continued)

**Chapter 3**  
**Software Project Planning**

**Administrative Security System**

	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Activity 8	Software work products that are needed to establish and maintain control of the software project are identified.	Software work products that are needed to establish and maintain control of the software project are identified.	Strength
Activity 9	Estimates for the size of the software work products (or changes to the size of software work products) are derived according to a documented procedure.	No documented procedure is used for estimating the size of software work products (or changes to the size of software work products).	Weakness
Activity 10	Estimates for the software project's effort and costs are derived according to a documented procedure.	No documented procedure is used for estimating the project's effort and cost.	Weakness
Activity 11	Estimates for the project's critical computer resources are derived according to a documented procedure.	No documented procedure is used for estimating the project's computer resources.	Weakness
Activity 12	The project's software schedule is derived according to a documented procedure.	No documented procedure is used for deriving the project schedule.	Weakness
Activity 13	The software risks associated with the cost, resource, schedule, and technical aspects of the project are identified, assessed, and documented.	The software risks associated with the cost, resource, schedule, and technical aspects of the project have been identified and documented, but have not been assessed for impact and mitigation options.	Weakness
Activity 14	Plans for the project's software engineering facilities and support tools are prepared.	Existing tools and the current software engineering environment have been identified for use.	Strength
Activity 15	Software planning data are recorded.	Software planning data are not recorded.	Weakness
Measurement 1	Measurements are made and used to determine the status of the software planning activities.	No measurements are made to determine the status of software planning activities.	Weakness
Verification 1	The activities for software project planning are reviewed with senior management on a periodic basis.	While periodic meetings are held with senior management, there was no evidence that activities for software project planning are addressed.	Weakness
Verification 2	The activities for software project planning are reviewed with the project manager on both a periodic and event-driven basis.	While periodic meetings are held with the project manager, there was no evidence that activities for software project planning are addressed.	Weakness
Verification 3	The software quality assurance group reviews and/or audits the activities and work products for software project planning and reports the results.	There is no software quality assurance group.	Weakness

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## Conclusions

Effective planning is the cornerstone of successful software development project management. While Customs showed some strengths in this KPA, its many weaknesses render its software project planning processes unrepeatable. Therefore, Customs has no assurance that the projects are effectively establishing plans, including reliable projections of costs and schedules, and effectively measuring and monitoring progress and taking needed corrective actions expeditiously.

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# Software Project Tracking and Oversight

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The purpose of software project tracking and oversight is to provide adequate visibility into the progress of the software development so that management can act effectively when the software project's performance deviates significantly from the software plans. Software project tracking and oversight involves tracking and reviewing the software accomplishments and results against documented estimates, commitments, and plans, and adjusting these plans based on the actual accomplishments and results.

According to the SW-CMM, effective software project tracking and oversight, among other things, includes (1) designating a project software manager to be responsible for the project's software activities and results, (2) having a documented software development plan for tracking software activities and communicating status, (3) following a written organizational policy for managing the project, (4) conducting periodic internal reviews to track technical progress, plans, performance, and issues against the software development plan, (5) tracking the software risks associated with the cost, resource, schedule, and technical aspects of the project, (6) explicitly assigning responsibility for software work products and activities, (7) tracking the sizes of the software work products (or sizes of the changes to the software work products) and taking corrective actions as necessary, and (8) periodically reviewing the activities for software project tracking and oversight with senior management.

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## Customs' Software Project Tracking and Oversight Process Is Immature

The projects evaluated exhibited some software project tracking and oversight practice strengths. For example, all three of the projects had a project software manager designated to be responsible for the project's software activities and results, and all had a documented software development plan for tracking software activities and communicating status. Also, NCAP 0.1 had strengths in all but five of this KPA's 24 key practices.

However, the three projects collectively had many weaknesses, and these weaknesses, including the five for NCAP 0.1, were significant and thus preclude Customs from meeting SEI's repeatable maturity level criteria. For example, none of the projects followed a written organizational policy for managing the software project. With no established policy, Customs increases the risk that key tracking and oversight activities will not be performed effectively. For example, for two of the three projects, the project managers did not (1) conduct periodic internal reviews to track technical progress, plans, performance, and issues against the software

**Chapter 4  
Software Project Tracking and Oversight**

development plan, (2) track software risks associated with cost, resource, schedule, and technical aspects of the project, (3) explicitly assign responsibility to individuals for software work products and activities, (4) track the sizes of the software work products (or sizes of the changes to the software work products) and take corrective actions, or (5) periodically review software project tracking and oversight activities with senior management.

Table 4.1 provides a comprehensive list of the three projects' strengths, weaknesses, and observations for the software project tracking and oversight KPA. The specific findings supporting the practice ratings cited in table 4.1 are in tables 4.2 through 4.4.

**Table 4.1: Software Project Tracking and Oversight Summary**

	<b>Key practice</b>	<b>NCAP 0.1</b>	<b>AES</b>	<b>Administrative</b>
Commitment 1	A project software manager is designated to be responsible for the project's software activities and results.	Strength	Strength	Strength
Commitment 2	The project follows a written organizational policy for managing the software project.	Weakness	Weakness	Weakness
Ability 1	A software development plan for the software project is documented and approved.	Strength	Observation	Observation
Ability 2	The project software manager explicitly assigns responsibility for software work products and activities.	Strength	Weakness	Weakness
Ability 3	Adequate resources and funding are provided for tracking the software project.	Strength	Weakness	Weakness
Ability 4	The software managers are trained in managing the technical and personnel aspects of the software project.	Weakness	Strength	Weakness
Ability 5	First-line software managers receive orientation in the technical aspects of the software project.	Strength	Strength	Weakness
Activity 1	A documented software development plan is used for tracking the software activities and communicating status.	Strength	Strength	Strength
Activity 2	The project's software development plan is revised according to a documented procedure.	Weakness	Weakness	Weakness
Activity 3	Software project commitments and changes to commitments made to individuals and groups external to the organization are reviewed with senior management according to a documented procedure.	Weakness	Observation	Observation
Activity 4	Approved changes to commitments that affect the software project are communicated to the members of the software engineering group and other software-related groups.	Strength	Strength	Weakness

(continued)



**Chapter 4**  
**Software Project Tracking and Oversight**

	<b>Key practice</b>	<b>NCAP 0.1</b>	<b>AES</b>	<b>Administrative</b>
Activity 5	The sizes of the software work products (or sizes of the changes to the software work products) are tracked, and corrective actions are taken as necessary.	Strength	Weakness	Weakness
Activity 6	The project's software effort and costs are tracked, and corrective actions are taken as necessary.	Strength	Strength	Weakness
Activity 7	The project's critical computer resources are tracked, and corrective actions are taken as necessary.	Strength	Weakness	Weakness
Activity 8	The project's software schedule is tracked, and corrective actions are taken as necessary.	Strength	Weakness	Strength
Activity 9	Software engineering technical activities are tracked, and corrective actions are taken as necessary.	Strength	Weakness	Weakness
Activity 10	The software risks associated with cost, resource, schedule, and technical aspects of the project are tracked.	Strength	Weakness	Weakness
Activity 11	Actual measurement data and replanning data for the software project are recorded.	Strength	Weakness	Weakness
Activity 12	The software engineering group conducts periodic internal reviews to track technical progress, plans, performance, and issues against the software development plan.	Strength	Weakness	Weakness
Activity 13	Formal reviews to address the accomplishments and results of the software project are conducted at selected project milestones according to a documented procedure.	Strength	Weakness	Weakness
Measurement 1	Measurements are made and used to determine the status of the software tracking and oversight activities.	Strength	Weakness	Weakness
Verification 1	The activities for software project tracking and oversight are reviewed with senior management on a periodic basis.	Strength	Weakness	Weakness
Verification 2	The activities for software project tracking and oversight are reviewed with the project manager on both a periodic and event-driven basis.	Strength	Weakness	Weakness
Verification 3	The software quality assurance group reviews and/or audits the activities and work products for software project tracking and oversight and reports the results.	Weakness	Weakness	Weakness

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Software Project Tracking and Oversight**

**Table 4.2: Software Project Tracking and Oversight Findings for NCAP 0.1**

<b>National Customs Automation Program 0.1</b>			
	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	A project software manager is designated to be responsible for the project's software activities and results.	The project software manager is designated to be responsible for the project's software activities and results.	Strength
Commitment 2	The project follows a written organizational policy for managing the software project.	There is no written organizational policy for managing the software project.	Weakness
Ability 1	A software development plan for the software project is documented and approved.	An approved and documented software development plan is contained in the project plan.	Strength
Ability 2	The project software manager explicitly assigns responsibility for software work products and activities.	The project software manager explicitly assigns responsibility for software work products and activities.	Strength
Ability 3	Adequate resources and funding are provided for tracking the software project.	Adequate resources and funding are provided for tracking the software project.	Strength
Ability 4	The software managers are trained in managing the technical and personnel aspects of the software project.	The software managers are not trained in managing the technical and personnel aspects of the software project.	Weakness
Ability 5	First-line software managers receive orientation in the technical aspects of the software project.	First-line software managers receive orientation in the technical aspects of the software project.	Strength
Activity 1	A documented software development plan is used for tracking the software activities and communicating status.	A documented software development plan is used for tracking the software activities and communicating status.	Strength
Activity 2	The project's software development plan is revised according to a documented procedure.	No documented procedure exists for revising the software development plan.	Weakness
Activity 3	Software project commitments and changes to commitments made to individuals and groups external to the organization are reviewed with senior management according to a documented procedure.	Software project commitments and changes to commitments made to individuals and groups external to the organization are not reviewed with senior management. Also, there is no documented procedure for such reviews.	Weakness
Activity 4	Approved changes to commitments that affect the software project are communicated to the members of the software engineering group and other software-related groups.	Approved changes to commitments that affect the software project are communicated to the members of the software engineering group and other software-related groups through weekly staff meetings.	Strength
Activity 5	The sizes of the software work products (or sizes of the changes to the software work products) are tracked, and corrective actions are taken as necessary.	The sizes of the software work products (or sizes of the changes to the software work products) are tracked; however, at the time of our evaluation, no corrective actions were needed.	Strength
Activity 6	The project's software effort and costs are tracked, and corrective actions are taken as necessary.	The project's software effort and costs are tracked; however, at the time of our evaluation, no corrective actions were needed.	Strength
Activity 7	The project's critical computer resources are tracked, and corrective actions are taken as necessary.	The project's critical computer resources are tracked; however, at the time of our evaluation, no corrective actions were needed.	Strength

(continued)

**Chapter 4  
Software Project Tracking and Oversight**

**National Customs Automation Program 0.1**

	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Activity 8	The project's software schedule is tracked, and corrective actions are taken as necessary.	The project's software schedule is tracked; however, at the time of our evaluation, no corrective actions were needed.	Strength
Activity 9	Software engineering technical activities are tracked, and corrective actions are taken as necessary.	Software engineering technical activities are tracked, and corrective actions are taken as necessary.	Strength
Activity 10	The software risks associated with cost, resource, schedule, and technical aspects of the project are tracked.	The software risks associated with cost, resource, schedule, and technical aspects of the project are tracked.	Strength
Activity 11	Actual measurement data and replanning data for the software project are recorded.	Actual measurement data and replanning data for the software project are recorded.	Strength
Activity 12	The software engineering group conducts periodic internal reviews to track technical progress, plans, performance, and issues against the software development plan.	The software engineering group conducts periodic internal reviews to track technical progress, plans, performance, and issues against the software development plan.	Strength
Activity 13	Formal reviews to address the accomplishments and results of the software project are conducted at selected project milestones according to a documented procedure.	Formal reviews to address the accomplishments and results of the software project are conducted at selected project milestones according to a documented procedure.	Strength
Measurement 1	Measurements are made and used to determine the status of the software tracking and oversight activities.	Measurements are made and used to determine the status of the software tracking and oversight activities.	Strength
Verification 1	The activities for software project tracking and oversight are reviewed with senior management on a periodic basis.	The activities for software project tracking and oversight are reviewed with senior management on a weekly basis.	Strength
Verification 2	The activities for software project tracking and oversight are reviewed with the project manager on both a periodic and event-driven basis.	The activities for software project tracking and oversight are reviewed with the project manager on both a periodic and event-driven basis.	Strength
Verification 3	The software quality assurance group reviews and/or audits the activities and work products for software project tracking and oversight and reports the results.	No software quality assurance group exists; therefore, there are no reviews and/or audits of the activities and work products for software project tracking and oversight.	Weakness

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**Table 4.3: Software Project Tracking and Oversight Findings for AES**

<b>Automated Export System</b>			
	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	A project software manager is designated to be responsible for the project's software activities and results.	A project software manager is designated to be responsible for the project's software activities and results.	Strength
Commitment 2	The project follows a written organizational policy for managing the software project.	There is no written organizational policy for managing the software project.	Weakness
Ability 1	A software development plan for the software project is documented and approved.	A software development plan for the project exists. However, this plan has not been approved.	Observation
Ability 2	The project software manager explicitly assigns responsibility for software work products and activities.	The project software manager does not explicitly assign responsibility for software work products and activities.	Weakness
Ability 3	Adequate resources and funding are provided for tracking the software project.	Adequate resources and funding are not provided for tracking the software project.	Weakness
Ability 4	The software managers are trained in managing the technical and personnel aspects of the software project.	The software managers are trained in managing the technical and personnel aspects of the software projects through training given at off-site retreats and guidance provided in the AES users' guide.	Strength
Ability 5	First-line software managers receive orientation in the technical aspects of the software project.	First-line software managers receive orientation in the technical aspects of the software project.	Strength
Activity 1	A documented software development plan is used for tracking the software activities and communicating status.	A documented software development plan is used for tracking the software activities and communicating status.	Strength
Activity 2	The project's software development plan is revised according to a documented procedure.	No documented procedure exists for revising the software development plan.	Weakness
Activity 3	Software project commitments and changes to commitments made to individuals and groups external to the organization are reviewed with senior management according to a documented procedure.	Software project commitments and changes to commitments made to individuals and groups external to the organization are reviewed in periodic meetings. However, there is no documented procedure for these reviews.	Observation
Activity 4	Approved changes to commitments that affect the software project are communicated to the members of the software engineering group and other software-related groups.	Approved changes to commitments that affect the software project are communicated to the members of the software engineering group and other software-related groups through e-mail and weekly status meetings.	Strength
Activity 5	The sizes of the software work products (or sizes of the changes to the software work products) are tracked, and corrective actions are taken as necessary.	The sizes of the software work products (or sizes of the changes to the software work products) are not tracked.	Weakness
Activity 6	The project's software effort and costs are tracked, and corrective actions are taken as necessary.	The project's software effort and costs are tracked, and corrective action is taken as necessary.	Strength

(continued)

**Chapter 4  
Software Project Tracking and Oversight**

**Automated Export System**

	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Activity 7	The project's critical computer resources are tracked, and corrective actions are taken as necessary.	The project's critical computer resources are not tracked.	Weakness
Activity 8	The project's software schedule is tracked, and corrective actions are taken as necessary.	The project's software schedule is not tracked.	Weakness
Activity 9	Software engineering technical activities are tracked, and corrective actions are taken as necessary.	Software engineering technical activities are not tracked.	Weakness
Activity 10	The software risks associated with cost, resource, schedule, and technical aspects of the project are tracked.	The software risks associated with cost, resource, schedule, and technical aspects of the project are not tracked.	Weakness
Activity 11	Actual measurement data and replanning data for the software project are recorded.	Actual measurement data and replanning data for the software project are not recorded.	Weakness
Activity 12	The software engineering group conducts periodic internal reviews to track technical progress, plans, performance, and issues against the software development plan.	The software engineering group does not conduct periodic internal reviews to track technical progress, plans, performance, and issues against the software development plan.	Weakness
Activity 13	Formal reviews to address the accomplishments and results of the software project are conducted at selected project milestones according to a documented procedure.	No documented procedure exists for conducting formal reviews to address the accomplishments and results of the software project at selected project milestones.	Weakness
Measurement 1	Measurements are made and used to determine the status of the software tracking and oversight activities.	Measurements are not made and used to determine the status of software tracking and oversight activities.	Weakness
Verification 1	The activities for software project tracking and oversight are reviewed with senior management on a periodic basis.	The activities for software project tracking and oversight are not reviewed with senior management on a periodic basis.	Weakness
Verification 2	The activities for software project tracking and oversight are reviewed with the project manager on both a periodic and event-driven basis.	The activities for software project tracking and oversight are not reviewed with the project manager.	Weakness
Verification 3	The software quality assurance group reviews and/or audits the activities and work products for software project tracking and oversight and reports the results.	The software quality assurance group does not review and/or audit the activities and work products for software project tracking and oversight and report the results.	Weakness

**Chapter 4  
Software Project Tracking and Oversight**

**Table 4.4: Software Project Tracking and Oversight Findings for Administrative Security System**

<b>Administrative Security System</b>			
	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	A project software manager is designated to be responsible for the project's software activities and results.	A project software manager is designated to be responsible for the project's software activities and results.	Strength
Commitment 2	The project follows a written organizational policy for managing the software project.	There is no organizational policy for managing the software project.	Weakness
Ability 1	A software development plan for the software project is documented and approved.	The project plan contains the software development plan; however, this plan has not been approved.	Observation
Ability 2	The project software manager explicitly assigns responsibility for software work products and activities.	The project software manager does not explicitly assign responsibility for software work products and activities.	Weakness
Ability 3	Adequate resources and funding are provided for tracking the software project.	Adequate resources and funding are not provided for tracking the software project.	Weakness
Ability 4	The software managers are trained in managing the technical and personnel aspects of the software project.	The software managers are not trained in managing the technical and personnel aspects of the software project.	Weakness
Ability 5	First-line software managers receive orientation in the technical aspects of the software project.	First-line software managers did not receive orientation on the technical aspects of the software project.	Weakness
Activity 1	A documented software development plan is used for tracking the software activities and communicating status.	A documented software development plan is used for tracking the software activities and communicating status.	Strength
Activity 2	The project's software development plan is revised according to a documented procedure.	No documented procedure exists for revising the software development plan.	Weakness
Activity 3	Software project commitments and changes to commitments made to individuals and groups external to the organization are reviewed with senior management according to a documented procedure.	Software project commitments and changes to commitments made to individuals and groups external to the organization are reviewed in periodic meetings. However, there is no documented procedure for these reviews.	Observation
Activity 4	Approved changes to commitments that affect the software project are communicated to the members of the software engineering group and other software-related groups.	There is no evidence to show that changes to commitments are either approved by project managers or communicated to the software engineers and other software-related groups.	Weakness
Activity 5	The sizes of the software work products (or sizes of the changes to the software work products) are tracked, and corrective actions are taken as necessary.	The sizes of the software work products (or sizes of the changes to the software work products) are not tracked.	Weakness
Activity 6	The project's software effort and costs are tracked, and corrective actions are taken as necessary.	The project's software effort and costs are not tracked.	Weakness
Activity 7	The project's critical computer resources are tracked, and corrective actions are taken as necessary.	The project's critical computer resources are not tracked.	Weakness

(continued)

**Chapter 4  
Software Project Tracking and Oversight**

**Administrative Security System**

	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Activity 8	The project's software schedule is tracked, and corrective actions are taken as necessary.	The project's software schedule is tracked, and corrective actions are taken as necessary.	Strength
Activity 9	Software engineering technical activities are tracked, and corrective actions are taken as necessary.	Software engineering technical activities are not tracked.	Weakness
Activity 10	The software risks associated with cost, resource, schedule, and technical aspects of the project are tracked.	The software risks associated with cost, resource, schedule, and technical aspects of the project are not tracked.	Weakness
Activity 11	Actual measurement data and replanning data for the software project are recorded.	Actual measurement data and replanning data for the software project are not recorded.	Weakness
Activity 12	The software engineering group conducts periodic internal reviews to track technical progress, plans, performance, and issues against the software development plan.	The software engineering group does not conduct periodic internal reviews to track technical progress, plans, performance, and issues against the software development plan.	Weakness
Activity 13	Formal reviews to address the accomplishments and results of the software project are conducted at selected project milestones according to a documented procedure.	No documented procedure exists for conducting formal reviews to address the accomplishments and results of the software project at selected project milestones.	Weakness
Measurement 1	Measurements are made and used to determine the status of the software tracking and oversight activities.	Measurements are not made and used to determine the status of software tracking and oversight activities.	Weakness
Verification 1	The activities for software project tracking and oversight are reviewed with senior management on a periodic basis.	The activities for software project tracking and oversight are not reviewed with senior management on a periodic basis.	Weakness
Verification 2	The activities for software project tracking and oversight are reviewed with the project manager on both a periodic and event-driven basis.	The activities for software project tracking and oversight are not reviewed with the project manager.	Weakness
Verification 3	The software quality assurance group reviews and/or audits the activities and work products for software project tracking and oversight and reports the results.	No software quality assurance group exists; therefore, there are no reviews and/or audits of the activities and work products for software project tracking and oversight.	Weakness

**Conclusions**

Despite several practice strengths in this KPA, the number and significance of the practice weaknesses that we found mean that Customs' current process for tracking and overseeing its projects is not repeatable, thereby increasing the chances of its software projects being late, costing more than expected, and not performing as intended.

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# Software Quality Assurance

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The purpose of software quality assurance is to independently review and audit the software products and activities to verify that they comply with the applicable procedures and standards and to provide the software project and higher-level managers with the results of these independent reviews and audits.

According to the SW-CMM, a repeatable software quality assurance process, among other things, includes (1) preparing a software quality assurance plan for the project according to a documented procedure, (2) having a written organizational policy for implementing software quality assurance, (3) conducting audits of designated work processes and products to verify compliance, (4) documenting deviations identified in the software activities and software work products and handling them according to a documented procedure, and (5) having experts independent of the software quality assurance group periodically review the activities and work products of the project's software quality assurance group.

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## Customs Lacks a Software Quality Assurance Process

All of the projects evaluated had extensive and significant software quality assurance practice weaknesses. For example, two of the projects did not have a software quality assurance plan; and none of the projects (1) had a written organizational policy for implementing software quality assurance, (2) conducted audits of designated work products to verify compliance, (3) documented deviations identified in the software activities and software work products and handled them according to a documented procedure, or (4) had experts independent of the software quality assurance group periodically review the group's work products. In fact, only one of the projects, AES, had any software quality assurance practice strengths, and these strengths were limited to only a few practices. In this case, the project had assigned responsibility for software quality assurance to a single individual and, for example, a software quality assurance plan had been drafted, although not according to a documented procedure. This virtual absence of software quality assurance on Customs' software projects increases greatly the risk of software process and product standards not being met, which in turn increases the risk of software not performing as intended, and costing more and taking longer to develop than necessary.

Table 5.1 provides a comprehensive list of the three projects' strengths, weaknesses, and observations for the software quality assurance KPA. The specific findings supporting the practice ratings cited in table 5.1 are in tables 5.2 through 5.4.



**Chapter 5**  
**Software Quality Assurance**

**Table 5.1: Software Quality Assurance**

	<b>Key practice</b>	<b>NCAP 0.1</b>	<b>AES</b>	<b>Administrative</b>
Commitment 1	The project follows a written organizational policy for implementing software quality assurance (SQA).	Weakness	Weakness	Weakness
Ability 1	A group that is responsible for coordinating and implementing SQA for the project (i.e., the SQA group) exists.	Observation	Strength	Weakness
Ability 2	Adequate resources and funding are provided for performing the SQA activities.	Weakness	Weakness	Weakness
Ability 3	Members of the SQA group are trained to perform their SQA activities.	Weakness	Strength	Weakness
Ability 4	The members of the software project receive orientation on the role, responsibilities, authority, and value of the SQA group.	Weakness	Strength	Weakness
Activity 1	A SQA plan is prepared for the software project according to a documented procedure.	Weakness	Observation	Weakness
Activity 2	The SQA group's activities are performed in accordance with the SQA plan.	Weakness	Weakness	Weakness
Activity 3	The SQA group participates in the preparation and review of the project's software development plan, standards, and procedures.	Weakness	Weakness	Weakness
Activity 4	The SQA group reviews the software engineering activities to verify compliance.	Weakness	Weakness	Weakness
Activity 5	The SQA group audits designated software work products to verify compliance.	Weakness	Weakness	Weakness
Activity 6	The SQA group periodically reports the results of its activities to the software engineering group.	Weakness	Weakness	Weakness
Activity 7	Deviations identified in the software activities and software work products are documented and handled according to a documented procedure.	Weakness	Weakness	Weakness
Activity 8	The SQA group conducts periodic reviews of its activities and findings with the customer's SQA personnel, as appropriate.	Weakness	Weakness	Weakness
Measurement 1	Measurements are made and used to determine the cost and schedule status of the SQA activities.	Weakness	Weakness	Weakness
Verification 1	The SQA activities are reviewed with senior management on a periodic basis.	Weakness	Weakness	Weakness
Verification 2	The SQA activities are reviewed with the project manager on both a periodic and event-driven basis.	Weakness	Weakness	Weakness
Verification 3	Experts independent of the SQA group periodically review the activities and software work products of the project's SQA group.	Weakness	Weakness	Weakness

**Chapter 5  
Software Quality Assurance**

**Table 5.2: Software Quality Assurance Findings for NCAP 0.1**

<b>National Customs Automation Program 0.1</b>			
	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The project follows a written organizational policy for implementing software quality assurance (SQA).	There is no written organizational policy for implementing SQA.	Weakness
Ability 1	A group that is responsible for coordinating and implementing SQA for the project (i.e., the SQA group) exists.	Although there is no group responsible for coordinating and implementing SQA for the project, there are plans to establish one and assign responsibility.	Observation
Ability 2	Adequate resources and funding are provided for performing the SQA activities.	There is no SQA group, and no resources and funding are provided for performing the SQA activities.	Weakness
Ability 3	Members of the SQA group are trained to perform their SQA activities.	There is no SQA group or plan to provide SQA training.	Weakness
Ability 4	The members of the software project receive orientation on the role, responsibilities, authority, and value of the SQA group.	Project staff do not receive orientation on the role, responsibilities, authority, and value of the SQA group.	Weakness
Activity 1	The SQA plan is prepared for the software project according to a documented procedure.	There is no SQA plan or documented procedure for preparing one.	Weakness
Activity 2	The SQA group's activities are performed in accordance with the SQA plan.	There is no SQA group.	Weakness
Activity 3	The SQA group participates in the preparation and review of the project's software development plan, standards, and procedures.	There is no SQA group.	Weakness
Activity 4	The SQA group reviews the software engineering activities to verify compliance.	There is no SQA group.	Weakness
Activity 5	The SQA group audits designated software work products to verify compliance.	There is no SQA group.	Weakness
Activity 6	The SQA group periodically reports the results of its activities to the software engineering group.	There is no SQA group.	Weakness
Activity 7	Deviations identified in the software activities and software work products are documented and handled according to a documented procedure.	Procedures for handling deviations in testing activities are documented. However, procedures for handling deviations in other software development activities (such as compliance with organizational policy and standards and adherence to software development plan) are not documented.	Weakness
Activity 8	The SQA group conducts periodic reviews of its activities and findings with the customer's SQA personnel, as appropriate.	There is no SQA group.	Weakness
Measurement 1	Measurements are made and used to determine the cost and schedule status of the SQA activities.	There is no SQA group.	Weakness
Verification 1	The SQA activities are reviewed with senior management on a periodic basis.	There is no SQA group.	Weakness

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**Chapter 5**  
**Software Quality Assurance**

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**National Customs Automation Program 0.1**

	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Verification 2	The SQA activities are reviewed with the project manager on both a periodic and event-driven basis.	There is no SQA group.	Weakness
Verification 3	Experts independent of the SQA group periodically review the activities and software work products of the project's SQA group.	There is no SQA group.	Weakness

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**Table 5.3: Software Quality Assurance Findings for AES**

<b>Automated Export System</b>			
	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The project follows a written organizational policy for implementing software quality assurance (SQA).	There is no written organizational policy for implementing SQA.	Weakness
Ability 1	A group that is responsible for coordinating and implementing SQA for the project (i.e., the SQA group) exists.	A single individual is responsible for coordinating and implementing SQA for the project.	Strength
Ability 2	Adequate resources and funding are provided for performing the SQA activities.	Adequate resources and funding are not provided for performing the SQA activities.	Weakness
Ability 3	Members of the SQA group are trained to perform their SQA activities.	Training has been provided to the single individual responsible for SQA to prepare him to perform his activities.	Strength
Ability 4	The members of the software project receive orientation on the role, responsibilities, authority, and value of the SQA group.	Members of the software project are oriented on the role, responsibilities, authority, and value of SQA. Briefings are held during retreats.	Strength
Activity 1	A SQA plan is prepared for the software project according to a documented procedure.	The SQA plan is not prepared according to a documented procedure; however, there is a draft plan.	Observation
Activity 2	The SQA group's activities are performed in accordance with the SQA plan.	The SQA group's activities are not performed in accordance with the SQA plan.	Weakness
Activity 3	The SQA group participates in the preparation and review of the project's software development plan, standards, and procedures.	The individual responsible for SQA does not participate in the preparation and review of the project's software development plan, standards, and procedures.	Weakness
Activity 4	The SQA group reviews the software engineering activities to verify compliance.	The individual responsible for SQA does not review the software engineering activities to verify compliance.	Weakness
Activity 5	The SQA group audits designated software work products to verify compliance.	The individual responsible for SQA does not audit software work products to verify compliance.	Weakness
Activity 6	The SQA group periodically reports the results of its activities to the software engineering group.	The individual responsible for SQA periodically reports the results of testing activities to the software engineering group. Other activities, such as the results of reviews of work products and audits, are not reported.	Weakness
Activity 7	Deviations identified in the software activities and software work products are documented and handled according to a documented procedure.	Procedures for handling deviations in testing activities are documented. However, procedures for handling deviations in other software development activities (such as compliance with organizational policy and standards and adherence to the software development plan) are not documented.	Weakness

(continued)

**Chapter 5**  
**Software Quality Assurance**

<b>Automated Export System</b>			
	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Activity 8	The SQA group conducts periodic reviews of its activities and findings with the customer's SQA personnel, as appropriate.	The SQA group does not conduct periodic reviews of its activities and findings with the customer's SQA personnel, as appropriate.	Weakness
Measurement 1	Measurements are made and used to determine the cost and schedule status of the SQA activities.	Measurements are not made to determine the cost and schedule status of the SQA activities.	Weakness
Verification 1	The SQA activities are reviewed with senior management on a periodic basis.	Senior management is not made aware of the SQA activities.	Weakness
Verification 2	The SQA activities are reviewed with the project manager on both a periodic and event-driven basis.	The project manager and team members are not made aware of SQA activities.	Weakness
Verification 3	Experts independent of the SQA group periodically review the activities and software work products of the project's SQA group.	SQA's activities and software work products are not reviewed by experts independent of the SQA group.	Weakness

**Chapter 5  
Software Quality Assurance**

**Table 5.4: Software Quality Assurance Findings for Administrative Security System**

<b>Administrative Security System</b>			
	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The project follows a written organizational policy for implementing software quality assurance (SQA).	There is no written organizational policy for implementing SQA.	Weakness
Ability 1	A group that is responsible for coordinating and implementing SQA for the project (i.e., the SQA group) exists.	No group is responsible for coordinating and implementing SQA for the project.	Weakness
Ability 2	Adequate resources and funding are provided for performing the SQA activities.	Adequate resources and funding are not provided for performing the SQA activities.	Weakness
Ability 3	Members of the SQA group are trained to perform their SQA activities.	There is no SQA group.	Weakness
Ability 4	The members of the software project receive orientation on the role, responsibilities, authority, and value of the SQA group.	Project staff do not receive orientation on the role, responsibilities, authority, and value of the SQA group.	Weakness
Activity 1	A SQA plan is prepared for the software project according to a documented procedure.	There is no documented procedure for preparing a SQA plan.	Weakness
Activity 2	The SQA group's activities are performed in accordance with the SQA plan.	There is no SQA group.	Weakness
Activity 3	The SQA group participates in the preparation and review of the project's software development plan, standards, and procedures.	There is no SQA group.	Weakness
Activity 4	The SQA group reviews the software engineering activities to verify compliance.	There is no SQA group.	Weakness
Activity 5	The SQA group audits designated software work products to verify compliance.	There is no SQA group.	Weakness
Activity 6	The SQA group periodically reports the results of its activities to the software engineering group.	There is no SQA group.	Weakness
Activity 7	Deviations identified in the software activities and software work products are documented and handled according to a documented procedure.	Procedures for handling deviations in testing activities are documented. However, procedures for handling deviations in other software development activities (such as compliance with organizational policy and standards and adherence to the software development plan) are not documented.	Weakness
Activity 8	The SQA group conducts periodic reviews of its activities and findings with the customer's SQA personnel, as appropriate.	There is no SQA group.	Weakness
Measurement 1	Measurements are made and used to determine the cost and schedule status of the SQA activities.	There is no SQA group.	Weakness
Verification 1	The SQA activities are reviewed with senior management on a periodic basis.	The SQA activities are not reviewed with senior management on a periodic basis.	Weakness

(continued)

<b>Administrative Security System</b>			
	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Verification 2	The SQA activities are reviewed with the project manager on both a periodic and event-driven basis.	The SQA activities are not reviewed with the project manager on both a periodic and event-driven basis.	Weakness
Verification 3	Experts independent of the SQA group periodically review the activities and software work products of the project's SQA group.	There is no SQA group.	Weakness

## **Conclusions**

Customs' software quality assurance process has many weaknesses and is, therefore, undefined and undisciplined. As a result, Customs cannot provide management with independent information about adherence to software process and product standards. To develop and maintain software effectively, Customs must adopt a structured and rigorous approach to software quality assurance.

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# Software Configuration Management

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The purpose of software configuration management is to establish and maintain the integrity of the products of the software project throughout the project's software life-cycle. Software configuration management involves establishing product baselines and systematically controlling changes to them.

According to the SW-CMM, a repeatable software configuration management process, among other things, includes (1) preparing a software configuration management plan according to a documented procedure, (2) establishing a configuration management library system as a repository for the software baselines, (3) identifying software work products to be placed under configuration management, (4) controlling the release of products from the software baseline library according to a documented procedure, (5) following a written organizational policy for implementing software configuration management, (6) recording the status of configuration items/units according to a documented procedure, (7) making and using measurements to determine the status of the software configuration management activities, and (8) reviewing software configuration management activities with senior management on a periodic basis.

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## Customs' Software Configuration Management Process Is Immature

Customs' processes for software configuration management show strengths in several activities. For example, all three projects had developed software configuration management plans according to a documented procedure. Also, two of the projects (NCAP 0.1 and AES) established configuration management library systems as repositories for the software baselines, identified software work products to be placed under configuration management, and controlled the release of products from the software baseline library according to a documented procedure.

However, the projects had many practice weakness that collectively jeopardize Customs' ability to maintain the integrity of the projects' software products. For example, none of the projects had a written organizational policy for implementing software configuration management, and none had documented procedures for recording the status of configuration items (e.g., code, documents). Moreover, none of the projects made or used measurements to determine the status of the software configuration management activities, or reviewed software configuration management activities with senior management on a periodic basis.



Table 6.1 provides a comprehensive list of the three projects' strengths and weaknesses for the software configuration management KPA. The specific findings supporting the practice ratings cited in table 6.1 are in tables 6.2 through 6.4.

**Figure 6.1: Software Configuration Management**

	<b>Key practice</b>	<b>NCAP 0.1</b>	<b>AES</b>	<b>Administrative</b>
Commitment 1	The project follows a written organizational policy for implementing software configuration management (SCM).	Weakness	Weakness	Weakness
Ability 1	A board having the authority for managing the project's software baselines (i.e., a software configuration control board) exists or is established.	Weakness	Strength	Weakness
Ability 2	A group that is responsible for coordinating and implementing SCM for the project (i.e., the SCM group) exists.	Weakness	Strength	Strength
Ability 3	Adequate resources and funding are provided for performing the SCM activities.	Weakness	Weakness	Weakness
Ability 4	Members of the SCM group are trained in the objectives, procedures, and methods for performing their SCM activities.	Weakness	Strength	Weakness
Ability 5	Members of the software engineering group and other software-related groups are trained to perform their SCM activities.	Weakness	Strength	Weakness
Activity 1	A SCM plan is prepared for each software project according to a documented procedure.	Strength	Strength	Strength
Activity 2	A documented and approved SCM plan is used as the basis for performing the SCM activities.	Weakness	Weakness	Weakness
Activity 3	A configuration management library system is established as a repository for the software baselines.	Strength	Strength	Weakness
Activity 4	The software work products to be placed under configuration management are identified.	Strength	Strength	Weakness
Activity 5	Change requests and problem reports for all configuration items/risks are initiated, recorded, reviewed, approved, and tracked according to a documented procedure.	Strength	Weakness	Weakness
Activity 6	Changes to baselines are controlled according to a documented procedure.	Strength	Weakness	Weakness
Activity 7	Products from the software baseline library are created and their release is controlled according to a documented procedure.	Strength	Strength	Weakness
Activity 8	The status of configuration items/units is recorded according to a documented procedure.	Weakness	Weakness	Weakness
Activity 9	Standard reports documenting the SCM activities and the contents of the software baseline are developed and made available to affected groups and individuals.	Weakness	Weakness	Weakness

(continued)

**Chapter 6**  
**Software Configuration Management**

	<b>Key practice</b>	<b>NCAP 0.1</b>	<b>AES</b>	<b>Administrative</b>
Activity 10	Software baseline audits are conducted according to a documented procedure.	Weakness	Weakness	Weakness
Measurement 1	Measurements are made and used to determine the status of the SCM activities.	Weakness	Weakness	Weakness
Verification 1	The SCM activities are reviewed with senior management on a periodic basis.	Weakness	Weakness	Weakness
Verification 2	The SCM activities are reviewed with the project manager on both a periodic and event-driven basis.	Weakness	Strength	Weakness
Verification 3	The SCM group periodically audits software baselines to verify that they conform to the documentation that defines them.	Weakness	Weakness	Weakness
Verification 4	The software quality assurance group reviews and/or audits the activities and work products for SCM and reports the results.	Weakness	Weakness	Weakness

**Chapter 6  
Software Configuration Management**

**Table 6.2: Software Configuration Management Findings for NCAP 0.1**

<b>National Customs Automation Program 0.1</b>			
	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The project follows a written organizational policy for implementing software configuration management (SCM).	The project has no organizational policy for implementing SCM.	Weakness
Ability 1	A board having the authority for managing the project's software baselines (i.e., a software configuration control board) exists or is established.	The project does not have a SCM board with authority for managing software baselines.	Weakness
Ability 2	A group that is responsible for coordinating and implementing SCM for the project (i.e., the SCM group) exists.	The project does not have a group that is responsible for coordinating and implementing SCM functions.	Weakness
Ability 3	Adequate resources and funding are provided for performing the SCM activities.	Adequate resources and funding are not provided for performing the SCM activities.	Weakness
Ability 4	Members of the SCM group are trained in the objectives, procedures, and methods for performing their SCM activities.	There is no SCM group.	Weakness
Ability 5	Members of the software engineering group and other software-related groups are trained to perform their SCM activities.	Members of the software engineering group and other software-related groups are not trained to perform their SCM activities	Weakness
Activity 1	A SCM plan is prepared for each software project according to a documented procedure.	A SCM plan was prepared according to procedures documented in the October 1996 SDLC.	Strength
Activity 2	A documented and approved SCM plan is used as the basis for performing the SCM activities.	The documented and approved SCM plan is used as the basis for performing code control; however, the plan is not used as a basis for doing SCM on software documentation and other software engineering products such as cost estimates and schedules.	Weakness
Activity 3	A configuration management library system is established as a repository for the software baselines.	A configuration management library system is established as a repository for the software baselines.	Strength
Activity 4	The software work products to be placed under configuration management are identified.	The software work products to be placed under configuration management are identified.	Strength
Activity 5	Change requests and problem reports for all configuration items/risks are initiated, recorded, reviewed, approved, and tracked according to a documented procedure.	Change requests and problem items/units are initiated, recorded, reviewed, approved, and tracked according to a procedure documented in the SCM plan.	Strength
Activity 6	Changes to baselines are controlled according to a documented procedure.	Changes to baselines are controlled according to a documented procedure in the SCM plan.	Strength
Activity 7	Products from the software baseline library are created and their release is controlled according to a documented procedure.	Products from the software baseline library are created and their release is controlled according to the SCM plan.	Strength

(continued)

**Chapter 6**  
**Software Configuration Management**

**National Customs Automation Program 0.1**

	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Activity 8	The status of configuration items/units is recorded according to a documented procedure.	The status of SCM items/units are not recorded according to a documented procedure.	Weakness
Activity 9	Standard reports documenting the SCM activities and the contents of the software baseline are developed and made available to affected groups and individuals.	Standard reports documenting the SCM activities and contents of the software baseline are not developed.	Weakness
Activity 10	Software baseline audits are conducted according to a documented procedure.	Software baseline audits are not conducted.	Weakness
Measurement 1	Measurements are made and used to determine the status of the SCM activities.	No measurements are taken to determine the status of SCM activities.	Weakness
Verification 1	The SCM activities are reviewed with senior management on a periodic basis.	The SCM activities are not reviewed with senior management on a periodic basis.	Weakness
Verification 2	The SCM activities are reviewed with the project manager on both a periodic and event-driven basis.	The SCM activities are not reviewed with the project manager on both a periodic and event-driven basis.	Weakness
Verification 3	The SCM group periodically audits software baselines to verify that they conform to the documentation that defines them.	No SCM audits are done to verify that software baselines conform to the documentation that defines them.	Weakness
Verification 4	The software quality assurance group reviews and/or audits the activities and work products for SCM and reports the results.	There is no quality assurance group; therefore, no one reviews and/or audits the activities and work products for SCM activities performed.	Weakness

**Chapter 6**  
**Software Configuration Management**

**Table 6.3: Software Configuration Management Findings for AES**

<b>Automated Export System</b>			
	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The project follows a written organizational policy for implementing software configuration management (SCM).	The project does not have a written organizational policy for SCM.	Weakness
Ability 1	A board having the authority for managing the project's software baselines (i.e., a software configuration control board) exists or is established.	AES has a Configuration Control Board. This board has the authority for managing the project's software baselines. The board consists of program support and user personnel.	Strength
Ability 2	A group that is responsible for coordinating and implementing SCM for the project (i.e., the SCM group) exists.	A group that is responsible for coordinating and implementing SCM for the project (i.e., the SCM group) exists.	Strength
Ability 3	Adequate resources and funding are provided for performing the SCM activities.	Adequate resources and funding are not provided for performing the SCM activities.	Weakness
Ability 4	Members of the SCM group are trained in the objectives, procedures, and methods for performing their SCM activities.	Members of the SCM group have extensive experience in the objectives, procedures, and methods for performing their SCM activities and receive on-the-job training.	Strength
Ability 5	Members of the software engineering group and other software-related groups are trained to perform their SCM activities.	Members of the software engineering group and other software-related groups have been briefed on performing their SCM duties at periodic retreat meetings.	Strength
Activity 1	A SCM plan is prepared for each software project according to a documented procedure.	A SCM plan was prepared according to procedures documented in the October 1996 SDLC.	Strength
Activity 2	A documented and approved SCM plan is used as the basis for performing the SCM activities.	The documented and approved SCM plan is used as the basis for performing code control; however, the plan is not used as a basis for doing SCM on software documentation and other software engineering products such as cost estimates and schedules.	Weakness
Activity 3	A configuration management library system is established as a repository for the software baselines.	The AES library is used as a repository for software baselines.	Strength
Activity 4	The software work products to be placed under configuration management are identified.	Software work products to be placed under SCM are identified in the SCM plan.	Strength
Activity 5	Change requests and problem reports for all configuration items/units are initiated, recorded, reviewed, approved, and tracked according to a documented procedure.	Change requests and problem reports for all configuration items are not initiated, recorded, reviewed, approved, and tracked according to a documented procedure.	Weakness

(continued)

**Chapter 6  
Software Configuration Management**

**Automated Export System**

	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Activity 6	Changes to baselines are controlled according to a documented procedure.	The procedures for controlling changes to baselines are documented in the SCM and SQA plans. However, there was no evidence provided to show that these procedures were being followed.	Weakness
Activity 7	Products from the software baseline library are created and their release is controlled according to a documented procedure.	Products from the baseline library are created, and releases are controlled according to procedures in the SCM plan.	Strength
Activity 8	The status of configuration items/units is recorded according to a documented procedure.	The status of configuration items/units is not recorded according to a documented procedure.	Weakness
Activity 9	Standard reports documenting the SCM activities and the contents of the software baseline are developed and made available to affected groups and individuals.	No reports documenting SCM activities and contents of the software baseline are made available to affected groups and individuals.	Weakness
Activity 10	Software baseline audits are conducted according to a documented procedure.	Software baseline audits are not conducted.	Weakness
Measurement 1	Measurements are made and used to determine the status of the SCM activities.	Measurements are not made and used to determine the status of the SCM activities.	Weakness
Verification 1	The SCM activities are reviewed with senior management on a periodic basis.	The SCM activities are not reviewed with senior management on a periodic basis.	Weakness
Verification 2	The SCM activities are reviewed with the project manager on both a periodic and event-driven basis.	Project management is updated on SCM activities on a weekly basis and bi-monthly at the retreat meetings, and as events warrant.	Strength
Verification 3	The SCM group periodically audits software baselines to verify that they conform to the documentation that defines them.	The SCM group does not verify that the software baseline conforms to the documentation that defines it.	Weakness
Verification 4	The software quality assurance group reviews and/or audits the activities and work products for SCM and reports the results.	The SQA group does not perform reviews and/or audits of the activities and work products for SCM and does not report the results.	Weakness

**Chapter 6  
Software Configuration Management**

**Table 6.4: Software Configuration Management Findings for Administrative Security System**

<b>Administrative Security System</b>			
	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Commitment 1	The project follows a written organizational policy for implementing software configuration management (SCM).	The project does not have a written organizational policy for implementing software configuration management.	Weakness
Ability 1	A board having the authority for managing the project's software baselines (i.e., a software configuration control board) exists or is established.	The project does not have a board (software configuration control board) with the authority for managing the software baselines.	Weakness
Ability 2	A group that is responsible for coordinating and implementing SCM for the project (i.e., the SCM group) exists.	The project manager is responsible for coordinating and implementing SCM functions.	Strength
Ability 3	Adequate resources and funding are provided for performing the SCM activities.	Adequate resources and funding are not provided for performing the SCM activities.	Weakness
Ability 4	Members of the SCM group are trained in the objectives, procedures, and methods for performing their SCM activities.	There is no evidence that the personnel assigned SCM functions on the project are trained in objectives, procedures, and methods for doing SCM.	Weakness
Ability 5	Members of the software engineering group and other software-related groups are trained to perform their SCM activities.	Members of the software engineering group are not trained to perform their SCM functions.	Weakness
Activity 1	A SCM plan is prepared for each software project according to a documented procedure.	A SCM plan was prepared according to procedures documented in the October 1996 SDLC.	Strength
Activity 2	A documented and approved SCM plan is used as the basis for performing the SCM activities.	Although there is a SCM plan for the project, there is no evidence that it is used to perform SCM functions.	Weakness
Activity 3	A configuration management library system is established as a repository for the software baselines.	A configuration management library system is established and used as a repository for software baselines for source code. However, other items in the software baseline (such as plans and schedules) are not identified or controlled.	Weakness
Activity 4	The software work products to be placed under configuration management are identified.	Software work products to be placed under configuration management (other than source code) are not identified.	Weakness
Activity 5	Change requests and problem reports for all configuration items/risks are initiated, recorded, reviewed, approved, and tracked according to a documented procedure.	The Automated Request For Service system handles change requests and problem reports. However, there is no documented procedure for its use and there was no evidence that the system was being used to initiate, record, review, approve, or track change requests and problem reports.	Weakness
Activity 6	Changes to baselines are controlled according to a documented procedure.	There is no documented procedure to control changes to baselines.	Weakness

(continued)

**Chapter 6  
Software Configuration Management**

**Administrative Security System**

	<b>Key practice</b>	<b>Finding</b>	<b>Rating</b>
Activity 7	Products from the software baseline library are created and their release is controlled according to a documented procedure.	There is no documented procedure that defines how products from the software baseline library should be created and released.	Weakness
Activity 8	The status of configuration items/units is recorded according to a documented procedure.	The status of SCM items/units is not recorded according to a documented procedure.	Weakness
Activity 9	Standard reports documenting the SCM activities and the contents of the software baseline are developed and made available to affected groups and individuals.	Affected groups and individuals are not notified of the SCM activities or informed of the contents of software baselines.	Weakness
Activity 10	Software baseline audits are conducted according to a documented procedure.	Software baseline audits are not conducted.	Weakness
Measurement 1	Measurements are made and used to determine the status of the SCM activities.	No measurements are made to determine the status of the SCM activities.	Weakness
Verification 1	The SCM activities are reviewed with senior management on a periodic basis.	The SCM activities are not reviewed with senior management on a periodic basis.	Weakness
Verification 2	The SCM activities are reviewed with the project manager on both a periodic and event-driven basis.	Project managers are not updated on SCM activities on a periodic basis.	Weakness
Verification 3	The SCM group periodically audits software baselines to verify that they conform to the documentation that defines them.	The SCM does not periodically audit the software baselines.	Weakness
Verification 4	The software quality assurance group reviews and/or audits the activities and work products for SCM and reports the results.	There is no quality assurance group.	Weakness

## Conclusions

Customs has many configuration management process weaknesses, and thus its capability to establish and maintain the integrity of the wide range of software products is nonrepeatable and ineffective. Without a mature configuration management process, Customs can lose control of the current software product baseline, potentially producing and using inconsistent product versions and creating operational problems.



# Customs Lacks a Software Process Improvement Program

To consistently develop software with specified functionality on time and within budget, Customs must improve its software development processes. According to SEI, an effective process improvement program includes (1) establishing a process improvement management structure, (2) developing a process improvement plan, (3) determining the organization's baseline capability and using this as a basis for targeting process initiatives, and (4) dedicating adequate resources for implementing the plan.

Although it has attempted in the past to initiate and sustain process improvement activities, these activities were terminated without having improved Customs processes. Currently, Customs has no software process improvement program.

## SEI Has Defined a Five-Phase Model for Software Process Improvement

In 1996, SEI published a software process improvement model, called IDEAL.<sup>1</sup> This model has five phases: Initiating, Diagnosing, Establishing, Acting, and Leveraging—IDEAL. Each of the phases is summarized below.

- **Initiating phase:** During this phase, an organization establishes the management structure of the process improvement program, defines and assigns roles and responsibilities, allocates initial resources, develops a plan to guide the organization through the first three phases of the program, and obtains management approval and funding for the program. Two key organizational components of the program management structure established during this phase are a management steering group and a software engineering process group (SEPG). Responsibility for this phase rests with senior management.
- **Diagnosing phase:** During this phase, the SEPG appraises the current level of software process maturity to establish a baseline of the organization's process capability, and identifies any ongoing process improvement initiatives. The SEPG then uses the baseline to identify weaknesses and target process improvement activities. It also compares these targeted activities with any ongoing process improvement activities and reconciles any differences. Responsibility for this phase rests primarily with line managers and practitioners.
- **Establishing phase:** During this phase, the SEPG prioritizes the software process improvement activities and develops strategies for pursuing them. It then develops a process improvement action plan that details the activities and strategies and includes measurable goals for the activities and metrics for monitoring progress against the goals. Also during this

<sup>1</sup>IDEAL: A User's Guide for Software Process Improvement (CMU/SEI-96-HB-001).

phase, the resources needed to implement the plan are committed and training is provided for SEPG's technical working groups, who will be responsible for developing and testing new or improved processes. Responsibility for this phase resides primarily with line managers and practitioners.

- Acting phase: In this phase, the work groups create and evaluate new and improved processes. Evaluation of the processes is based on pilot tests that are formally planned and executed. If the pilots are successful, the work groups develop plans for organization-wide adoption and institutionalization, and once approved, execute them. Responsibility for this phase resides primarily with line managers and practitioners.
- Leveraging phase: During this phase, results and lessons learned from earlier phases are assessed and applied, as appropriate, to enhance the process improvement program's structure and plans. Responsibility for this phase rests primarily with senior management.

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## **Customs Does Not Currently Have a Software Process Improvement Program**

In 1996, Customs initiated some limited software process improvement activities. Specifically, it hired a contractor to develop a process improvement plan, which was completed in September 1996. According to the plan, Customs was to reach CMM level 2 process maturity (the repeatable level) by 1998 and CMM level 3 (the defined level) by 2002. Customs began limited implementation of the plan in May of 1997, when it established process improvement teams for two KPAs—software project planning and project tracking and oversight. Generally, the teams were tasked with defining, implementing, and maintaining CMM-based processes for their respective KPAs. Customs did not staff or fund any other KPA improvement activities at this time. In August 1997, Customs discontinued all process improvement activities. Customs officials stated that this decision was based on the need to focus staff and resources on the agency's Year 2000 conversion program.

Currently, Customs does not have a software development process improvement program, and it has not taken steps to initiate one. Although it has assigned two people part-time to process improvement, it has not assigned organizational responsibility and authority, established a program management structure, developed a plan of action, and committed resources needed (trained staff and funding) to execute the plan.

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## **Conclusions**

Customs does not have an effective software development process improvement program. As a result, it cannot expect to improve its immature software development processes.

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# Overall Conclusions, Recommendations, and Agency Comments

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Customs develops and maintains software for systems that are critical to its ability to fulfill its mission. However, its software development processes are ad hoc and sometimes chaotic, and are not repeatable even on a project-by-project basis. As a result, Customs' success or failure in developing software depends largely on specific individuals, rather than on well-defined and disciplined software management practices. This greatly reduces the probability that its software projects, whether new developments or maintenance of existing software, will consistently perform as intended and be delivered on schedule and within budget. For Customs software projects to mature beyond this initial level, the agency must implement basic management controls and instill self-discipline in its software projects.

Customs acknowledges the importance of software process maturity and the need to improve its software development processes. However, it does not have a program for improving its software development processes and has not begun to establish one. Until it does, Customs has no assurance that its large investment in software development and maintenance will produce systems that perform needed functions, on time, and within budget.

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## Recommendations

We recommend that, after ensuring that its mission-critical systems are Year 2000 compliant but before investing in major software development efforts like ACE, the Commissioner of Customs direct the Chief Information Officer to

- assign responsibility and authority for software development process improvement;
- develop and implement a formal plan for software development 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 (trained staff and funding) and defines a process improvement management structure;
- ensure that every new software development effort in Customs adopts processes that satisfy at least SW-CMM level 2 requirements; and
- ensure that process improvement activities are initiated for all ongoing essential software maintenance projects.

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## Agency Comments and Our Evaluation

In its written comments on a draft of this report, Customs acknowledged the importance of software process improvement and maturity. Also, it

agreed with GAO's overall findings, including that Customs' software development processes have not attained SW-CMM level 2 maturity.

To address these weaknesses, Customs stated that it has taken the first step toward implementing our recommendations by assigning responsibility and authority for software process improvement as part of a reorganization of its Office of Information and Technology, which Customs stated will be implemented in early 1999. Customs further stated that once the reorganization is implemented, a formal software process improvement program will be established, and that this program will include definition of an action plan, commitment of resources, and specification of goals for achieving CMM levels 2 and 3. According to Customs, these improvement activities are in their early stages. When they are successfully implemented, they should address many of our recommendations.

Customs also stated that because its legacy systems are aging and need to be enhanced and replaced, software process improvement must occur in parallel with continued software development investments. History has shown that attempting to modernize without first instituting disciplined software processes has been a characteristic of failed modernization programs.<sup>1</sup> Until it implements disciplined software processes (i.e., at least level 2 process maturity), Customs cannot prudently manage major system investments, such as ACE with an estimated life cycle cost exceeding \$1 billion.

Customs' comments also included a request to meet with us to discuss system-specific KPA practice strength and weakness determinations. We met prior to requesting comments on a draft of this report and then again on January 12, 1999, to discuss SEI's SW-CMM requirements and the basis for our determinations. We are prepared to continue assisting Customs as it improves its software processes.

Appendix I provides the full text of Customs' comments and our responses to additional Customs comments not discussed above.

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<sup>1</sup>Tax Systems Modernization: Management and Technical Weaknesses Must Be Corrected If Modernization Is To Succeed ([GAO/AIMD-95-156](#), July 26, 1995), Tax Systems Modernization: Actions Underway But IRS Has Not Yet Corrected Management and Technical Weaknesses ([GAO/AIMD-96-106](#), June 7, 1996), and Air Traffic Control: Immature Software Acquisition Processes Increase FAA System Acquisition Risks ([GAO/AIMD-97-47](#), March 21, 1997).

# Comments From the Department of the Treasury

Note: GAO comments supplementing those in the report text appear at the end of this appendix.



## DEPARTMENT OF THE TREASURY

### U.S. CUSTOMS SERVICE

DATE: DEC 16 2009

FILE: AUD-1-OP AK

MEMORANDUM FOR GENE L. DODARO  
ASSISTANT COMPTROLLER GENERAL

FROM: Director, Office of Planning

SUBJECT: Customs Service Modernization: Immature Software  
Development Processes Increase Customs System  
Development Risks

Thank you for providing us with a copy of your draft report entitled "Customs Service Modernization: Immature Software Development Processes Increase Customs System Development Risks."

We have taken steps to change the organizational structure of the Office of Information and Technology to commit resources and establish an office with responsibility and authority for the software development process improvement. However, it is important to note that our legacy systems are aging. Without continued approval and funding of enhancements and replacement systems, there will be nationwide implications. Therefore, software development process improvement activities must occur in parallel with continued approval and funding for Information Technology software development investments.

Customs requests a meeting with GAO to discuss specific findings with regard to each system evaluated and each Key Process Area. A meeting would be the appropriate forum to highlight the specific areas of disagreement and to seek clarification where appropriate.

Attached are our comments on the draft report. If you have any questions regarding the attached comments please have a member of your staff contact Ms. Anita Keeler on (202) 927-0957.

  
William F. Riley

Attachment



Equal Opportunity Employer

**Draft Report entitled, "Customs Service Modernization: Immature Software Development Processes Increase Customs System Development Risks"**

**Customs Management Comments:**

- o In general, the Office of Information and Technology (OIT) concurs with the finding that software development within Customs has not yet matured to a Level 2 rating using the Software Engineering Institute's (SEI) CMM model for assessing software development/maintenance maturity.
- o Aware of the importance of software process improvement (SPI) and the desire to mature to repeatable and measurable practices across the organization, OIT has assigned organizational responsibility and authority for this effort. This is reflected in the new OIT organization that will be implemented in early 1999. Upon establishment of a formal SPI effort within Customs, a defined action plan, committed resources, and new goals for achieving level 2 and level 3 maturity will be defined. These activities which are in their early stages currently, will satisfy many of the recommendations outlined in this report.
- o It is noted in the report that Customs discontinued its formal process improvement program to divert resources to the Y2K program and to ACE. It is an accurate statement that resources were shifted to the Y2K program. However, resources were not refocused toward the major systems development effort, ACE.
- o Although OIT concurs with the overall findings, it is important to note in the Executive Summary that Customs has made progress given the severe shift in resources toward the Y2K Program. Customs has published a new Systems Development Life Cycle document which includes newly defined processes for Project Management and Project Tracking and Oversight, two of the Key Process Areas (KPAs) against which we were evaluated. Formal training has been scheduled for December 1998 and January 1999.
- o The report cites that Customs has a history of performing poorly when developing software-intensive systems and further refers to Customs limited success in delivering promised system capabilities on time and within budget. Customs requests clarification on and evidence supporting the statements above. Customs has successfully delivered systems on-time and within budget, demonstrated by the deployment of the Automated Export System (AES), Tinman, and in the Y2K conversion activities. Customs is prepared to discuss additional development activities that have proven successful in the recent years.
- o The report indicates that \$4.5M will be spent to enhance its Administrative Systems. These funds will be expended upon maintenance of these systems and will not fund enhancements, i.e., new functionality.

See comment 1.

See comment 2.

See comment 3.

See comment 4.

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The following are responses to additional comments in Customs' letter dated December 16, 1998.

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## **GAO Comments**

1. The report has been modified to reflect Customs' comment.
2. Customs provided us a copy of its new Systems Development Life Cycle (SDLC) document after it provided us comments on a draft of this report, and we have not yet evaluated it. To develop systems effectively, Customs will have to ensure that its SDLC addresses the software development KPAS discussed in this report and that it effectively implements the SDLC.
3. The statement that "Customs has a history of performing poorly when developing software-intensive systems" has been removed from the report. Regarding the statement in the report referring to "Customs' limited success in delivering promised system capabilities on time and within budget," there is clear evidence that Customs has not been successful in developing ACE software on time. Specifically, the first release of ACE, which is Customs' largest software development effort, was delivered over 8 months late. Also, because Customs does not track actual ACE costs by release against original estimates, it does not know the cost performance history of ACE. With the respect to the three systems that Customs cites as having been successfully delivered, the first (the Year 2000 program) is still incomplete and thus its success cannot yet be assessed. Because we have not previously reviewed the other two (AES and Tinman), we cannot comment on either's success in delivering promised capabilities on time and within budget. The report has been clarified to reflect these points.
4. The report has been clarified to reflect Customs' comment.



# Major Contributors to This Report

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