Audit Report

OFFICE OF THE INSPECTOR GENERAL

MANAGEMENT OF THE DIGITAL PRODUCTION SYSTEM DEVELOPMENT AT THE DEFENSE MAPPING AGENCY

Report No. 95-043 November 28, 1994

Department of Defense

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Acronyms

AIS	Automated Information System
COTR	Contracting Officer's Technical Representative
DMA	Defense Mapping Agency
DPS	Digital Production System
MC&G	Mapping, Charting, and Geodesy

INSPECTOR GENERAL
DEPARTMENT OF DEFENSE
400 ARMY NAVY DRIVE
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November 28, 1994

MEMORANDUM FOR UNDER SECRETARY OF DEFENSE FOR ACQUISITION AND TECHNOLOGY
ASSISTANT SECRETARY OF DEFENSE (COMMAND, CONTROL, COMMUNICATIONS AND INTELLIGENCE)
DIRECTOR, DEFENSE MAPPING AGENCY

SUBJECT: Audit Report on Management of the Digital Production System Development at the Defense Mapping Agency (Report No. 95-043)

We are providing this report for your information and use. The audit was made in response to two anonymous DoD Hotline complaints regarding funding, contracting, development, and operation of projects at the Defense Mapping Agency. The report focuses on issues concerning the development and oversight of the Digital Production System, which provides the capability to use digital imagery and computer-assisted techniques to produce mapping, charting, and geodesy products. Management comments on a draft of this report were considered in preparing the final report.

Management comments were responsive to the intent of the recommendations; however, the Assistant Secretary of Defense (Command, Control, Communications and Intelligence) disagreed on the materiality of the internal control weaknesses. The apparent disagreement may be due to semantics, in that management concurs that serious weaknesses were identified and has taken corrective action. Therefore no response to the final report is required.

We appreciate the courtesies extended to the audit staff. If you have questions on this audit, please contact Mr. Charles Santoni, Audit Program Director, at (703) 604-9556 (DSN 664-9556) or Mr. John Mundell, Audit Project Manager, at (703) 604-9562 (DSN 664-9562). The distribution of this report is listed in Appendix I. The audit team members are listed inside the back cover.

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Report No. 95-043 **November 28, 1994**
(Project No. 3RC-8008)

MANAGEMENT OF THE DIGITAL PRODUCTION SYSTEM DEVELOPMENT AT THE DEFENSE MAPPING AGENCY

EXECUTIVE SUMMARY

Introduction. We made this audit in response to two anonymous DoD Hotline complaints containing 25 allegations (the audit reviewed 20 allegations; other DoD offices reviewed 5 allegations) regarding the management of the Defense Mapping Agency (DMA). DMA's mission is to produce and distribute mapping, charting, and geodesy products to all DoD Components. In 1982, DMA started developing the Digital Production System to produce mapping, charting, and geodetic products using digital imagery. With the Digital Production System, DMA's primary source material is digital data instead of film. Development and acquisition costs of the Digital Production System totaled $2.6 billion in November 1992. In addition, from FY 1989 through FY 1993, DMA spent $322 million to operate and maintain Digital Production System hardware and software and $113 million to develop and procure Digital Production System modifications and enhancements. DMA plans to spend $1.0 billion from FY 1994 through FY 1999 to operate and maintain the Digital Production System and to develop products and capabilities that may directly or indirectly affect the Digital Production System.

Objective. The objective of the audit was to evaluate the validity of the Hotline allegations that sound management practices were not used in the acquisition and operation of DMA projects. Specifically, we evaluated the policies and procedures used to manage and review the development of the Digital Production System.

Audit Results. The audit substantiated or partly substantiated six allegations that identified problems regarding the contracting, development, and operation of the DPS. The audit results regarding five of those six allegations are discussed in the findings. The sixth allegation is discussed in our audit Report No. 94-076, "Contracting Authority at the Defense Mapping Agency," April 1, 1994. In addition, the audit substantiated or partly substantiated 10 allegations, but identified no adverse effect. Four allegations were not substantiated. The audit results regarding the 20 allegations are summarized in Appendix D.

The DMA did not identify customer requirements for the Flight Information Publications and Automated Air Facilities Information File products, analyze causes of software problems, correct configuration management deficiencies, and define modifications for the Digital Production System (Finding A). Further, oversight of the Digital Production System development and its modification needs strengthening (Finding B). Without improved development procedures and oversight, the DMA may experience further delays in completing products and expend unnecessary resources for modifications.

Internal Controls. The audit limited the evaluation of internal controls to the DoD Hotline allegations. The audit identified material internal control weaknesses in the Defense Mapping Agency's procedures for managing the development of the Digital Production System. The controls assessed are described in Part I of the report, and the weaknesses are discussed in Finding A.

Potential Benefits of Audit. Implementation of the recommendations will improve the management and oversight of the Digital Production System. In addition, the development status of the Digital Production System and the planned modifications to the Digital Production System will be determined, documented, and reported (see Appendix G). No monetary benefits are associated with this audit.

Summary of Recommendations. We recommend procedures be implemented for product specification development and revised for problem reporting. Also, we recommend plans be developed for correcting configuration management deficiencies and modifying the Digital Production System. In addition, we recommend a Milestone IV (Major Modification Approval) review of the Digital Production System be performed and independent oversight of mapping, charting, and geodesy matters be provided.

Management Comments. The Assistant Secretary of Defense (Command, Control, Communications and Intelligence) submitted consolidated comments for himself; the Under Secretary of Defense for Acquisition and Technology; and the Director, DMA. The Assistant Secretary stated that DMA either had implemented or was in the process of implementing revised procedures for product specification development, problem reporting, and configuration management. The Assistant Secretary also stated that DMA would prepare a comprehensive strategic plan by February 1995 to reduce DPS operation and maintenance costs and to meet new requirements caused by the new world order. The Assistant Secretary disagreed that a Milestone IV review should be conducted because the planned modifications are below the monetary threshold for a Milestone IV review. However, he stated that the Deputy Assistant Secretary of Defense (Command, Control, Communications and Intelligence Acquisition) would conduct an in-process review of the DPS. The purpose of the in-process review would be to assess the status of the DPS, to review DMA's strategic plan for the DPS, and to determine intervals for future in-process reviews. The Assistant Secretary disagreed that the internal control weaknesses were material because DMA's internal control processes had identified the problems. DMA either had already implemented or was in the process of implementing solutions to the weaknesses. See Part II for a discussion of management's response and Part IV for the complete text of the comments.

Audit Response. Management comments were responsive to the recommendations. The corrective actions taken or planned to be taken will resolve the internal control weaknesses discussed in the report and improve management of this large and expensive program.

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Part I - Introduction

Background

Defense Mapping Agency Mission. The mission of the Defense Mapping Agency (DMA) is to provide support to the Office of the Secretary of Defense, Military Departments, Joint Staff, unified commands, Defense agencies, and other Federal Departments and Agencies on matters concerning mapping, charting, and geodesy (MC&G). Also, DMA provides nautical data to worldwide merchant marine and private vessel operators. DMA provides more than 270 types of MC&G products and services to the customers it supports.

Purpose of the Digital Production System. DMA developed the Digital Production System (DPS) to provide a capability to produce certain MC&G products from advanced imaging systems using digital imagery and computer-assisted techniques. In 1982, Congress endorsed guidance by the Office of Secretary of Defense that required DMA to develop an all-digital production system capable of meeting critical demands for MC&G support. With the new production system, DMA's primary source material is digital data instead of film. The DPS interfaces with external agencies to obtain imagery and once all required imagery is collected, produces MC&G products through a tightly controlled and structured process. The DPS is a DMA-standard system used by the three DMA production components: Aerospace Center, St. Louis, Missouri; Hydrographic/Topographic Center, Brookmont, Maryland; and Reston Center, Reston, Virginia. DMA estimated that using digital imagery in an integrated automated system would reduce production time by 50 percent and product completion time by 75 percent.

DPS Development. In 1982, DMA established the Special Program Office for Exploitation Modernization (disestablished and replaced by the DMA Systems Center in 1987) to develop the MARK 85 and MARK 90 systems. DMA used a non-DoD agency to contract for the MARK 85 and MARK 90 systems.

MARK 85-Initial Capability to Use Digital Data. MARK 85 was a transitional program to upgrade DMA's existing film-based production system by providing an initial digital exploitation capability using new source materials. MARK 85 was used during Operations Desert Shield and Desert Storm to produce MC&G products. During the audit, DMA was still using MARK 85 for the production of MC&G products. However, MARK 85 is not a fully integrated system and does not have all capabilities intended for the fully developed DPS.

MARK 90-Integrated System Using Digital Data. DMA developed the MARK 90 to provide a fully integrated system with an all-digital production capability for designated products. DMA considers MARK 90, augmented by certain MARK 85 capabilities, to be the DPS. DMA cartographers use specialized workstations to perform tasks, such as identifying the imagery's specific location on the earth and extracting digital data from the imagery.

The DPS consists of seven segments:

- o Data Services,
- o Production Management,
- o Source Acquisition,
- o Source Preparation,
- o Hardcopy Exploitation,
- o Data Extraction, and
- o Product Generation.

DMA developed portions of Production Management and the majority of Source Acquisition and Hardcopy Exploitation for the MARK 85, then incorporated them in the DPS as it was developed. Generally, work on a product cannot commence in a particular segment until all work in the previous segment has been completed. The functions of the seven DPS segments are described in Appendix A.

Contracting, Size, and Cost of the DPS. The use of digital data to make MC&G products was a new technology in 1982. Because various technical skills were required, DMA awarded separate contracts for each segment of the DPS. Consequently, the DPS has no overall contractor. DMA, with contractor engineering support, serves as the system integrator. Six contractors developed the software in eight programming languages for the seven DPS segments. DPS is used on more than 1,000 workstations and is run by about 8 million lines of contractor-developed software code. DMA awarded cost-plus-award-fee contracts to the development contractors and expected the DPS to be fully implemented in the mid-1990's. The total cost to develop the DPS, from the inception of MARK 85 to DMA's determination of full operational capability in November 1992, was $2.6 billion. In addition, DMA expended $322 million from FY 1989 through FY 1993 to operate and maintain DPS hardware and software and $113 million to develop DPS modifications and enhancements. DMA plans to spend $1.0 billion from FY 1994 through FY 1999 to operate and maintain the DPS and to develop products and capabilities that may directly or indirectly affect the DPS.

DPS Products. The DPS is designed to produce specific MC&G products categorized as aeronautical, hydrographic, topographic, and digital. DMA changed the specific products in each category as the DPS was being developed and as customer requirements for MC&G products changed. When DMA selected development contractors for the DPS in 1984, DMA planned that the DPS would produce 28 products. DMA revised the list in 1989 to 24 products, of which 4 are no longer required. A list of the 24 products is in Appendix B. The changes made to the DPS products since 1984 are detailed in Appendix C.

DoD Hotline Allegations. Two anonymous DoD Hotline complaints, submitted during 1992, alleged improprieties in the management of DMA and in the development and operation of DMA projects. One Hotline complaint alleged that the overall management of DMA was ineffective and that guidelines were bypassed for funding and contracting of DMA projects. The other Hotline complaint alleged improprieties in the funding, contracting, development, and operation of the DPS.

Objective

The audit objective was to evaluate the validity of the Hotline allegations that sound management practices were not being used in the acquisition and operation of DMA projects. Specifically, we evaluated the policies and procedures used to manage the development and acquisition of the DPS.

Scope and Methodology

Audit Work Performed. We made the audit in conjunction with auditors from another Government agency and reviewed 20 of the 25 allegations. DoD Hotline officials referred four allegations either to Departmental Inquiries, Office of the Inspector General, DoD, or Inspector General, DMA, for evaluation. We referred one allegation to the Defense Criminal Investigative Service, Office of the Inspector General, DoD, for evaluation. A summary of the 20 allegations and audit results is in Appendix D.

We reviewed DMA's overall strategy and its policies for project development and examined DPS program documentation, dated from December 1982 to March 1994, that related to the development and operation of the DPS. Specifically, we reviewed DPS plans and system specifications, contracts, budgets, test plans and results, training plans, configuration management plans, production readiness reviews, production plans, and status reports on the development of the system. In addition, we:

- identified and analyzed software discrepancy reports, dated from FY 1988 to FY 1993, by DPS segment;

- reconciled the funds allotted to DMA with obligation documents;

- selected (judgmentally) project tasks that were to be completed from April through October 1992 and determined how tasks were contracted and funds were used;

- analyzed the number of personnel trained on the DPS and the number of workstations used on the DPS;

o interviewed DMA officials and contractor personnel who either were involved in the DPS development or had knowledge of its production status; and

o interviewed DMA officials and cartographers who used the system and Office of Secretary of Defense officials having knowledge of DoD major acquisition procedures and related oversight responsibilities.

Technical Assistance and Computer-Processed Data. A software engineer from the technical assessment staff of the Office of the Inspector General, DoD, assisted the Inspector General, DoD, auditors in reviewing procedures for controlling changes to system documentation. Also, the auditors used computer-processed data from DMA's Automated Configuration Management System to identify the number of software discrepancy reports. The auditors determined the accuracy of the data by reviewing the controls on data entry for the Automated Configuration Management System. Organizations visited during the audit are listed in Appendix H.

Auditing Standards. This program audit was made from March 1993 through March 1994 in accordance with auditing standards issued by the Comptroller General of the United States, as implemented by the Inspector General, DoD. Accordingly, the audit included such tests of internal controls as were considered necessary.

Internal Controls

Adequacy of Internal Controls. We did not evaluate DMA's implementation of the DoD Internal Management Control Program as defined by DoD Directive 5010.38, "Internal Management Control Program," April 14, 1987. We limited our evaluation of internal controls to funding, contracting, development, and operation of the DPS. The audit identified material internal control weaknesses in identifying all customer requirements, analyzing software problems, maintaining configuration management of the DPS, and defining modifications needed for the DPS. DMA did not report those weaknesses in its Internal Management Control Program report because they did not believe the weaknesses were material. Implementation of all the recommendations in Finding A will correct the internal control weaknesses. A copy of the report will be provided to the senior official responsible for internal controls within DMA.

Prior Audits and Other Reviews

Office of the Inspector General, DoD, Audit Report No. 94-076, "Contracting Authority at the Defense Mapping Agency," April 1, 1994. The report discusses the propriety of contracting support provided to the DPS by a non-DoD agency and the benefits that could be attained if DMA performed

the contracting for the DPS. The report recommended that the DMA develop a plan to transfer contracting responsibility to the DMA. DMA concurred in the recommendation and began developing a plan to transition DPS contracting to the DMA. The report is classified.

Office of the Inspector General, DoD, Inspection Report No. 89-INS-02, "Report on the Inspection of the Defense Mapping Agency," February 7, 1989. The report discusses the results of an overall inspection of DMA performed in FY 1988. The report recommended that the Under Secretary of Defense for Acquisition (now the Under Secretary of Defense for Acquisition and Technology) conduct a Milestone II review of the program management process for the DPS. The Under Secretary responded that the Defense Acquisition Board process was inappropriate for reviewing the management and documentation of the DPS. Our current audit showed that the Defense Acquisition Board should review the DPS (Finding B). Report No. 89-INS-02 also recommended that the Assistant Secretary of Defense (Command, Control, Communications and Intelligence) conduct the equivalent of a Milestone II review of the DPS. The Assistant Secretary initially concurred, but did not conduct the review. Instead, personnel on his staff attended the DPS critical design review in December 1988 and DMA briefings on the DPS. Our current audit determined that lack of oversight by the Assistant Secretary contributed to problems in the DPS development (Finding B). Report No. 89-INS-02 further recommended that DMA reduce the security classification of DPS documentation to facilitate the transfer of information to DMA employees. In June 1989, DMA reduced the security level of some aspects of the program.

Part II - Findings and Recommendations

Finding A. Management of Digital Production System Development

The Defense Mapping Agency's development of the Digital Production System needed improvements. The Defense Mapping Agency did not:

- o identify all product specifications for the Flight Information Publications and Automated Air Facilities Information File products,
- o analyze causes of software problems,
- o maintain configuration management of the Digital Production System, and
- o define modifications needed for the Digital Production System.

As a result, customer requirements for the Flight Information Publications and Automated Air Facilities Information File products in the Digital Production System were not met. Further, until the Digital Production System is fully operational, the Defense Mapping Agency may experience further delays in the production of the 24 scheduled MC&G products and may unnecessarily expend resources for system modifications.

Background

Program Management of the DPS Development. The DMA Systems Center was primarily responsible for developing the DPS. To help manage the development of the DPS, DMA established a series of review boards. The review boards performed such functions as approving the configuration of the DPS, determining the production readiness of the DPS, and controlling the deployment of the DPS to the production components. Senior officials from DMA Headquarters, Systems Center, and the production components generally comprised the review boards. By including those representatives, DMA wanted to ensure that the DPS development was well-coordinated and represented the system that would meet DMA's needs.

Identifying Customer Requirements for the DPS

Software Requirements for the Flight Information Publications and Automated Air Facilities Information File Products. The Systems Center did not develop comprehensive product specifications for the Flight Information Publications and Automated Air Facilities Information File products. In March

1993, Systems Center testing determined that the DPS software for the Flight Information Publications and the Automated Air Facilities Information File products did not work properly. The Systems Center assembled a team of DMA and contractor personnel on March 9, 1993, to review the software development status for the two products. On March 18, 1993, the team issued a report identifying nine problems in the development of software for the Flight Information Publications and Automated Air Facilities Information File products. For example, the team determined that the Systems Center did not draft the product specifications according to standards and did not formally review the specifications. In addition, the Systems Center had not incorporated 18 customer-requested changes in specifications for the Flight Information Publications and the Automated Air Facilities Information File products. To correct those problems, the contractor performed extensive work during 1993 on the software for the products. The revised software did not pass all additional factory acceptance tests until December 1993, more than 1 year after DMA determined on November 5, 1992, that the DPS had reached full operational capability.

Additional Software Changes. At the time of the audit, DMA customers were identifying changes to their requirements for the Flight Information Publications. Because Flight Information Publications are critical to flight safety, the Systems Center must change the product specification and develop or modify software to meet changes in customer requirements. The Systems Center estimated that the DPS will not be capable of meeting current customer specifications for Flight Information Publications products until at least late FY 1995.

Contracted Maintenance of Software. As new information was obtained for the Flight Information Publications, DMA used contractors to change the data. DMA budgeted about $2.0 million and $1.8 million for FYs 1994 and 1995, respectively, for the data maintenance. DMA planned to use the DPS to change data for the Flight Information Publications. Because of the number of individual products within the Flight Information Publications, DMA planned to phase out the contractor maintenance through FY 1997. Until the DPS is capable of updating needed data for individual products, the DMA must continue to contract for the maintenance of the Flight Information Publications products. To prevent further delays in the development of the software for the Flight Information Publications products and to avoid paying data maintenance charges for maintenance that should be done by the DPS, the Systems Center must ensure product specifications are complete.

Analyzing Problems in DPS Software Development

Reporting Procedures. DMA personnel recorded problems in the DPS in discrepancy reports. A discrepancy report contains information, such as a description of the problem, the date it occurred, its priority and status, the organization responsible for fixing the discrepancy, and the reason why the problem occurred. DMA personnel submitted the discrepancy reports into

DMA's Automated Configuration Management System. The Automated Configuration Management System generates data for engineering review boards responsible for reviewing the data, determining causes for the problems, and prioritizing their correction.

Reasons for Problems. The Systems Center developed category codes to represent causes of problems identified in discrepancy reports. However, the engineers responsible for determining the causes of the problems did not enter all category codes in the final discrepancy reports or in the Automated Configuration Management System, as shown in the table below. Procedures for using the Automated Configuration Management System do not require the category code field to be completed. Without all category codes, engineers could not track development problems.

Category Codes Omitted from Closed Discrepancy Reports
(August 1 to September 30, 1993)

	Discrepancy Reports	
DPS Segment	Total	Without a Category Code
Data Services	444	21
Production Management	694	467
Source Acquisition	82	46
Source Preparation	665	18
Hard Copy Exploitation	7	4
Data Extraction	1,297	45
Product Generation	784	168

Some problems identified in the discrepancy reports could have been prevented if the engineering review boards had been able to develop a methodology for analyzing overall causes and their trends. By identifying systemic problems, DMA may be able to make changes to software requirements before production is affected and will be able to utilize budget resources more efficiently. As discussed below, DMA expects to encounter many more software defects that will affect production and satisfaction of customer requirements.

Software Defects in the DPS. The system integration contractor prepared the "Software Maintenance Study for DMA," August 1, 1993, to estimate the number of defects in the DPS and to evaluate maintenance requirements. Studies made by the software industry of completed software systems have determined that in any major software development, a number of defects exist in the software delivered to the user. Inherent defects stem mainly from the difficulty in adequately defining the users' requirements and in writing software code that satisfies user requirements. To estimate the number of defects in the DPS software, the system integration contractor used a computer model based on the experiences of other large-scale DoD development programs. The system integration contractor estimated that the DPS had about 82,000 defects when the software was delivered to DMA at the end of the factory acceptance tests.

DPS Compared to Similar Programs. The system integration contractor estimated that for other comparable DoD programs, program officials discovered about 70 percent of the inherent defects by production start-up. As of November 5, 1992, when DMA determined that the DPS had reached full operational capability, DMA had discovered only 15,265 (19 percent) of the expected 82,000 defects. As of August 31, 1993, DMA had discovered only 24,720 (30 percent) of the expected 82,000 defects. It is realistic to expect that DMA will discover about 81 percent of the estimated defects while the DPS is being used for production operations. By using the DPS before it is fully tested and before most errors are identified, DMA gains greater familiarity of the system, tests the system in an operational environment, and gets some production work accomplished. However, defects discovered after the software has been delivered are harder and more expensive to fix than defects discovered during initial development and cause delays in production.

Configuration Management for the DPS

Purpose of Configuration Management. As of March 15, 1994, DMA had not resolved deficiencies in configuration management identified by a 1993 Systems Center review. Configuration management is an integral part of the systems engineering management process. The role of configuration management is to identify the functional and physical characteristics of system components during the system's life cycle. Configuration management is particularly important for the DPS since it was developed by several contractors and since numerous changes are being made to the DPS to fix software defects and to add capabilities. Changes to a system are controlled and documented using configuration management procedures to ensure all users and developers are aware of the current configuration status of the system. Weak configuration management increases the risk that software may not be adequately documented. Without adequate documentation, incorrect software modifications could occur and resources may be wasted.

Systems Center Review of Configuration Management. During August through November 1992, Systems Center personnel, in conjunction with the three production components and the system integration contractor, reviewed the configuration management process and organization used by the DPS contractors and DMA. In addition, the personnel reviewed the implementation of configuration management procedures for documentation, software, hardware, and discrepancy reporting. The review identified 15 deficiencies in DMA's configuration management.

During April through June 1993, Systems Center personnel, again in conjunction with personnel from the three production components and the system integration contractor, conducted a more detailed configuration management audit and followed up on the deficiencies identified in the 1992 review. The Systems Center review determined that DMA had corrected

only 4 of the 15 identified deficiencies. The 1993 Systems Center review concluded that configuration control of the DPS could be disrupted if actions were not taken to fix the deficiencies.

Establishment of a Configuration Management Steering Group. To identify solutions to DMA's configuration management deficiencies and to monitor the corrective actions, the Director, Systems Center, formed a steering group in September 1993. The steering group consisted of personnel from Headquarters, DMA, the Systems Center, the production components, and the system integration contractor.

Correction of Configuration Management Deficiencies. To determine the status of actions taken to resolve the 11 deficiencies, we reviewed the minutes of the steering group's meetings from October 1993 through February 1994, and interviewed the Chairman of the Steering Group. The minutes showed that the Steering Group considered one deficiency resolved. The Steering Group also had established formal target dates to resolve 2 of the remaining 10 deficiencies. One of those two deficiencies was resolved when DMA reorganized the Systems Center on March 20, 1994, and administratively established a configuration management organization within the Systems Center, although it had not yet staffed that organization.

As of February 3, 1994, the Systems Center was still pursuing solutions for the remaining eight deficiencies. Those remaining deficiencies included configuration management training, configuration control records, and configuration control guidelines for the engineering review boards. DMA needs to follow through on physically establishing and staffing an effective organization for configuration management and on developing solutions to remaining problems. Without effective configuration management, resources could be wasted through changes that do not correct system software defects and through inappropriate system modifications.

Program Management Plan for DPS Modifications

Short- and Long-Term DPS Modifications. The DMA had not developed a program management plan that clearly defined the objectives and development strategy for the short- and long-term modifications planned for the DPS. A program management plan describes the program's history and objectives and serves as the vehicle for guiding the overall program. Supporting plans for all phases of system development include plans for the test and evaluation of the system during development and maintenance for the developed system. As system development progresses, program plans are revised to include more details.

From FY 1994 through FY 1999, DMA planned to use about $185 million in Research, Development, Test and Evaluation funds either for modifying the DPS or for developing new products. In addition, the DMA planned to spend $220 million from FY 1994 through FY 1999 on research and development

efforts that may directly or indirectly result in modifications to DPS operations or products. Since the Systems Center is already modifying the DPS, a program management plan would help to verify that modifications to DPS are completed according to priority and that resources are not wasted.

Modifications of DPS Products and Operations. Expected modifications to the DPS include new products, equipment, and procedures.

o Customers require new products, such as a 1:100,000 Topographic Line Map and a Tactical Terrain Data digital product.

o DPS equipment will have to be replaced because of changes in technology since DPS development started. DMA has already made some equipment changes. For example, a contractor-developed switch in the Data Services segment was replaced with a commercial off-the-shelf interface. The interface is more reliable and is more easily maintained because of its commercial applications.

o New DPS operational procedures are needed because of changes in the world order. The DPS was designed for a long-term production program, concentrating primarily on the known adversary, the Soviet Union. The DPS must be modified to provide an efficient crisis-reaction capability to better handle various operations, such as Operation Restore Hope in Somalia.

A maintenance advisory panel of personnel from industry and Government convened by the Director, DMA, in 1993 also identified needed changes in DPS development and modification procedures. In the report, "Advisory Panel Report on Digital Production System Maintenance Management," July 22, 1993, the advisory panel made 10 recommendations regarding the further development and maintenance of the DPS. Those recommendations included establishing a separate, permanent development and test capability that replicates the DPS and replacing the development contractors with a single contractor for maintaining all DPS segments. The advisory panel also recommended that DMA prepare a strategic plan for DPS modifications that identified cost, schedule, and performance planning. The Director, DMA, directed that each of the advisory panel's 10 recommendations be implemented. Although the Systems Center developed the DPS using a non-DoD development process, the Director, Systems Center, intends to follow DoD Directive 5000.1, "Defense Acquisitions," February 23, 1991, for future modifications. Additional details on the development strategy are in Appendix E. DMA must develop a program management plan for all modifications to DPS development to ensure that resources are used wisely.

Recommendations, Management Comments, and Audit Response

We recommend that the Director, Defense Mapping Agency:

1. Implement procedures for identifying and coordinating customer technical requirements for the Flight Information Publications and Automated Air Facilities Information File products before specifications are given to the contractor for development.

2. Revise procedures for discrepancy reporting for the Digital Production System to require that the category codes identifying causes of problems be entered in discrepancy reports and in the Defense Mapping Agency's Automated Configuration Management System.

3. Establish procedures and a methodology for analyzing causes of and trends in problems identified in discrepancy reports on the Digital Production System.

4. Assign personnel to the configuration management organization responsible for developing configuration management procedures and for providing oversight of the configuration management function in the Defense Mapping Agency.

5. Develop and implement plans with completion dates for the correction of the deficiencies identified in the Systems Center 1993 configuration management review.

6. Develop a comprehensive program management plan that defines the modifications to be made to the Digital Production System and that details how and when the modifications will be accomplished.

Management Comments on the Recommendations and Internal Controls. The Assistant Secretary of Defense (Command, Control, Communications and Intelligence) submitted consolidated comments for himself; the Under Secretary of Defense for Acquisition and Technology; and the Director, DMA. The Assistant Secretary concurred in all recommendations, but did not agree that material weaknesses existed in DMA's process for customer requirement identification, software problem analysis, configuration management, and DPS modification definition. The Assistant Secretary stated that DMA's internal control procedures had identified each of the weaknesses and that DMA had either implemented or was in the process of implementing solutions.

Audit Response. Management comments were responsive to the recommendations. We considered the internal control weaknesses material because DMA experienced delays in the development of the DPS and resources could have been wasted. However, since management concurred in the recommendations the apparent disagreement could be because of semantics. The corrective actions taken or planned to be taken will resolve the internal control weaknesses and no further management comments are required.

Finding B. Oversight of Digital Production System Development

The development and modification of the Digital Production System lacked sufficient oversight. Because the Digital Production System was not subject to acquisition policies in DoD directives and instructions, the Defense Acquisition Board had not reviewed the development of the Digital Production System. With DMA's decision in 1994 to transfer contracting responsibilities for the Digital Production System from a non-DoD agency to the DMA, the Digital Production System is subject to DoD acquisition policies. Further, the Assistant Secretary of Defense (Command, Control, Communications and Intelligence) relied on a Defense Mapping Agency liaison officer to provide oversight of the Digital Production System. If sufficient oversight is not provided, the Defense Mapping Agency may expend resources for unneeded modifications and experience further delays in the production of MC&G products.

Background

Categories of Software Systems. DoD categorizes software systems as either mission-critical computer resources or automated information systems (AISs), depending on how the software is used. A mission-critical computer resource is physically part of, dedicated to, or essential to a weapon system. An AIS performs functions, such as collecting, processing, transmitting, and displaying information, and is not part of a weapon system. Mission-critical computer resources and AISs are expected to be constantly changing and evolving as new requirements are identified and implemented. The DPS is an AIS.

Software Development Policies and Procedures. DoD Directive 8120.1, "Life-Cycle Management (LCM) of Automated Information Systems (AISs)," January 14, 1993, and DoD Directive 8120.2, "Automated Information System (AIS Life-Cycle Process, Review, and Milestone Approval Procedures)," January 14, 1993, establish policies and procedures for the development of AISs. The Major Automated Information System Review Council provides oversight of the development of AISs. The Assistant Secretary of Defense (Command, Control, Communications and Intelligence) is responsible for the Major Automated Information System Review Council. DoD Directive 5000.1, "Defense Acquisitions," February 23, 1991, and DoD Instruction 5000.2, "Defense Acquisition Management Policies and Procedures," February 23, 1991, establish policies and procedures for the acquisition of major and nonmajor weapon systems. Although most of the terms of DoD Directive 5000.1 do not apply to AISs, DoD Directive 8120.1 requires that AISs be managed as consistently as possible according to policies in DoD Directive 5000.1. In addition, DoD Instruction 8120.2 states that "AISs that

exceed the Defense Acquisition Board thresholds shall be forwarded to the Defense Acquisition Board for review." According to DoD Instruction 5000.2, "Defense Acquisition Management Policies and Procedures," February 23, 1991, the threshold for Defense Acquisition Board review of an AIS is a total expenditure for research and development of more than $300 million in FY 1990 constant dollars (acquisition category I).

Oversight of the DPS

External Review of the DPS. Because DoD considered DPS a classified program and because DMA used non-DoD channels and practices in the DPS development, the Assistant Secretary of Defense (Command, Control, Communications and Intelligence) did not require the DMA to comply with DoD acquisition policies that unclassified programs must follow. As a result, the Major Automated Information System Review Council exempted the DPS from review. Inspector General, DoD, Inspection Report No. 89-INS-02, "Report on the Inspection of the Defense Mapping Agency," February 7, 1989, recommended that the Under Secretary of Defense for Acquisition (now the Under Secretary of Defense for Acquisition and Technology) conduct a Milestone II review of the DPS. In response, the Under Secretary declined to review the DPS, because he deemed the Defense Acquisition Board process inappropriate for reviewing the DPS development.

To provide some external oversight, the former Director, DMA, periodically informed the Assistant Secretary of Defense (Command, Control, Communications and Intelligence) on the status of overall DPS development. As part of the annual budget process, DMA Comptroller personnel provided briefings on DPS development to congressional committee staff with a demonstrated need to know. In addition, DMA convened independent panels in FY 1988 and FY 1993 to review the DPS. The Red Team, composed of personnel from industry, academia, and Government, reviewed the overall development of the program in FY 1988. As previously discussed, the Maintenance Advisory Panel reviewed maintenance requirements for the DPS in FY 1993. Those reviews helped the DMA focus on key development and maintenance issues.

Review of Programs at Major Milestones. For programs that are not exempted, the Major Automated Information System Review Council or Defense Acquisition Board reviews costly programs, such as the DPS, as the program transitions to each major milestone in the development process. The milestone reviews determine whether the program has made adequate progress and whether appropriate management controls are in place for the program to proceed to the next milestone. Programs cannot continue unless criteria established for moving to the next development phase have been met.

Status of DPS Development and Production. Significant progress had been made in the development of the DPS, but the capability to produce all products had not been demonstrated and production was limited. As previously

discussed, the Systems Center estimated that the DPS will not be capable of meeting all customer requirements for Flight Information Publications products until late FY 1995. In addition, because customer requirements had changed, additional work was needed to make the Digital Feature Analysis Data, Level II, product releasable to the customers. Systems Center integration officials estimated that the software for the revised Digital Feature Analysis Data, Level II, product would be implemented in the DPS in mid-1994. Further, as of September 9, 1993, DMA had not demonstrated whether the DPS could produce seven other products by either producing a finished version or testing[1] the finishing of the seven products listed below.

- o Air Target Chart
- o Joint Operations Graphic (Radar)
- o Tactical Pilotage Chart
- o Operational Navigation Chart
- o Point Positioning Data Base
- o Harbor and Approach Chart, and
- o Combat Chart

DMA production and integration officials told us that the capability to produce those seven products had been demonstrated by the test or production of similar products and that limited time was available for testing. Until all products are fully produced or tested, DMA cannot be assured of DPS capabilities.

To fully demonstrate the capabilities of the DPS, more products need to be finished. The number of finished products was limited because the majority of the work done on the DPS was in preparation for finishing products. Work began in July 1992 in the Source Preparation segment on determining the position of imagery on the earth. Work began in November 1992 in the Data Extraction segment to extract information from the imagery and to enter it in the MC&G data base. However, as of January 31, 1994, only one 1:50,000[2] Topographic Line Map and one Digital Terrain Elevation Data product had been finished through the Product Generation segment. The DPS produced Point Positioning Program products, but those products were produced in the Source Preparation segment, not in the Data Extraction and Product Generation segments.

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[1]In addition to the seven products discussed, DMA was not testing four other products that were no longer required; they will be replaced in FY 1996 by a new single product.

[2]1:50,000 is the scale of the map. For a 1:50,000 Topographic Line Map, the actual geographical area shown on the map is approximately 50,000 times larger than depicted on the map.

Production operations are key to demonstrating the effectiveness of the DPS. The Systems Center transferred control over DPS production operations to the DMA production components on October 1, 1993. For DMA's FY 1994 production program, the DMA production components committed to finishing products through the Product Generation segment. The number of work years planned as of February 18, 1994, for the DPS FY 1994 production program and the number of products to be produced are shown in Appendix F.

Oversight Needed by the Defense Acquisition Board. Effective oversight is critical to ensure the best use of allocated resources. The DPS is an AIS and would have been reviewed by the Major Automated Information System Review Council, if the DPS had not been exempted from review. Due to total development costs and planned expenditures, the Defense Acquisition Board should review the DPS. The DMA spent $2 billion in Research, Development, Test and Evaluation funds in developing the DPS. DMA also planned to spend about $185 million more from FY 1994 through FY 1999 in Research, Development, Test, and Evaluation funds either for enhancing the capabilities of the DPS or for developing new products. In addition, DMA planned to spend $220 million from FY 1994 through FY 1999 on research and development efforts that may directly or indirectly result in modifications to DPS operations or products. DPS expenditures exceed the dollar threshold for a Defense Acquisition Board review, and the capability to produce all products has not been verified. Therefore, the Board should conduct a Milestone IV (Major Modification Approval) review of the DPS.

Production Backlog. A Defense Acquisition Board review of DPS development is also needed because MC&G products are critical for military operations. At the time of the audit, DoD lacked adequate MC&G coverage for many parts of the world. As of November 1993, DMA had a production backlog of about 140,000 customer requirements. Of that production backlog, customers considered about 83,000 requirements to be critical or essential to the accomplishment of assigned operational missions. The planned DPS capabilities and efficiencies should reduce the number of backlogged MC&G products. The need for a system to quickly and accurately produce MC&G products was demonstrated by the U. S. involvement in Operation Desert Storm in Southwest Asia. The United States may be required to intervene in other areas of the world where more rugged terrain would provide cartographers many more challenges than the desert terrain in Southwest Asia. DoD must have an effective digital MC&G production system to help ensure that all military objectives can be effectively achieved.

Purpose of Milestone IV Review. A Defense Acquisition Board Milestone IV review of the DPS would assess all aspects of the program to verify that DMA has an effective development strategy and that the program meets planned objectives as development is finalized and major modifications are made. The review should determine the status of DPS software and establish criteria for the DPS to formally enter the Operations and Support phase and for DMA to proceed with modifying the DPS. The security level of the program has been reduced and the Director, Systems Center, intended to use the development

process prescribed by DoD Directive 5000.1 for the modifications to the DPS. The Defense Acquisition Board review would ensure DMA complied with the provisions of DoD Directive 5000.1.

Assistant Secretary of Defense (Command, Control, Communications and Intelligence) Expertise in MC&G. DoD Directive 5137.1, "Assistant Secretary of Defense (Command, Control, Communications and Intelligence) (ASD(C^3I))," February 12, 1992, states that the Assistant Secretary of Defense (Command, Control, Communications and Intelligence) is responsible for exercising direction, authority, and control over the DMA. However, the staff of the Assistant Secretary of Defense (Command, Control, Communications and Intelligence) lacks sufficient expertise in MC&G matters. To provide the necessary expertise, the DMA assigned a liaison officer to the Assistant Secretary. The liaison officer worked on the Assistant Secretary's staff, but an official in DMA Headquarters prepared the officer's performance evaluation. The liaison officer is not a top-level decision maker in the Assistant Secretary's office or in the DMA. However, as a staff officer, the individual analyzes courses of action and makes recommendations. Working as a staff officer for the Assistant Secretary and being evaluated by a DMA official creates a potential conflict of interest for the individual. Although the perception of a conflict of interest exists, the audit did not identify any instances in which the integrity of the liaison officer was compromised. Independent oversight by the Assistant Secretary, as required by DoD Directive 5137.1, would prevent any actual or perceived conflict of interest.

Conclusion

An effective digital MC&G production system will have significant utility and is needed by the DoD. The development of the DPS to date has been a complex task and is the result of hard work by many dedicated Government and contractor personnel. Further, the DMA plans to modify the DPS to meet new customer requirements and to produce new products. The DPS is being used for production, but the proof of the system will be completed products. Given the size, complexity, cost, and importance of the DPS, more intensive oversight of the DPS is warranted.

Recommendations, Management Comments, and Audit Response

1. We recommend that the Under Secretary of Defense for Acquisition and Technology conduct a Defense Acquisition Board Milestone IV review of the current status and planned modifications of the Digital Production System.

2. We recommend that the Assistant Secretary of Defense (Command, Control, Communications and Intelligence) provide independent oversight of mapping, charting, and geodesy activities at the Defense Mapping Agency as required by DoD Directive 5137.1, "Assistant Secretary of Defense (Command, Control, Communications and Intelligence) (ASD(C^3I))," February 12, 1992.

Management Comments on the Recommendations. The Assistant Secretary of Defense (Command, Control, Communications and Intelligence) partially concurred in the recommendations to perform a Milestone IV review and to provide independent oversight of the Digital Production System. The Assistant Secretary disagreed that a Milestone IV review should be conducted, but stated that the Deputy Assistant Secretary of Defense (Command, Control, Communications and Intelligence Acquisition) would conduct an in-process review of the DPS. The Assistant Secretary stated that the purpose of the in-process review was to assess the status of the DPS, to review DMA's strategic plan for the DPS, and to determine intervals for future in-process reviews.

Audit Response. The Assistant Secretary's comments meet the intent of the recommendations, and no further comments are required.

Part III - Additional Information

Appendix A. Description of Digital Production System Segments

The DPS consists of seven segments. Generally, production work cannot begin in one segment until work has been completed in previous segments. The functions of the seven segments are briefly described below.

Data Services. This segment transfers data among the segments and archives MC&G data extracted from digital imagery. Data Services uses five programming languages and has about 911,000 lines of software code. This segment was developed by the Hughes Corporation.

Production Management. This segment provides a single integrated production management capability for all DMA production systems. Production Management schedules, manages, and monitors production resources and assignments. Production Management uses four programming languages and contains about 1.4 million lines of software code. The contractor for Production Management was General Electric Aerospace Division, a division of the General Electric Company, that was bought by Martin Marietta Corporation in 1993. The Systems Center transferred about 750,000 lines of software code from the MARK 85 Data Integration segment to Production Management.

Source Acquisition. This segment controls DMA's imagery data and asks external agencies to collect digital imagery for the DPS. Source Acquisition was developed for the MARK 85 system and is now used in the DPS. Source Acquisition contains 558,000 lines of software code and uses four programming languages. General Electric Aerospace Division (now a component of Martin Marietta Corporation) developed the Source Acquisition segment.

Source Preparation. This segment evaluates source materials and prepares production feasibility studies. In combination with Hardcopy Exploitation, another DPS segment, Source Preparation geopositions the digital imagery. Geopositioning matches points or areas on the imagery to points on the earth's surface. In addition, Source Preparation produces Point Positioning products. Source Preparation uses four programming languages and contains about 1.4 million lines of software code. E-Systems, Inc., developed the Source Preparation segment.

Hardcopy Exploitation. This segment performs final steps in geopositioning the imagery. DBA Systems developed the Hardcopy Exploitation segment originally for the MARK 85. Hardcopy Exploitation contains about 353,000 lines of software code and uses one programming language.

Data Extraction. This segment uses two images simultaneously to extract feature and elevation data from digital imagery. Dual data extraction enables heights of features and elevations of terrain to be identified. Data Extraction performs quality control checks to ensure extracted data are in compliance with extraction specifications. In addition, Data Extraction produces Terrain

Contour Matching Terminal Matrix products. The General Dynamics Corporation developed this segment, which uses about 900,000 lines of software code and four programming languages.

Product Generation. Except for Point Positioning Products and the Terrain Contour Matching Terminal Matrix product, all product finishing work is performed in this segment. Product Generation performs quality control checks to ensure production is in compliance with product specifications. When heights of features and elevations of terrain are not required, Product Generation uses one image to extract feature data from digital imagery and cartographic sources. Product Generation uses one programming language and is the largest segment with about 2.2 million lines of software code. The Intergraph Corporation developed this segment.

Appendix B. Digital Production System Products

The Digital Production System is designed to produce 24 MC&G products.

Aeronautical Products

Flight Information Publications
Tactical Pilotage Chart
Operational Navigation Chart
Joint Operations Graphic (Air)
Joint Operations Graphic (Radar)
U.S. Air Target Chart (1:200,000)
Point Positioning Programs
Point Positioning Data Base

Hydrographic Products

Harbor and Approach Chart
Coastal Chart
Combat Chart

Topographic Products

1:50,000 Topographic Line Map
Joint Operations Graphic (Ground)
1:50,000 Tactical Terrain Analysis Data Base[1]
1:250,000 Planning Terrain Analysis Data Base[1]

Digital Products

Automated Air Facilities Information File
Digital Feature Analysis Data, Level I
Digital Feature Analysis Data, Level II
Digital Terrain Elevation Data, Level I
Digital Terrain Elevation Data, Level II[1]
TERCOM[2] Landfall Matrix
TERCOM Enroute/Midcourse Matrix
TERCOM Terminal Matrix
Vertical Obstruction Data[1]

[1]The product is no longer needed because customers terminated their requirements. The product will be replaced by Tactical Terrain Data in FY 1996.
[2]Terrain Contour Matching.

Appendix C. Changes to Digital Production System Products

The products DPS was intended to produce changed as customer requirements changed during DPS development. The DPS products at significant points in the DPS development are listed below.

	Development Contracts (May 1984) 28 Products	Critical Design Review (December 1988) 31 Products	DMA's Product Baseline (September 1989) 24 Products
Aeronautical Products			
Flight Information Publications	x	x	x
Tactical Pilotage Chart	x	x	x
Operational Navigation Chart	x	x	x
Joint Operations Graphic (Air)	x	x	x
Joint Operations Graphic (Radar)	x	x	x
U.S. Air Target Chart (1:200,000)	x	x	x
Point Positioning Programs		x	x
Point Positioning Data Base	x	x	x
Radar Fixed-Point Mini-Graphic	x	--[1]	N/A[2]
Point Mensuration and Graphic	x	--[3]	N/A
Hydrographic Products			
Harbor and Approach Chart	x	x	x
Coastal Chart	x	x	x
Combat Chart	x	x	x
Bottom Contour Chart	x	--[4]	N/A
Bathymetric Navigation Planning Chart		x	--[5]
Topographic Products			
1:50,000 Topographic Line Map	x	x	x
Joint Operations Graphic (Ground)	x	x	x
1:50,000 Tactical Terrain Analysis Data Base	x	x	x[6]
1:250,000 Planning Terrain Analysis Data Base	x	x	x[6]

See footnotes on next page.

	Development Contracts (May 1984) 28 Products	Critical Design Review (December 1988) 31 Products	DMA's Product Baseline (September 1989) 24 Products
Topographic Products (con't)			
City Graphic	x	x	--[7]
1:50,000 Transportation Map		x	--[6]
1:250,000 Transportation Map		x	--[6]
1:50,000 Cross Country Movement Map		x	--[6]
1:250,000 Cross Country Movement Map		x	--[6]
Digital Products			
Automated Air Facilities Information File	x	x	x
Digital Feature Analysis Data, Level I	x	x	x
Digital Feature Analysis Data, Level II	x	x	x
Digital Feature Analysis Data, Level X	x	x	--[1]
Digital Terrain Elevation Data, Level I	x	x	x
Digital Terrain Elevation Data, Level II	x	x	x[6]
TERCOM[8] Landfall Matrix	x	x	x
TERCOM Enroute/Midcourse Matrix	x	x	x
TERCOM Terminal Matrix	x	x	x
Vertical Obstruction Data	x	x	x[6]

[1]Customer requirements for product terminated.
[2]Not Applicable.
[3]Changed to Point Positioning Programs.
[4]Replaced by Bathymetric Navigation Planning Chart.
[5]Requirements not defined; requirements will be included in Defense Hydrographic Initiative in FY 1997.
[6]Will be replaced by Tactical Terrain Data in FY 1996.
[7]Not cost-effective for production on DPS.
[8]Terrain Contour Matching.

Appendix D. Summary of DoD Hotline Allegations

We made the audit as a result of two anonymous DoD Hotline complaints containing 25 allegations related to DMA and DPS. One of the Hotline complaints contained allegations regarding the overall management of the DMA and the funding and contracting of DMA projects. The second Hotline complaint alleged improprieties in the funding, contracting, development, and operation of the DPS. DoD Hotline officials referred four allegations either to Departmental Inquiries, Inspector General, DoD, or Inspector General, DMA, for review. In addition, the Inspector General, DoD, referred one allegation to the Defense Criminal Investigative Service for investigation. The remaining 20 allegations and the audit results are summarized in the following paragraphs. Based on the audit results, allegations 2, 3, 4, 7, and 10 relate to deficiencies in DMA's development of the DPS and are discussed in Part II of the report.

1. Allegation. DMA was managing the DPS as a classified program, even though a great deal of the program was not classified.

Audit Result. The allegation was substantiated. In June 1989, the relationship between DMA and the DPS contractors was declassified. Additional steps could be taken to reduce the security level of most future contracts. On April 1, 1994, the Inspector General, DoD, issued Audit Report No. 94-076, "Contracting Authority at the Defense Mapping Agency," on DPS contracting that will result in more contracts that do not require special security controls. In response, the DMA began developing a plan to transition contracting from a non-DoD agency to DMA. Certain aspects of the program remain classified, and personnel must have appropriate security access to sensitive compartmented information in developing and operating the DPS.

2. Allegation. DoD directives and instructions were not followed, and the program had not been formally reviewed by external decision makers. Without baseline agreements and external reviews, the DPS can be whatever the Systems Center says it is.

Audit Result. The allegation was partly substantiated in that regulations were not followed and an external review was not done. The Assistant Secretary of Defense (Command, Control, Communications and Intelligence) did not require DMA to comply with DoD acquisition policies because non-DoD channels and practices were used in the DPS development. The DMA identified specific products for production on the DPS and changed the products as customer requirements changed. The development of the DPS and the lack of external reviews are discussed in Part II, Finding B.

3. Allegation. Little program documentation exists to trace the requirements for the DPS or for its milestones.

Audit Result. The allegation was partly substantiated in that configuration management procedures needed improving. The Systems Center developed

system and product specifications and interface control documents that identified the requirements for the DPS. In addition, the Systems Center prepared detailed plans for DPS development. We reviewed the hierarchy of specifications and traced milestone definitions in program documents for initial operational capability and full operational capability to the original documents. Good configuration management procedures would help ensure sufficient and consistent documentation. The audit results regarding configuration management are discussed in Part II, Finding A.

4. Allegation. The DPS does not work as originally planned. Original requirements that could not be met cannot be traced.

Audit Result. The allegation was partly substantiated because specifications changed as the DPS was developed and used. However, the basic objective of using digital imagery instead of film to produce MC&G products remained the same. The audit showed that the Systems Center could track requirements. Based on the results of 1992 reviews of completed system segments, the Systems Center determined that except for 162 of 4,595 segment and segment interface specifications, the software developed by the contractors met contract specifications. DMA's Executive Configuration Control Board approved waivers for 112 of the 162 unmet specifications because the Board considered delivered capability to be sufficient. As a result of additional tests and corrections of software defects, the Systems Center considered 49 of the remaining 50 unmet specifications to have been met by September 30, 1993. As of March 10, 1994, the Systems Center was completing a waiver for the final unmet specification. As the DPS software has been used in operational testing and production, DMA has identified software errors and needed modifications. Software development for the Flight Information Publications and Automated Air Facilities Information File products and software discrepancy reports are discussed in detail in Part II, Finding A.

5. Allegation. The DPS could not replicate the criteria for initial operational capability after the DMA declared that the criteria had been met.

Audit Result. The allegation was substantiated, but the audit identified no adverse consequences. DMA determined that to declare initial operational capability, the system would have to be capable of producing 4 of the 24 DPS products. According to the system integration contractor's "Final Report for Demonstration 909: Single Product Operations (SPO) Demonstration," May 28, 1991, which contains the results of initial operational capability testing, all four products were completed by March 23, 1991. DMA declared initial operational capability on March 27, 1991. Systems Center personnel stated that they changed the system shortly after DMA declared initial operational capability. The changes prevented the system from operating in the same manner as when initial operational capability was declared. The Systems Center made the changes to fix problems identified during the production of the products for the initial operational capability milestone and to further enhance the system. The Systems Center continued to develop and enhance the DPS during FY 1991 and FY 1992 in preparation for initiating production

operations. The DMA did not use the DPS to initiate the production of MC&G products until July 1992, when geopositioning of imagery began in the Source Preparation segment.

6. Allegation. The definition of full operational capability was not consistent throughout the program development.

Audit Result. The allegation was substantiated. Criteria were inconsistent in the DPS System Specification and the DPS Transition Integration Plan for deciding when full operational capability of the DPS had been achieved. The DPS System Specification E9000B, September 13, 1984, as revised on September 6, 1989, defined full operational capability as follows. "At Final Operational Capability (FOC-E4.5) the MARK 90 System will have sufficient capability to produce 100 percent of the DMA production allocated to it." The DPS Transition Integration Plan, June 15, 1990, as revised on June 12, 1991, defined full operational capability as follows. "At Full Operational Capability (FOC), the MARK 90 System is in an operational condition, with the capability to produce the assigned customer-releasable products." Although that criteria had been approved by DMA's Executive Configuration Control Board, Systems Center development officials stated that they based the declaration of full operational capability on the completion of certain operational tests. The determination of full operational capability by Systems Center officials is discussed below.

7. Allegation. Development of the program was tied to milestone dates rather than to milestone criteria.

Audit Result. The allegation was partly substantiated. When Systems Center officials determined full operational capability was achieved, the DPS could not produce the Flight Information Publications and Automated Air Facilities Information File products. The software for the Flight Information Publications and Automated Air Facilities Information File products was not included in the tests for declaring full operational capability and did not pass all acceptance tests until December 1993. In addition, the Digital Feature Analysis Data, Level II, product produced for declaring full operational capability was not customer-releasable because it did not meet customer requirements. Also, as of September 9, 1993, DMA had not demonstrated that the DPS was capable of producing 7 of 24 scheduled products by producing them either in testing or in production operations. Those seven products are discussed further in Part II, Finding B.

The date for full operational capability changed as the DPS was developed. In FY 1986, as a result of DoD budget reductions, DMA moved the scheduled full operational capability date from September 1991 to March 1992. In FY 1989, as a result of the Red Team's review, discussed in Part II, Finding B, DMA again changed the scheduled full operational capability date from March 1992 to November 1992. Schedules for DPS tests slipped after 1989, but DMA did not change the full operational capability date again or establish incremental full operational capability dates for DPS operations as individual products were developed and produced. DMA officials informed us that the full operational capability date was not considered important to DPS development because more

cartographers would transfer to the DPS system and the number of products being produced would increase through FY 1995. DMA officials told us that they wanted to develop the system on time and on budget and that they had done so.

DMA officials stated that they based the declaration of full operational capability on the completion of Demonstration (Demo) 910. Demo 910 was the last of a series of tests culminating in tests of all DPS segments. During Demo 910, 8 of 24 DPS products were tested and produced. DPS integration officials stated that in 1989, an internal Tiger Team identified the 24 products to be produced by the DPS and the 8 products to be tested during Demo 910. The eight products tested during Demo 910 were the:

- o 1:50,000 Topographic Line Map;
- o Joint Operations Graphic (Ground);
- o Coastal Chart;
- o TERCOM* Landfall Matrix;
- o TERCOM Enroute/Midcourse Matrix;
- o TERCOM Terminal Matrix;
- o Digital Feature Analysis Data, Level II; and
- o Digital Terrain Elevation Data, Level I.

The Tiger Team selected the eight products for testing because engineering analysis determined that the software in those eight products represented the most important and frequently used software in the DPS. Systems Center officials believed that sufficient time was not available in the program schedule to test all 24 products, and they wanted to maximize use of the limited available time. The last of the eight products in Demo 910 was completed on October 31, 1992, and DMA declared full operational capability on November 5, 1992.

We believe Systems Center officials did not have a sound basis to determine that full operational capability had been met as of November 5, 1992. Demo 910 testing was based on a limited set of cartographic data and did not assure that the DPS was capable of producing all products. Although the declaration of full operational capability may have been premature, we could not identify any adverse consequences. As discussed in Part II, Finding B, the DPS was not formally reviewed by external DoD decision makers and the DMA was allowed to use its own tailored development process (see Appendix E). As discussed in Allegation 8, the declaration did not affect the funding appropriation used for the development of the DPS.

*Terrain Contour Matching

8. Allegation. The DPS would be declared fully operational capable in November 1992 in order to use Operation and Maintenance funds to fix the DPS.

Audit Result. The allegation was not substantiated. DMA's decision to cease using the Research, Development, Test, and Evaluation appropriation to fund DPS development was based on segment completion reviews rather than on the declaration of full operational capability. Segment completion reviews, conducted from May to September 1992, determined that the segments were ready to proceed to system level tests. DMA had budgeted Research, Development, Test, and Evaluation funds for the development of the DPS through September 1992, the end of FY 1992. The date for full operational capability was scheduled for and declared on November 5, 1992. DMA has budgeted for modifications to the DPS using Research, Development, Test, and Evaluation funds through FY 1999.

9. Allegation. Modifications to the system were identified as preplanned product improvements when the modifications were not planned as part of the original program. Calling the modifications preplanned improvements is a way to hide problems.

Audit Result. The allegation was not substantiated, although specifications and the products to be produced on the DPS changed as the DPS was developed. The evolution of the products to be produced by the DPS is summarized in Appendix C. Modifications to the DPS are discussed in Part II, Finding A.

10. Allegation. DMA lacks effective mid- to long-term planning. The lack of planning has caused unnecessary overtime and contracting of work.

Audit Result. The allegation was substantiated regarding the development of the Flight Information Publications and Automated Air Facilities Information File products and regarding program planning for the modification of the DPS. The audit results are discussed in Part II, Finding A. The adequacy of planning for all of DMA will be reviewed as part of an FY 1995 Inspector General, DoD, inspection of DMA. In addition, DMA's plan to standardize digital MC&G data used in DoD systems will be audited by the Inspector General, DoD, during FY 1994.

11. Allegation. Senior DMA officials were not aware of the status of the DPS development because status reports, such as the quarterly report submitted to the Director, DMA, on April 1, 1992, were misleading.

Audit Result. The allegation was partly substantiated in that the quarterly reports were general in nature. During FY 1992, the Directors of DMA components submitted their quarterly reports to the Director, DMA. Because the reports did not meet the intended purpose of focusing on significant issues, the former Director, DMA, canceled the reporting requirement on September 22, 1992. However, Systems Center officials gave the former Director, DMA, a monthly briefing on the status of the DPS development. Based on our review of the briefing charts used at those meetings and on our

interviews with DMA senior officials and the former Director, DMA, substantive development issues were briefed and the former Director, DMA, was informed of significant problems that occurred.

12. Allegation. All the extra hours worked by DMA employees to make the system work were not reported and were not recognized in the cost of the DPS.

Audit Result. The allegation was substantiated, but DoD does not require that costs attributed to Government employees be included in the acquisition costs of major systems. Based on discussions with DMA personnel, many DMA employees worked many extra hours and were dedicated to the successful development of the DPS.

13. Allegation. Non-DPS projects were put on DPS contracts in FY 1992. The non-DPS projects were outside the scope of the DPS contracts, and the non-DPS projects were not funded from the same budget program element as the DPS projects. Putting projects funded by different program elements on the same contract was inappropriate.

Audit Result. The allegation was partly substantiated. The Systems Center placed "non-DPS" projects on DPS development contracts because the capabilities being developed would be part of the DPS. The Systems Center differentiated between "non-DPS" and DPS projects only to distinguish between enhancements to the DPS and its initial development capability.

The audit identified 47 "non-DPS" projects that included 53 tasks that were to be completed from April through October 1992. We judgmentally selected 7 of the 53 tasks to determine how the tasks were contracted and whether the funds involved were used for DPS enhancements or for system development. Four of the seven tasks were placed on existing DPS development contracts, one task was placed on a new contract, and two tasks were placed on other existing contracts. Based on our interviews with Systems Center officials and reviews of contract files, the audit determined that the four tasks placed on existing DPS contracts were for capabilities that would be used in the DPS and were within the scope of the DPS contracts.

Regarding funding, we determined that "non-DPS" and DPS projects were funded under different budget line numbers, but both line numbers were within budget program element 305139B. Within certain limits, the DMA was authorized to transfer funds between projects within the same budget program element. Generally, transfers of less than $4 million or new projects costing less than $2 million had to be approved by DMA's Executive Configuration Control Board and Headquarters, DMA. Transfers of more than $4 million or new projects costing more than $2 million had to be approved by the Under Secretary of Defense (Comptroller) and appropriate congressional committees. DPS program documents showed that the funds for the seven "non-DPS" tasks were used for development of the capability specified in the tasking or were reallocated to other "non-DPS" projects. The audit concluded that no improprieties occurred in putting the "non-DPS" projects on the DPS contracts.

14. Allegation. A contracting officer's technical representative (COTR) held unauthorized discussions with a contractor on a proposed contract, and negotiations were concluded shortly after the discussions were held.

Audit Result. The allegation was not substantiated. The audit found no evidence that the COTR had violated his position of trust. COTRs hold discussions with contractors regarding contract proposals to ensure that bids represent the work desired by DMA and to obtain additional information regarding the details of the cost proposal. The contracting officer and contracting specialists knew of no instance in which a COTR had conducted a fact-finding session with a contractor without the knowledge of the contracting officer or specialist.

15. Allegation. The COTRs gave direction to the contractors and obligated the Government.

Audit Result. The allegation was not substantiated regarding COTR actions since 1991. In 1991, the Systems Center determined that a COTR had taken action that could have obligated the Government. Because of that action, the contracting officer issued a memorandum, "Unauthorized Commitments," September 6, 1991, to Systems Center personnel, and a message, "Unauthorized Commitments," September 10, 1991, to contractors, emphasizing that only the contracting officer can obligate the Government. Also, the contracting officers require COTRs to sign a statement acknowledging their responsibilities and lack of authority to obligate the Government. The audit found no evidence that COTRs had given inappropriate directions to the contractors or had taken actions that would have obligated the Government since 1991.

16. Allegation. The COTRs are relying on rough order of magnitude estimates submitted by contractors without verifying the accuracy of the estimates.

Audit Result. The allegation was substantiated, but the audit identified no impropriety. Contractors submit rough order of magnitude cost estimates to DMA on system changes proposed by either the contractors or DMA. The Executive Configuration Control Board uses the estimates in determining whether the proposed change is needed and affordable to pursue negotiations with the contractor. The rough orders of magnitude lack sufficient detail to be analyzed for accuracy. After the Executive Configuration Control Board determines that the proposed change is needed and affordable, the contractor submits detailed cost estimates to the contracting officer for analysis by the COTRs. If the proposed cost exceeds $1 million, the contracting officer also sends the estimates to the Defense Contract Audit Agency for analysis. For some tasks, the contractor is allowed to begin work before negotiations are completed, but the Government's liability for the work performed by the contractor does not exceed an amount specified by the contracting officer. Otherwise, contractual obligations are not made until negotiations based on detailed cost information are completed.

17. Allegation. Contracts are awarded on a sole source basis to contractors.

Audit Result. The allegation was partly substantiated in that some contracts have been awarded on a sole source basis. DMA awarded the development contracts for the seven DPS segments on a competitive basis and awarded contracts for other work regarding the DPS on both a competitive and a sole source basis. The audit examined the justifications for seven sole source contracts for DPS enhancements or system support that were awarded during January 1990 through May 1993. The audit determined that the award of the seven contracts on a sole source basis was justified.

18. Allegation. The prime contractors for the DPS segments are also subcontractors to each other.

Audit Result. The allegation was substantiated, but the audit found no evidence indicating irregularities in the relationships. The use of subcontractors is a business decision made by the prime contractor, depending on a comparison of its expertise to expertise available from other companies at a cost-effective price.

19. Allegation. DMA has contracts with three contractors to provide engineering support for the DPS when one contractor would suffice. In addition, engineering support contractors were doing work that was within the scope of another engineering support contractor.

Audit Result. The allegation was substantiated in that, during the audit, the Systems Center had contracts with three contractors to do engineering support work, and some overlap existed in the contractors' statements of work. The Systems Center desired the overlap because in some cases, the expertise of one contractor was better than another in a particular technical area. The overlap allowed the contractor with more expertise to be selected to perform a specific task. The contracts with the engineering support contractors were cost or time and materials type contracts. In cost and time and materials contracts, the contractor is paid only for work performed.

20. Allegation. The system integration contractor has a potential conflict of interest because that contractor is also responsible for developing DPS segments.

Audit Result. The allegation was substantiated in that a potential conflict of interest existed, but the audit found no evidence that actual conflicts of interest had occurred. The potential conflict of interest was recognized by both DMA and the contractor, General Electric Aerospace Division, (purchased by Martin Marietta Corporation in 1993). General Electric Aerospace and Martin Marietta established organizational and procedural safeguards to assure the independence of the system integrator function.

Appendix E. Development Strategy

DMA's strategy for the development of the DPS evolved as DMA gained experience in major systems development and better understood DPS requirements. Because of the complexity and unique functionality of the DPS, DMA implemented a three-phase approach to DPS development. The three-phase approach resulted primarily from DMA's desire to develop a functional system that would be enhanced later and from the need to develop a data base of digital MC&G data before products could be produced.

Phase One-Developing DPS Core Capability. During the first phase, DMA developed the basic DPS capability. Following a 1988 review by a panel of software experts from industry, Government, and academia, DMA identified 24 products to be produced by the DPS. Development of the capability to produce other products required by DMA customers was deferred until completion of the capability to produce the 24 products. DMA officials determined that the DPS achieved full operational capability on November 5, 1992. Those officials informed the Director, DMA, that with the initiation of full operational capability, information would be placed in the MC&G data base and that finishing of products would start later in FY 1993 as data became available in the MC&G data base.

Phase Two-Entering Data in a Digital Data Base and Increasing System Usage. The second phase was to enter MC&G data in a digital data base and increase usage of the system.

Entering MC&G Data into a Digital Data Base. To produce finished products on the DPS, MC&G data must be in a digital data base. Establishing a digital data base of MC&G data encompasses the following responsibilities.

o DMA asks external agencies to collect specific digital imagery.

o External agencies collect digital imagery and forward it to DMA with all management support data.

o Cartographers identify the location of the digital imagery to its position on the earth, extract MC&G data from the digital imagery, and store it in the MC&G digital data base.

The process of obtaining digital imagery and placing information in the MC&G data base can take more than 1 year.

Increasing DPS Usage. DMA planned to increase both DPS usage and production through FY 1995, at which time DMA estimated that two shifts would be working on all segments of the DPS and that all products would be in production.

Phase Three-Enhancing DPS Capability. The third phase of DPS development involves modifying the DPS to produce additional products. The need to modify the production capability of DPS resulted from DMA's decision

in 1989 to defer the development of certain products. In addition, as the world order changed with the dissolution of the Soviet Union, DMA identified additional modifications needed for DPS operations and capabilities. Systems Center personnel developed the core system using a tailored development process. For phase three, the Director, Systems Center, intends to use the development process prescribed by DoD Directive 5000.1 as discussed in Part II, Finding B.

Appendix F. FY 1994 Production Program for the Digital Production System

The DMA production components accepted DPS for use in their production programs beginning with FY 1994. During FYs 1994 and 1995, DMA was planning to increase production usage of the system. During FY 1994, DMA was focusing DPS finishing efforts on selected products. The production program for each of the production components for FY 1994, in terms of work years and finished products, is shown below.

	Work Years for DPS Production During FY 1994					
	Aerospace Center		Hydrographic/ Topographic Center		Reston Center	
Production Activity	Work Years	Product Outputs[1]	Work Years	Product Outputs	Work Years	Product Outputs
Geopositioning	13.2	170	13.2	170	14.0	204
Data Extraction	109.9	111	157.3	345	163.0	161
Finishing[2]						
Source Preparation Segment	10.2	1,439	--	--	3.4	600
Product Generation Segment	48.6	77	12.6	14	N/A[3]	N/A

[1]Product output measures the number of units produced during the fiscal year. Different units are used to measure products in different production activities. For example, geopositioning is measured in terms of the number of 1^{o} x 1^{o} rectangles completed. Output from Product Generation is measured in terms of finished customer-releasable products.
[2]Details of the finishing program for FY 1994 are shown on the next page.
[3]Not Applicable. Except for Point Positioning and Terrain Contour Matching Terminal Matrix products, the DPS was not designed to finish products at the Reston Center.

Planned Finishing of DPS Products During FY 1994
(As of February 18, 1994)

DPS Product	Aerospace Center		Hydrographic/ Topographic Center		Reston Center	
	Work Years	Product Outputs	Work Years	Product Outputs	Work Years	Product Outputs
Flight Information Publications (Text)	10.0	21	--	--	--	--
Tactical Pilotage Chart	--	--	--	--	--	--
Operational Navigational Chart	--	--	--	--	--	--
Joint Operations Graphic (Air)	9.0	1	1.4	0	--	--
Joint Operations Graphic (Radar)	2.6	2	--	--	--	--
U.S. Air Target Chart (1:200,000)	--	--	--	--	--	--
Point Positioning Programs	10.2	1,439	--	--	3.4	600
Point Positioning Data Base	--	--	--	--	--	--
Harbor and Approach Chart	--	--	5.0	1	--	--
Coastal Chart	--	--	3.0	0	--	--
Combat Chart	--	--	.1	0	--	--
1:50,000 Topographic Line Map	26.3	32	2.0	8	--	--
Joint Operations Graphic (Ground)	--	--	--	--	--	--
1:50,000 Tactical Terrain Analysis Data Base[4]	--	--	--	--	--	--
1:250,000 Planning Terrain Analysis Data Base[4]	--	--	--	--	--	--
Automated Air Facilities Information File	--	--	--	--	--	--
Digital Feature Analysis Data, Level I	--	--	--	--	--	--
Digital Feature Analysis Data, Level II	--	--	--	--	--	--
Digital Terrain Elevation Data, Level I	.7	42	1.1	5	--	--
Digital Terrain Elevation Data, Level II[4]	--	--	--	--	--	--
TERCOM[5] Landfall Matrix	--	--	--	--	--	--
TERCOM Enroute/Midcourse Matrix	--	--	--	--	--	
TERCOM Terminal Matrix	--	--	--	--	--	--
Vertical Obstruction Data[4]	--	--	--	--	--	--

[4]Product is no longer needed because customers deleted their requirements.
[5]Terrain Contour Matching.

Appendix G. Summary of Potential Benefits Resulting from the Audit

Recommendation Reference	Description of Benefit	Type of Benefit
A.1.	Internal Controls and Program Results. Implementing procedures to identify and coordinate customer requirements early in system development will reduce the risk of errors and unnecessary expenditures.	Nonmonetary.
A.2. and A.3.	Internal Controls and Program Results. Identifying and analyzing causes for problems will help prevent system errors.	Nonmonetary.
A.4. and A.5.	Internal Controls and Program Results. Assigning personnel to the configuration management function and developing plans for the correction of the configuration management deficiencies will improve configuration management of the DPS and reduce the risk of unnecessary expenditures.	Nonmonetary.
A.6.	Internal Controls and Program Results. Developing a comprehensive plan for the modifications to the DPS will reduce the risk of unnecessary expenditures.	Nonmonetary.
B.1.	Program Results. Conducting a Defense Acquisition Board Milestone IV review of the DPS will ensure that DPS requirements are documented and modifications are well planned.	Nonmonetary.
B.2.	Compliance. Providing independent oversight will enhance the integrity of the oversight of the DMA.	Nonmonetary.

Appendix H. Organizations Visited

Office of the Secretary of Defense

Under Secretary of Defense for Acquisition and Technology, Washington, DC
Defense Systems Management College, Fort Belvoir, VA
Under Secretary of Defense (Comptroller), Washington, DC
Assistant Secretary of Defense (Command, Control, Communications and Intelligence), Washington, DC

Defense Agency

Defense Mapping Agency, Fairfax, VA

Non-Government Organizations

Martin Marietta Corporation, Valley Forge, PA
Intergraph Corporation, Huntsville, AL

Appendix I. Report Distribution

Office of the Secretary of Defense

Under Secretary of Defense for Acquisition and Technology
Under Secretary of Defense (Comptroller)
Assistant Secretary of Defense (Command, Control, Communications and Intelligence)
Assistant to the Secretary of Defense (Intelligence Oversight)
Assistant to the Secretary of Defense (Public Affairs)

Department of the Army

Auditor General, Department of the Army

Department of the Navy

Commander, Naval Facilities Engineering Command
Auditor General, Department of the Navy

Department of the Air Force

Auditor General, Department of the Air Force

Defense Agencies

Director, Defense Contract Audit Agency
Director, Defense Logistics Agency
Director, Defense Mapping Agency
Director, National Security Agency
Inspector General, Central Imagery Office
Inspector General, Defense Intelligence Agency
Inspector General, National Security Agency
Director, Defense Logistics Studies Information Exchange

Non-Defense Federal Organizations

Office of Management and Budget
U.S. General Accounting Office, National Security and International Affairs Division, Technical Information Center

Non-Defense Federal Organizations (cont'd)

Chairman and Ranking Minority Member of Each of the Following Congressional Committees and Subcommittees

Senate Committee on Appropriations
Senate Subcommittee on Defense, Committee on Appropriations
Senate Committee on Armed Services
Senate Committee on Governmental Affairs
Senate Select Committee on Intelligence
House Committee on Appropriations
House Subcommittee on Defense, Committee on Appropriations
House Committee on Armed Services
House Committee on Government Operations
House Subcommittee on Legislation and National Security, Committee on Government Operations
House Permanent Select Committee on Intelligence
House Subcommittee on Oversight and Evaluation, House Permanent Select Committee on Intelligence
House Subcommittee on Program and Budget Authorization, House Permanent Select Committee on Intelligence

Part IV - Management Comments

Assistant Secretary of Defense (Command, Control, Communications and Intelligence) Comments

ASSISTANT SECRETARY OF DEFENSE

WASHINGTON, D.C. 20301-3040

COMMAND, CONTROL, COMMUNICATIONS AND INTELLIGENCE

October 13, 1994

MEMORANDUM FOR INSPECTOR GENERAL OF THE DEPARTMENT OF DEFENSE

SUBJECT: Draft DoD Inspector General Audit Report on the Management of the Digital Production System Development at the Defense Mapping Agency (Project No. 3RC-8008)

The Draft Audit Report has been jointly reviewed and the Assistant Secretary of Defense (Command, Control, Communications and Intelligence) will provide the single coordinated response to your findings and recommendations. Our specific comments are set forth in the attachment to this memorandum.

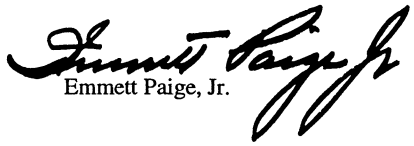
The DoD IG report raises the question of deficiencies in the management and oversight of the Digital Production System (DPS) development. While we agree that there continues to be room for improvement in the processes and methodologies employed to manage and oversee the development of a system as complex as the Digital Production System, the DoD IG did not recognize several significant accomplishments and ongoing program initiatives to address problem areas identified by the Defense Mapping Agency (DMA). System performance improvements are evident as a result of Defense Mapping Agency's implementation of procedures to identify aeronautical product customer requirements prior to development, the use of category codes to identify causes of problems being entered in the Agency's Configuration Management System, and the use of software measurements and metrics analyses to manage change to the baseline.

We agree that, without adequately trained and experienced configuration management personnel, it is difficult to diagnose the causes of hardware and software problems impacting the system. Adequate human resources now exist to diagnose and resolve system performance problems--as evidenced by numerous instances in which software metrics have been used to identify, analyze, and resolve the Digital Production System performance problems at operational sites. Although the DoD IG reported that significant software defects existed in the program's baseline, the DoD IG neglected to mention that the Defense Mapping Agency had already taken positive steps to establish and implement appropriate procedures to analyze the causes of trends in problems identified in the Digital Production System discrepancy reports and to take corrective action.

We disagree with the DoD IG determination that there were material weaknesses in Defense Mapping Agency's internal material control processes for customer requirements identification, software problem analysis, configuration control, and Defense Production System modification definition. In each of these areas, the Defense Mapping Agency's internal control processes identified the problems and implemented (or were implementing) solutions.

Finally, we point out that the Assistant Secretary of Defense (Command, Control, Communications and Intelligence) consistent with the statutory authorities contained in Public Law 96-511 and DoD Directive 5137.1, has overall supervision and management authorities to act as the DoD Senior Information Management Official responsible for the oversight of all DoD information management programs and Federal Information Processing resources; and, as such, will conduct appropriate independent oversight reviews of the Digital Production System consistent with the life-cycle management policies and procedures contained in the DoDD 8000-series. Therefore, a Milestone IV review following the Defense Acquisition Board procedures is unnecessary.

Detailed comments on the report findings and recommendations are enclosed. We appreciate the opportunity to comment on the draft report.



Emmett Paige, Jr.

DoD INSPECTOR GENERAL DRAFT AUDIT REPORT - DATED AUGUST 24, 1994 (DOD IG PROJECT NO. 3RC-8008)

"MANAGEMENT OF THE DIGITAL PRODUCTION SYSTEM DEVELOPMENT AT THE DEFENSE MAPPING AGENCY"

ITEM SPECIFIC COMMENTS

Finding A: Management of the Digital Production System Development

Identifying Customer Requirements for the Digital Production System (DPS). The report stated that DMA did not identify all product specifications for the Flight Information Publications (FLIP) and Automated Air Facilities Information File (AAFIF) products. Specifically, it states that DMA did not develop comprehensive FLIP and AAFIF product specifications that conformed to standards and were formally reviewed. Consequently, 18 customer-requested specification changes were not incorporated. In addition, the report faults DMA for permitting additional changes to the product specifications, which required further development.

COMMENT: Concur. There was a problem with omission of several changes to the product specifications; however, the IG report inaccurately presents the product specification control process.

The Aeronautical Data Maintenance (ADM) subsystem of the DPS supports the FLIP and AAFIF products. FLIP and AAFIF specifications, which are developed and controlled by external organizations (FLIP Coordinating Committee, Federal Aviation Agency, International Civil Aeronautics Organization, etc.) change about every 3 months. In accordance with a Defense Science Board recommendation, the specifications for ADM were frozen in 1989 to provide a stable baseline for implementation. An ADM baseline revision was planned prior to full operational capability.

In order to meet DMA's mission during ADM development, the older non-DPS production systems, under a separate operational configuration management process, continued to incorporate product specification changes. In the ADM baseline revision process, 18 of 150 changes were omitted.

IG RECOMMENDATION A.1: Implement procedures to identify and coordinate customer requirements for FLIP and AAFIF products before specifications are given to the contractor for development.

COMMENT: Concur. DMA merged all AAFIF and FLIP product specification changes into one configuration management process. By November 1993, all FLIP and AAFIF product specification changes were baselined to the ADM. To ensure timely delivery of future changes, DMA implemented an early coordination process with the contractor.

The revised process flow is documented in the DMA Configuration Policy Handbook, DMA PH-907-1. There have been no further problems since the implementation of this new process.

DMA is also working with the external organizations to reduce the frequency of implementing specification changes from three to six months updates. This would greatly reduce system impacts while still meeting customer needs and flight safety requirements.

DMA considers these actions to have effectively implemented and closed IG recommendation A.1.

Analyzing Problems in DPS Software Development. The audit reported that engineers could not track development problems due to inadequate discrepancy reporting and a lack of methodology for trend analysis. Specifically, the report stated that engineers reviewing Discrepancy Reports (DRs), which are used to document problems with the DPS, did not enter all category codes in 19% of the DRs or in the Automated Configuration Management System (ACMS) and that lack of category codes information made trend analysis impossible. The report goes on to state that only 19% of the 82,000 predicted software defects were discovered by production startup in November 1992 compared with an expected rate of 70% discovery for comparable programs.

COMMENT: Partially Concur. The DMA Engineering Review Boards (ERBs) use a variety of elements to track, analyze, and prioritize development problems including daily and weekly tri-center reviews with production personnel. Classification by category as directed by MIL STD-2167B (i.e., hardware, software, documentation, or design problem) is provided by another ACMS field, the DR TYPE, which has always been a required field. The category code further stratifies software problems and was useful in identifying interface problems during system integration.

During the DPS development, trend analyses were performed, using data from ACMS as well as the development contractor's configuration control systems. These analyses were presented by senior DMA engineers at monthly reviews with the Director, DMA Systems Center and by the segment contractors in quarterly reviews. DMA believes the contractor trend analyses mitigated subsequent DR production impacts. There were, however, no written procedures for

performing these analyses. As the system transitioned into production, the emphasis on trend analysis was reduced.

During segment level testing, DMA analysis of the DPS software indicated that, prior to delivery to site, defects were detected and removed from the system at rates comparable to the industry average, i.e. 70% of the defects present after initial coding had been removed prior to delivery to system-level test. This rate compares favorably to comparable DoD test programs in a 1989 OSD Comptroller review.

DMA Systems Center completed development testing of system interfaces and major functional threads (i.e., data extraction, etc.) in October 1992. Exercise and Rehearsal (E&R) testing of the major functional threads using users began in early 1992. These functional threads were then scheduled to be turned over to production incrementally. In August 1993, a conscious decision was made by DMA to terminate the E&R testing prior to completion of all threads in favor of a complete turnover to production. This was based on an assessment that continued E&R testing provided only marginal value when compared with its costs. The decision was influenced by the July 1993 "Advisory Panel Report on DPS Maintenance Management" which recommended that DMA "direct the most expeditious introduction of DPS into production ... to achieve the earliest return on its large investment and for discovery and resolution of inherent defects."

Since delivery to site, as noted in the IG report, the defect discovery rate has been well below expected values. DMA believes that this is a function of system use, driven by the long pipeline times required to complete a production job (e.g., six months for a new 1:50,000-scale Topographic Line Map).

IG RECOMMENDATION A.2: Revise procedures for discrepancy reporting to require that category codes be entered in discrepancy reports and in ACMS.

COMMENT: Concur. ACMS software has been modified to require completion of the category code field. DMA considers this action to have effectively implemented and closed IG recommendation A.2.

IG RECOMMENDATION A.3: Establish procedures and a methodology for analyzing causes of and trends in problems identified in discrepancy reports.

COMMENT: Concur. The IG's recommendation to formalize procedures for trend analysis and provide appropriate education to ERB staffs reflects several on-going DMA initiatives.

DMA is presently revamping its overall DR analysis strategy and expects trend analysis to play an important role. In December 1993, DMA issued procedures for DPS Engineering Review Boards and production components to institute a metrics data collection and measurement analysis program.

DMA has instituted other activities to improve software quality. DMA is currently performing static analysis of the DPS software to identify overly complex modules. The initial analysis will be completed January 1995; the results, in conjunction with actual DR trend data, will be used to identify software units that are candidates for redesign.

In June 1994, DMA approved the Software Measurement and Metric Analysis Handbook which defines the life cycle measurement and metric analysis processes to be used for DMA-designated migration systems. Collection and analysis of a core set of metrics are required for follow-on DPS operations, maintenance, and development contracts.

Based on these initiatives, formal training will be developed and provided to the ERB staff by February 1995. With the efforts outlined above, DMA will consider IG recommendation A.3 closed with the implementation of the ERB training in February 1995.

Configuration Management for the DPS. The IG reported that DMA did not maintain configuration control of the DPS because it had not resolved 9 of 11 Configuration Management (CM) deficiencies identified in a 1993 DMA internal review. These included CM training, control records, and CM guidelines for the engineering review boards.

COMMENT: Partially Concur. Configuration control of the DPS has been maintained throughout the life cycle of the program in accordance with approved CM documents including DPS System Configuration Management Plan, System Transition Integration Plan, and the DPS Program Implementation Directive. The referenced deficiencies did exist but did not result in loss of system configuration control.

IG Recommendation A.4: Assign personnel to the configuration management organization responsible for developing configuration management procedures and for oversight of the configuration management function.

COMMENT: Concur. In March 1994, DMA Systems Center established the System Test and Configuration Management Division within the Program Execution Directorate. This division has now been staffed, with two additional full time individuals to be assigned in December 1994. DMA will consider IG recommendation A.4 closed with the assignment of these individuals in December 1994.

IG RECOMMENDATION A.5: Develop and implement plans with completion dates for the correction of the deficiencies identified in the DMA Systems Center 1993 Configuration Management Review.

COMMENT: Concur. The remaining deficiencies will be corrected, except one, with the implementation of DMA Policy Instruction 907-1, issued January 1994 and DMA Procedural Handbook (DMAPH) 907-1 which was approved and implemented at the June 1994 Executive Configuration Control Board.

The remaining deficiency, "Level of CM knowledge and experience is inadequate," is scheduled to be closed in December 1994. DMA Human Resources is working with the Configuration Management Steering Group to prepare a CM training course, schedule, and required attendance roster focused on implementation of procedures identified above. DMA will consider IG recommendation A.5 closed with the completion of this training in December 1994.

Program Management Plan for DPS Modifications. The IG report stated that DMA had not developed a program management plan that clearly defined the objectives and development strategy for the short- and long-term modifications planned for the DPS. It also stated that DMA planned to spend $185 million in RDT&E for modifying DPS or developing new products and $220 million on research and development efforts that may directly or indirectly result in modifications to DPS operations or products.

COMMENT: Partially Concur. DMA managed the DPS development according to a very comprehensive program management plan with accompanying system engineering, test and evaluation, and segment logistics support plans. As the DPS transitioned into the operational DMA production system footprint, further modifications were planned and executed along functional lines which reflected the production line environment (i.e., Computer Systems, Production Management, Product Generation, Hydrographic Programs, etc.). In essence, the DPS was losing its identity to the larger MC&G production System (MPS). In Oct 93, DMA formed a Technology and Information Steering Committee (TISC) to plan the strategic direction for this MC&G Production System. In Feb 1994, the MPS was defined and certified as a migration system in accordance with ASD(C3I) policy. In Aug 1994, the TISC produced the Technology and Information Strategic Plan (TISP) which details strategic goals and objectives for the MPS with a supporting MPS migration plan which details the technical road map for achieving those goals. In response, DMA Systems Center's functional program managers are preparing Program Management Plans for each of their areas detailing how and when their respective modifications will be executed. These plans are due December 1994.

IG RECOMMENDATION A.6: Develop a comprehensive program management plan that defines the modifications to be made to the DPS and that details how and when the modifications will be accomplished.

COMMENT: Concur. In May 1993, DMA decided to request approval to recapitalize the DPS hardware and software to dramatically reduce its operations and maintenance costs and meet changing user requirements as a result of the Cold War cessation. This DPS recapitalization program does indeed necessitate a comprehensive strategic plan which is scheduled to be prepared by February 1995.

Finding B: Oversight of the Digital Production System Development. The DoD IG reported that the development and modification of the Digital Production System (DPS) lacked sufficient oversight and that because DPS was not subject to acquisition policies in DoD directives and instructions, the Defense Acquisition Board had not reviewed the development of the program

The DoD IG also noted that because non-DoD channels and practices were used in the development of DPS, the ASD(C3I) did not require the DMA to comply with acquisition policies in DoD directives and instructions, and as a result, the Major Automated Information System Review Council exempted the DPS from review. The DoD IG noted that it recommended based on a 1989 inspection of the Defense Mapping Agency that the Under Secretary of Defense for Acquisition (now the Under Secretary of Defense for Acquisition and Technology) conduct a Milestone II review of the program. In response, the Under Secretary of Defense for Acquisition declined to review the program, because the Defense Acquisition Board review process was inappropriate for reviewing the program's development. The DoD IG also noted that external oversight of DPS was provided by the ASD(C3I) through a series of periodic status briefings regarding DPS development. The DoD IG also found that the DMA personnel provided additional briefings on DPS development to congressional committee staff with a demonstrated need to know. In addition, DMA convened independent panels in FY 1988 and FY 1993, respectively to review and assess DPS development.

The DoD IG noted that effective oversight of DPS is critical to ensure the best use of allocated resources. The DoD IG further noted that DPS is an automated information system that would have been reviewed by the Major Automated Information System Review Council (MAISRC), provided DPS had not been exempted from review.

IG RECOMMENDATIONS B.1: Partially Concur. The DoD disagrees with the DoD IG statement that DPS was not subject to or required to comply with acquisition policies. As DPS was formerly designated by the Secretary of Defense as a highly

sensitive, classified program in 1982, it was precluded from the traditional life-cycle management reviews under MAISRC process or DAB process. However, consistent with the authorities and responsibilities contained in DoD Directive 5137.1 and DoD Instruction 5000.2, Part 2, the ASD(C3I) conducted oversight of DPS to assess development progress and actions to complete core program activities. However, we agree that completion of core capabilities and planned product improvements warrant continued oversight review. Since development oversight currently resides with the ASD(C3I), we do not agree that the USD(A&T) should conduct a Milestone IV review of the planned modifications which are valued below the major program level. Instead, the ASD(C3I) has tasked the DASD(C3IA) to conduct an OSD In-Process Review of the Digital Production System within the next 120 days. The purpose of the review will be to assess the program status, to review the DPS Strategic Plan, and to determine future in-process review intervals.

IG RECOMMENDATIONS B.2: PARTIALLY CONCUR. The DoD disagrees with the DoD IG Statement that DPS was not subject to independent oversight by the Assistant Secretary of Defense (Command, Control, Communications and Intelligence). As the program was formerly designated by the Secretary of Defense as a highly sensitive, classified program in 1982, DPS core activities were managed by the ASD(C3I) in accordance with DoD Instructions 5000.2, Part 2. As the program is evolving to meet near-term cold war requirements through a series of DPS enhancements, a DPS Strategic Plan will be developed to establish a system-wide baseline so that future focused oversight reviews of the program may be conducted as DPS migrates to full and open competition and to an open system environment.

Audit Team Members

This report was prepared by the Readiness and Operational Support Directorate, Office of the Assistant Inspector General for Auditing, Department of Defense.

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