

Audit

Report



PREPARATION OF THE GLOBAL POSITIONING SYSTEM
FOR YEAR 2000

Report Number 99-229

August 9, 1999

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Acronyms

FAR	Federal Acquisition Regulation
GPS	Global Positioning System
Y2K	Year 2000
MOSC	Mission Operations Support Center
IMOSC	Phase IIA of the Integrated Mission Operations Support Center



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August 9, 1999

MEMORANDUM FOR ASSISTANT SECRETARY OF THE AIR FORCE
(FINANCIAL MANAGEMENT AND COMPTROLLER)

SUBJECT: Audit Report on Preparation of the Global Positioning System
for Year 2000 (Report No. 99-229)

We are providing this report for your information and use. This report is one in a series of reports being issued by the Inspector General, DoD, in accordance with an informal partnership with the Chief Information Officer, DoD, to monitor DoD efforts to address the year 2000 computing challenge. We considered management comments on a draft report of this report in preparing the final report.

Comments on the draft of this report conformed to the requirements of DoD Directive 7650.3 and left no unresolved issues. Therefore, no additional comments are required.

We appreciate the courtesies extended to the audit staff. Questions on the audit should be directed to Mr. Charles M. Santoni at (703) 604-9051 (DSN 664-9051) (csantoni@dodig.osd.mil) or Mr. Sean Mitchell at (703) 604-9034 (DSN 664-9034) (smitchell@dodig.osd.mil). See Appendix B for the report distribution. The audit team members are listed inside the back cover.

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Report No. 99-229
(Project No. 8AL-0041.05)

August 9, 1999

Preparation of the Global Positioning System for Year 2000

Executive Summary

Introduction. This report is one of a series being issued by the Inspector General, DoD, in accordance with an informal partnership with the Chief Information Officer, DoD, to monitor DoD efforts to address the year 2000 computing challenge. This report addresses the year 2000 issues that pertain to the Global Positioning System.

Audit Objectives. The audit objective was to determine whether planning and management are adequate to ensure that the Global Positioning System will continue to operate effectively in the year 2000. The Global Positioning System consists of an Operational Control Segment, a Space Segment, and a User Segment. Specifically, we audited the Operational Control and the Space Segments. The year 2000 compliance status of the User Segment was addressed in Inspector General, DoD, Report No. 99-063. (See Appendix A, Summary of Prior Coverage.) Because the Global Positioning System has a unique internal time system designated as "Global Positioning System Time," we also determined whether the Global Positioning System Time would operate effectively after the End-of-Week rollover on August 21, 1999.

Audit Results. The GPS Program Office and the 2nd Space Operations Squadron actively planned and managed the year 2000 and End-of-Week rollover issues for the Global Positioning System Operational Control Segment. However, the Operational Control Segment's operational and programmatic contingency plans were incomplete and needed improvement.

The Space Segment's satellite vehicles do not use conventional date and time data and are, therefore, inherently Y2K compliant. Workaround procedures, addressing satellite vehicle End-of-Week rollover issues, were appropriately developed and tested. However, the Global Positioning System Program Office did not actively plan and manage Y2K issues for the Space Segment's support equipment. The target certification date for Phase IIA of the Integrated Mission Operations Support Center, the replacement system for the Mission Operations Support Center, is December 1, 1999, which may not allow sufficient time to correct unexpected errors, changes, and delays in solving Y2K problems. Further, the development of the interface between the Operational Support System and the Integrated Mission Operations Support Center slipped to August 1999, thereby impeding the initiation of Integrated Mission Operations Support Center testing. In addition, the Global Positioning System Program Office did not develop workaround procedures for the Mission Operations Support Center in the event that the Integrated Mission Operations Center is not deployed and operational by December 31, 1999; did not determine the training and resource requirements to operate a Mission Operations Support Center workaround; and did not prepare contingency plans for the Space Segment. As a result, the Global Positioning

System Program Office increased its risk for Y2K interruptions. For details of the audit results, see the finding section of the report.

Summary of Recommendations: We recommend that the Commander, Air Force 50th Space Wing update the Operational Control Segment's operational contingency plan to include start dates for precontingency actions, End-of-Week rollover procedures, and point-of-contact lists for internal and external support staff.

We recommend that the Program Manager, Global Positioning System, develop, document, and test year 2000 workaround procedures and implement them if the Integrated Mission Operations Support Center is not completed, tested, and installed before December 31, 1999. We also recommend developing and testing contingency plans for the Space Segment, and revising the programmatic contingency plan for the Operational Control Segment to include updated point-of-contact lists, start dates for precontingency actions, and additional training and resource needs.

Management Comments. The Assistant Secretary of the Air Force, in coordination with the Commander, Air Force 50th Space Wing and the Program Manager, Global Positioning System concurred with all recommendations. The 50th Space Wing and the Global Positioning System Program Office took action to correct the deficiencies. A discussion of management comments is in the Finding section of the report and the complete text is in the Management Comments section.

Audit Response: The comments provided by the Air Force were responsive. We commend the Commander for the Air Force 50th Space Wing and the Program Manager for the Global Positioning System for expediting the necessary actions to address the recommendations of the report.

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Background

Executive Order No. 13073. Because there is a potential for computers to fail to run or function throughout the Government on January 1, 2000, the President issued an Executive Order, "Year 2000 Conversion," February 4, 1998. The Executive Order makes it policy that Federal agencies ensure that no critical Federal program experiences disruption because of the year 2000 (Y2K) problem and requires the head of each agency to ensure that efforts to address the Y2K problem receive the highest priority.

Federal Acquisition Regulation (FAR) Y2K Compliance Requirements. Clauses addressing Y2K compliance issues are contained in FAR 39, "Acquisition of Information Technology." FAR 39.002 states that information technology is Y2K compliant when it is capable of accurately processing date and time data in the 20th and 21st centuries, as well as in leap years. FAR 39.106, "Year 2000 Compliance," states that agencies acquiring information technology that requires date and time processing after December 31, 1999, must ensure that contracts and solicitations include a Y2K compliance clause.

DoD Y2K Management Plan Guidance. The DoD Y2K Management Plan provides the overall DoD strategy and guidance for inventorying, prioritizing, repairing or retiring systems, and monitoring progress. The DoD Y2K Management Plan makes DoD Components responsible for implementing a five-phase, Y2K management process and also identifies the Y2K and End-of-Week rollover test dates. December 31, 1998, was the DoD target completion date for implementing mission-critical systems and March 31, 1999, was the completion date for all other systems. Systems that were noncompliant after these dates were to be considered high risk.

The DoD Y2K Management Plan states that system-level contingency plans should include the procedures necessary to restore a system in the face of all anticipated and unanticipated Y2K disruptions. Contingency plans should provide for continuing operations when the support from a single system or group of closely related systems is disrupted.

Y2K Implications for DoD Weapon Systems. DoD weapon systems are becoming increasingly advanced through the extensive use of computers and software. The development and acquisition of software, information technology systems, and software embedded in weapon systems that accommodate the century change are essential to future mission effectiveness. The weapons include smart munitions, missile systems, armored vehicles, ships, aircraft, and communication and navigation systems. DoD mission-critical systems could be affected if DoD weapon systems' computers and software are unable to accurately process date and time data after December 31, 1999.

End-of-Week Rollover. The Global Positioning System (GPS) maintains its own internal time system called GPS Time, which has a unique End-of-Week rollover problem that will occur at 23:59:47 Universal Time Coordinated on August 21, 1999. GPS missions could be affected if computers and software are unable to accurately process time after August 21, 1999.

Air Force Guidance. The Air Force "Year 2000 (Y2K) Continuity or Operations Planning Guide," September 17, 1998, requires that timelines be established to trigger specific actions for identified precontingency actions but does not provide guidance for the GPS End-of-Week rollover. The Air Force developed the Y2K Compliance Checklist to aid system and device program, product, and project managers in ensuring their systems and devices are tested, documented, and determined to be Y2K compliant.

Objectives

The audit objective was to determine whether planning and management are adequate to ensure that the GPS will continue to operate effectively in the year 2000. The GPS consists of an Operational Control Segment, a Space Segment, and a User Segment. Specifically, we audited the Operational Control and the Space Segments. We also determined whether the unique GPS Time system would operate effectively after the End-of-Week rollover that is scheduled to occur on August 21, 1999. See Appendix A for a discussion of the audit scope, methodology, and prior audit coverage.

Program Compliance Status

The GPS Program Office and the 2nd Space Operations Squadron actively planned and managed the Y2K and End-of-Week rollover issues for the GPS Operational Control Segment. However, the Operational Control Segment's operational and programmatic contingency plans were incomplete because they did not include start dates for precontingency actions, updated point-of-contact lists, workaround procedures addressing the Y2K and End-of-Week rollover problems, and training needs and resources for contingency workarounds.

The Space Segment's satellite vehicles do not use conventional date and time data and are, therefore, inherently Y2K compliant. Workaround procedures addressing satellite vehicle End-of-Week rollover issues were appropriately documented and tested.

The GPS Program Office did not actively plan and manage Y2K issues for Space Segment support equipment. The Program Office did not act early enough to ensure that Phase IIA of the Integrated Mission Operations Support Center (IMOSC), the replacement system for the Mission Operations Support Center (MOSC), would be deployed before December 31, 1999. The IMOSC target certification date is December 1, 1999, which may not allow sufficient time to correct unexpected errors, changes, and delays in solving Y2K problems. Also, the Program Office did not issue the Operational Support System interface development contract early enough to ensure Boeing would have access to test the IMOSC by June 1, 1999. In addition, the GPS Program Office did not develop, document, and test workaround procedures for the MOSC in case the IMOSC cannot be deployed and operational by December 31, 1999. The GPS Program Office also did not determine whether additional training and resources were needed to operate a MOSC workaround and did not prepare contingency plans for the Space Segment. Therefore, contingency plans and workaround procedures for Y2K issues and End-of-Week rollover issues were not documented.

As a result, the Space Segment support equipment is not Y2K compliant and may not be compliant by December 31, 1999. The delay in starting the renovation of GPS Space Segment mission-essential support equipment and the lack of sufficient emphasis on developing and documenting workaround procedures and contingency plans for the Space Segment have increased the risk for Y2K interruption. Therefore, the GPS Program Office must intensively manage the remaining Y2K conversion tasks, prepare the Space Segment contingency plans, and take additional action to minimize risk.

System Description

Mission. The GPS is a space-based, radio-positioning system, consisting of a constellation of 27 orbiting satellites (29 by December 31, 1999), that provides global navigation and timing information to users. In addition to the satellites, the system consists of a worldwide satellite control network and GPS receiver units that translate satellite signals into position information. The GPS satellite control network is operated and controlled by the 2nd Space Operations Squadron, 50th Space Wing, located at Schriever (formerly Falcon) Air Force Base, Colorado. The GPS Joint Program Office at the Air Force Materiel Command's Space and Missile Systems Center, Los Angeles Air Force Base, California, manages the acquisition of the GPS. Our audit examined the GPS Space Segment and the GPS Operational Control Segment.

Features. GPS satellites orbit the earth every 12 hours emitting continuous navigation signals. With the proper equipment, users can receive signals to calculate time, location, and velocity. GPS provides the following 24-hour, worldwide services: accurate three-dimensional location information (providing latitude, longitude and altitude readings), accurate velocity information, passive all-weather operations, precise timing services, continuous real-time information, and support to an unlimited number of users and areas.

Operational Control Segment. The primary component of the Operational Control Segment is the GPS Operation Control Station, which is operated by the 2nd Space Operations Squadron. The Operational Control Segment, consisting of a Master Control Station and remote sites hosting monitor stations and ground antennas, is responsible for monitoring, commanding, and controlling the GPS satellite constellation. The GPS-dedicated ground system has five monitor stations and four ground antennas located around the world. The monitor stations use GPS receivers to passively track the navigation signals of all satellites. The Operational Control Segment is a mission-critical (mission criticality Group I¹) system. The ground satellite antennas transmit and receive state-of-health information from the satellite vehicles. The 50th Space Wing and the 2nd Space Operations Squadron is responsible for developing and maintaining the operational contingency plan for the GPS Operational Control Segment.

Space Segment. The GPS Space Segment consists of satellite vehicles and mission-support systems. The overall rating for the GPS Space Segment is mission critical (mission criticality Group I). However, the Space Segment support equipment is a mission-essential (mission criticality Group II²) system. The GPS Program Office is responsible for developing and maintaining the

¹ Mission-critical (mission criticality Group I): the loss of these critical functions would cause immediate stoppage of direct mission support of wartime operations.

² Mission-essential (mission criticality Group II): the loss of these areas would reduce operational capability because of loss of equipment or parts. If not corrected, degradation eventually causes loss of mission capability.

programmatic contingency plan for the GPS Operational Control Segment and the operational and programmatic contingency plans for the GPS Space Segment.

Satellite Vehicles. The four generations of the GPS satellite are the Block I, Block II/IIA, Block IIR, and Block IIF. The on-orbit constellation consists of 26 Block II and IIA satellite vehicles and one Block IIR satellite vehicle. Two Block IIR satellite vehicles are scheduled to be launched this year.

Mission Operations Support Center. The MOSC is part of the Data Transfer System and is a primary support system of the GPS Space Segment. The MOSC is a network of telemetry collection and data analysis systems for GPS Block II/IIA satellite vehicles. The Data Transfer System provides daily data on every satellite vehicle function and provides a chronological history of performance. Every day, Boeing engineers at Schriever Air Force Base use the data to determine the state-of-health of the satellite vehicles, analyze satellite vehicle anomalies, and perform trend analysis to predict anomalies. The MOSC is composed of five Data General computers, associated peripheral equipment, and communications and cryptographic equipment. The MOSC is classified mission essential and is not Y2K compliant.

Integrated Mission Operations Support Center. The IMOSC is being developed as a Y2K-compliant support system to replace the noncompliant MOSC. The IMOSC is a distributed network of telemetry processing equipment that will provide Space Segment contractors, the Space and Missile Systems Center, and Aerospace personnel with telemetry data archival and retrieval, data analysis, and real-time telemetry display capabilities to support the GPS satellite vehicle constellation. The IMOSC will support on-orbit satellite vehicles interfacing simultaneously with the Master Control Station and the Air Force Satellite Control Network.

Interfaces. The GPS has 19 external interface agreements. Officials from the GPS Program Office reviewed each interface agreement, found them complete, and identified no Y2K issues. We reviewed the documentation supporting the GPS Program Office interface agreement review and determined that it adequately addressed Y2K issues. To ensure the technical accuracy and adequacy of their review, our engineers reviewed judgmentally selected interface agreements. The engineers selected the following three interface agreements for review: the Navstar GPS Space Segment and Navigation User Segment (Interface Control Document-GPS-200), the GPS Control Segment and Defense Mapping Agency (Interface Control Document-GPS-211), and the Navstar GPS Block IIR Space Segment and Control Segment Interfaces (Interface Control Document-GPS-401). The engineers did not identify any Y2K issues or technical problems with those agreements.

Importance of GPS. The GPS has been so thoroughly integrated into the United States' military and civilian infrastructure that system maintenance is critical. GPS is being integrated into nearly all facets of the modern battlefield. Allied forces' forward air controllers, pilots, tank drivers, and ground troops all use GPS. During Operations Desert Shield and Desert Storm, coalition forces relied heavily on GPS to navigate the featureless deserts of the Middle East. GPS is also a critical part of civilian infrastructure. Civilian air traffic

controllers rely on GPS to control air traffic and cities use the GPS timing signal to control the timing of electrical power, water, and transportation functions. Loss of GPS would severely impact both military and civilian functions.

Emmett Paige Jr., former Assistant Secretary of Defense (Command, Control, Communications and Intelligence), told the House Subcommittee on Government Management, Information, and Technology, Committee on Government Reform, that:

The most significant system today that is not Y2K compliant is GPS, which would have more impact than anything else. Yet I have no doubt that GPS will be ready along with all the other weapon systems and command and control systems in the Department of Defense.

Program Management

Y2K Compliance Checklist. The GPS Program Office used the Air Force Y2K Compliance Checklist and determined that the Operational Control Segment and the Space Segment's satellite vehicles were Y2K compliant, but that the Space Segment support equipment was not. The Program Office analysis stated that algorithms in the:

- Operational Control Segment's Master Control Station contained date references that were Y2K compliant;
- Space Segment satellite vehicles contained no date references; therefore, the satellite vehicles were inherently Y2K compliant; and
- Space Segment support equipment contained date references that were not Y2K compliant.

Y2K Compliance Status of the Operational Control Segment. The Air Force Material Command appropriately certified the Operational Control Segment as Y2K compliant on February 22, 1999. The GPS Program Office and the 2nd Space Operations Squadron followed the five-phase management process and documented the verification testing, interfaces, and contingency plans before certification. The data transmitted by the Master Control Station to GPS satellite vehicles and the data processed in the satellite vehicles are not date or time dependent; therefore, they are inherently Y2K compliant. The GPS Program Office and the 2nd Space Operation Squadron identified several Y2K deficiencies in the Operational Control Segment hardware and software and took corrective actions. However, the operational contingency plan, which is developed by the 2nd Space Operations Squadron, and the programmatic contingency plan, which is developed by the GPS Program Office, need to be updated.

Y2K Contingency Plans for the Operational Control Segment. The operational and the programmatic contingency plans did not provide a start or trigger date for precontingency actions or identify the personnel responsible for

executing actions that are specified in the plans. The contingency plans also did not include the up-to-date points of contact for support personnel, ground antenna support personnel, and space vehicle vendor personnel and did not indicate the date they were received, the reviewer, and dates they were reviewed. Further, the contingency plans did not address training and the additional resources needed for contingency workarounds. However, the contingency plan deficiencies will not affect the ability of the 2nd Space Operations Squadron to effectively monitor, command, and control the satellite constellation after December 31, 1999. These deficiencies need to be addressed to ensure efficient management if Y2K problems should occur.

Y2K Compliance Status of the Space Segment. The Space Segment is not Y2K compliant because much of the support equipment contains algorithms that are not Y2K compliant. The Y2K compliance status for the satellite vehicles and support equipment follows.

Y2K Compliance Status of the Space Segment Satellite Vehicles. The Space Segment satellite vehicles are inherently Y2K compliant because their algorithms do not use conventional date and time data.

Y2K Compliance Status of Space Segment Support Equipment. The Space Segment support equipment is date and time dependent and is not Y2K compliant. Planning and management for Space Segment support equipment was not adequate to ensure the continued health of the GPS space vehicles or the vehicles' ability to operate effectively in the year 2000. The GPS Program Office completion date for the support equipment may not allow sufficient time for unexpected errors, changes, and delays in solving Y2K problems.

Y2K-Compliant IMOSC to Replace the Noncompliant MOSC. Officials of the GPS Program Office did not initiate action early enough to ensure that the Y2K compliant IMOSC would be fully implemented to replace the noncompliant MOSC before December 31, 1999. In 1996, GPS Program Office officials learned that MOSC operating systems were not Y2K compliant. They decided to replace the MOSC, rather than make it Y2K compliant, because much of its custom software used two-digit date fields, and the contractor no longer manufactured or supported the equipment. The Program Office planned to replace the MOSC with the IMOSC, a Y2K-compliant system being designed and developed. However, officials of the GPS Program Office waited until the summer of 1998 to shift the IMOSC implementation date from mid-2000 to September 1999. Phase IIA of the IMOSC is scheduled to start final functional testing and to begin parallel operation with the MOSC on September 1, 1999, and to be completely tested and operational by December 1, 1999. However, delays in IMOSC development and the Operational Support System interface could result in the IMOSC not being online by January 1, 2000. As a result, the delay in starting the renovation of the MOSC support equipment has increased the risk for Y2K interruptions.

Operational Support System Interface with IMOSC. The GPS Program Office did not initiate action early enough to ensure that the interface development between the Operational Support System and the IMOSC would be completed for testing in June 1999. The IMOSC will receive space vehicle data

through an interface from the Operational Support System. Boeing requires the Operational Support System interface to be completed by June 1, 1999, to test the IMOSC. However, GPS Program Office personnel stated that the contract for the Operational Support System interface was not issued until the end of February 1999, and that the interface would not be completed until August 1999. Delays in interface development will impede IMOSC testing.

MOSC Workaround. Officials of the GPS Program Office did not develop, document, and test workaround procedures for the MOSC, in case the IMOSC cannot be deployed and operational by December 31, 1999. Boeing engineers stated that a MOSC workaround would require intensive human intervention. The GPS Program Office also did not determine whether additional training and resources were required to operate a MOSC workaround. If the IMOSC is not operational by December 31, 1999, the delay in documenting, testing, and resourcing MOSC workaround procedures could result in mission degradation of the GPS satellite constellation. Delay in starting the renovation of the mission-essential MOSC support equipment increased the risk for Y2K interruptions.

Concerns of the 2nd Space Operations Squadron. The 2nd Space Operations Squadron is greatly concerned that the IMOSC might not be in place by December 31, 1999, and that a viable MOSC workaround might not be developed and tested. Management stated that MOSC is mission essential and a critical tool for GPS. Nine GPS satellite vehicles are past their design life of 7.5 years and 16 GPS satellite vehicles are past their mean expected life of 8.8 years. As satellite vehicles age, the possibility of failure increases. The MOSC functions are invaluable in determining the cause of an anomaly and the solution to correct an anomaly. MOSC functions can be performed manually, but would be manpower intensive and require considerably more analysis time. Analysis would be further compounded if an anomaly occurred in more than one satellite vehicle.

Operational Support System. The Operational Support System provides the telemetry analysis, data storage, and retrieval functions for the Block IIR satellite vehicles and will provide telemetry data to the IMOSC when it becomes operational. The Operational Support System is not Y2K compliant. The planned installation of the SUN Operating System SOLARIS 2.6, and the reintegration of applications software will satisfy all Y2K processing criteria. Lockheed Martin is accomplishing this effort, to be completed in September 1999, under the Block IIR contract. The renovation was delayed because of difficulty with the telemetry data communications handling equipment, and because some support was diverted to assist the Boeing IMOSC development.

Block II and IIA Telecom Simulator. The Telecom Simulator is composed of the same boxes and components as the GPS Block II/IIA spacecraft, with the addition of a computer to command the various boxes. The boxes and components are Y2K compliant, with the exception of the computer. When the GPS Program Office completes the Telecom Simulator upgrade, a new Y2K-compliant personal computer will be installed to control the Telecom Simulator. The commercial-off-the-shelf software used to control the Telecom Simulator is Y2K compliant. During software functional testing, Y2K

compliance will be verified as part of the test plan. Officials of the GPS Program Office do not expect any difficulties during this test. The Telecom Simulator should become compliant after the Telecom Simulator upgrade, with the caveat that the Radio Frequency/Digital Unit will need the two End-of-Week rollover workaround procedures performed on August 21, 1999, and August 22, 1999.

Ground Support Software for IIR Satellites, Bus Ground Support Equipment, and Payload Ground Support Equipment. Bus Ground Support Equipment and Payload Ground Support Equipment are used to test Block II-R satellite vehicles before launch. The Bus Ground Support Equipment and Payload Ground Support Equipment use conventional date and time data for processing and their operating systems are not Y2K compliant. Program officials decided to turn back the date to 1972, rather than replace the operating systems, because Bus Ground Support Equipment and Payload Ground Support Equipment will probably not be used after the last II-R satellite is launched in 2004.

Space Segment Y2K Management Plan and Y2K Contingency Plans. The GPS Program Office did not finalize the GPS Space Segment's Y2K Management Plan. The GPS Program Office developed a first draft in January 1999 and updated the draft in March 1999. However, as of March 1999, the management plan was still being developed. In addition, the GPS Program Office did not develop contingency plans for the GPS Space Segment. Contingency plans address the actions that need to be taken if the support equipment validation is not completed before the year 2000 or if equipment, which is believed to be Y2K-compliant, experiences system failure on January 1, 1999.

By not placing sufficient emphasis on the DoD Y2K Management Plan and contingency plans for the Space Segment, the GPS Program Office increased the risk of mission-essential systems not being operational after December 31, 1999, and of responsible personnel not knowing what to do when faced with Y2K failures.

GPS Time and End-of-Week Rollover

The GPS system has a unique design characteristic called the End-of-Week rollover, which will occur at 23:59:47 Universal Time Coordinated on August 21, 1999. GPS Time is defined in Z-counts, which are the number of 1.5-second X1 code repetitions in a week of GPS Time. Z-counts range from 0 at the start of the week to 403,199 just before end of the week. GPS Time is segmented into periods of 1024 weeks. GPS missions could be affected if system computers, software, and GPS receivers are unable to accurately process time after August 21, 1999.

End-of-Week Testing for Satellite Vehicles. Boeing performed an End-of-Week rollover study with the 2nd Space Operations Squadron, in February 1997, which tested the actual performance of on-orbit vehicles. GPS Block II satellite vehicles (13 through 21) experienced no problems. GPS

Block IIA satellite vehicles (22 through 40) experienced a problem that can be corrected using a command procedure the day before the rollover on August 21, 1999, and another command procedure on the first day of the next GPS major period. In January 1999, Boeing and the 2nd Space Operations Squadron successfully ground tested the actual correction procedures for satellite vehicle GPS-38. Additional tests are scheduled. The operational contingency plan for the GPS Operational Control Segment needs to designate the responsibility for ensuring that the End-of-Week command procedures are documented and implemented. The operational contingency plan also needs to address the contingency actions to be taken if the command procedures do not work.

Radio Frequency/Digital Unit. The Radio Frequency/Digital Unit, a subsystem of the satellite vehicle, is used to cross-link data with other GPS satellite vehicles. The Radio Frequency/Digital Unit relies on GPS Time defined in Z-counts and is affected by the End-of-Week rollover. The 2nd Space Operations Squadron will have to perform the command procedure the day before the End-of-Week rollover on August 21, 1999, and another command procedure on the first day of the next GPS major period.

Block II and IIA Telecom Simulator. The Telecom Simulator support equipment is composed of the same boxes and components as the GPS Block II/IIA spacecraft, with the addition of a computer to command the various boxes; therefore, it will respond to Y2K and End-of-Week rollover testing in a manner similar to the space vehicles. The Radio Frequency/Digital Unit in the Telecom Simulator will undergo the same two End-of-Week rollover procedures as the Radio Frequency/Digital Unit in the on-orbit satellite vehicles.

Block IIR Space Vehicle Hardware and Software for the Spacecraft Processor Unit. The GPS Block IIR spacecraft buses and subsystems are largely independent of date and time; however, the Spacecraft Processor Unit software does rely on GPS Time and is therefore affected by the End-of-Week rollover. For End-of-Week rollover compliance, the Spacecraft Processor Unit software requires a manual update, which will be accomplished through a pre-programmed, on-board command macro executed just before the GPS End-of-Week rollover. The macro is supplied as part of the full macro library that is loaded in each Spacecraft Processor Unit before launch and makes the Spacecraft Processor Unit End-of-Week rollover compliant.

Target Dates for Completing Y2K Solutions

The GPS Program Office developed a draft Y2K Management Plan, dated January 25, 1999, and revised the draft on March 1, 1999. The target dates established for fixing, testing, and deploying Y2K-compliant support systems ranged from April 1999 through December 1999; thus, it was implicitly acknowledged that GPS mission-essential support systems would miss the March 31, 1999, goal and be termed high risk.

GPS System Compliance

GPS could be at risk for Y2K disruptions, although officials of the GPS Program Office maintain that the Y2K compliance changes they initiated for the Space Segment's support equipment will not affect the GPS mission. The officials further indicated that any anomalies affecting the state-of-health of the satellite vehicles could still be manually researched and resolved.

Failure to complete the IMOSC installation by December 31, 1999, could affect the GPS mission operations. Boeing determined that intensive human intervention would be required if the MOSC has to be used after December 31, 1999. Because the GPS Program Office did not document, test, and resource the procedures to operate the MOSC after December 31, 1999, the Y2K impact on its operations is unknown. The GPS Program Office was confident that IMOSC would be certified as compliant before December 31, 1999, and that operations would not be affected if Y2K changes were not made. Therefore, the GPS Program Office did not believe that the development of contingency plans addressing the GPS Space Segment's Y2K issues was a high priority. As a result, GPS has an increased risk for Y2K disruptions.

Conclusion

Although the GPS Program Office initiated actions that it believed would make its mission-essential systems Y2K compliant, its Y2K strategy is not without significant risk; therefore, sound contingency planning is particularly important. The GPS Program Office needs to intensively manage its high-risk systems and take additional measures to minimize risk.

Recommendations and Management Comments

1. We recommend that the Commander, 50th Space Wing, update the 2nd Space Operations Squadron's operational contingency plan to include:
 - a. Start dates for precontingency actions and the identity of personnel responsible for executing those actions.
 - b. Point of contact lists with 24-hour telephone numbers for both internal and external support staff.
 - c. End-of-Week rollover procedures, detailing the actions to be taken if the End-of-Week rollover does not work, and the personnel responsible for executing the procedures.

Management Comments. The Director, Space and Nuclear Deterrence, Office of the Assistant Secretary of the Air Force (Acquisition), in coordination with the Commander, 50th Space Wing, concurred with Recommendation 1. and stated that the operational contingency plan has been updated to include start dates for various precontingency actions, to identify individuals responsible for executing these actions, to provide a point-of-contact listing, and to detail End-of-Week rollover procedures.

2. We recommend that the Program Manager, Global Positioning System:

- a. Update the programmatic contingency plan for the Operational Control Segment to include:**
 - 1) Start dates for precontingency actions and the identity of personnel responsible for executing the actions; and**
 - 2) Point-of-contact lists with 24-hour telephone numbers for both internal and external support staff, ground antenna support personnel, and space vehicle vendor personnel.**
- b. Develop, document, and test workaround procedures for the Mission Operations Support Center and implement the procedures if the Integrated Mission Support Center is not completed, tested, installed and functioning appropriately by December 31, 1999.**
- c. Determine and document whether additional training and resources are needed to execute year 2000 workaround procedures.**
- d. Develop contingency plans for the Space Segment, which includes contingency actions and workaround procedures for year 2000 and End-of-Week rollover issues.**

Management Comments. The Director, Space and Nuclear Deterrence, concurred with Recommendations 2. and stated that the Global Positioning Program Office updated the Operational Control Segment's Programmatic Contingency Plan, developed and is testing Mission Operations Support Center year 2000 workaround procedures, determined that no additional training or resources are required for upgrades and workaround procedures for the Space Segment's support equipment, and updated the Space Segment Program Management Plan to contain contingency actions and workaround procedures.

Appendix A. Audit Process

This report is one in a series being issued by the Inspector General, DoD, in accordance with an informal partnership with the Chief Information Officer, DoD, to monitor DoD efforts to address the Y2K computing challenge. For a listing of audit projects addressing this issue, see the Y2K webpage on IGnet at (<http://www.ignet.gov>).

Scope

Work Performed. We reviewed the GPS Y2K Management Plan to determine whether GPS was working towards ensuring that the system would be operational after December 31, 1999. Engineers from the Inspector General, DoD, Audit FollowUp and Technical Support Directorate reviewed software and hardware requirements to determine whether the microprocessors in GPS satellite vehicles were properly inventoried. The engineers also judgmentally selected and reviewed 3 of 19 external interface agreements. We interviewed officials from the Joint Program Office of the Project Manager, the 2nd Space Operations Squadron, and Boeing. We obtained documentation dated from January 1996 through March 1, 1999, that included the GPS Y2K Program Management Plan; the operational contingency plan; the programmatic contingency plan; the Renovation, Validation, and Implementation Plan; interface agreements; and space vehicle schematics. We determined whether planning and management of the GPS program was adequate to ensure that the GPS would operate effectively in the year 2000.

DoD-Wide Corporate-Level Government Performance and Results Act Goals. In response to the Government Performance and Results Act, DoD has established 6 DoD-wide performance level objectives and 14 goals to meet these objectives. This report pertains to the achievement of the following objective and goal:

- **Objective:** Prepare now for an uncertain future.
- **Goal:** Pursue a focused modernization effort that maintains U.S. qualitative superiority in key war fighting capabilities. (DoD-3.)

DoD Functional Area Reform Goals. Most major DoD functional areas have also established performance improvement reform objectives and goals. This report pertains to the achievement of the following functional area objectives and goals

Information Technology Management Functional Area.

- **Objective:** Become a mission partner.
- **Goal:** Serve mission information users as customers. (ITM-1.2)
- **Objective:** Provide services that satisfy customer information needs

-
- **Goal:** Modernize and integrate Defense information infrastructure. (ITM-2.2)
 - **Objective:** Provide services that satisfy customer information needs.
 - **Goal:** Upgrade technology base. (ITM-2.3)

The General Accounting Office High-Risk Area. The General Accounting Office has identified several high-risk areas in the Department of Defense. This report provides coverage of the year 2000 high-risk area.

Methodology

Use of Technical Assistance. We used hardware and software engineers from the Audit FollowUp and Technical Support Directorate to evaluate some of the hardware, microchips, interfaces, and software in the GPS satellite vehicles.

Use of Computer-Processed Data. We did not use computer-processed data to perform this audit.

Audit Period, Standards, and Locations. We performed this economy and efficiency audit from January 1999 through March 1999, in accordance with auditing standards issued by the Comptroller General of the United States, as implemented by the Inspector General, DoD.

Contacts During the Audit. We visited or contacted individuals and organizations within the Department of the Air Force and contractors. Further details are available upon request.

Management Control Program. We did not review the management control program related to the overall audit objective because DoD recognized the Y2K computing problem as a material management control weakness area in the FY 1998 Annual Statement of Assurance.

Summary of Prior Coverage

The General Accounting Office and the Inspector General, DoD, have conducted multiple reviews related to Y2K issues. The General Accounting Office has not issued any reports specifically addressing the GPS Y2K issues. General Accounting Office reports can be accessed on the Internet at <http://www.gao.gov>. The Inspector General, DoD, issued Report No. 99-063, "Global Positioning System Receiver Compliance with Y2K Requirements," December 31, 1998. DoD reports can be accessed on the Internet at <http://www.dodig.osd.mil>.

Appendix B. Report Distribution

Office of the Secretary of Defense

Under Secretary of Defense for Acquisition and Technology
Director, Defense Logistics Studies Information Exchange
Under Secretary of Defense (Comptroller)
Deputy Chief Financial Officer
Deputy Comptroller (Program/Budget)
Assistant Secretary of Defense (Command, Control, Communications and Intelligence)
Deputy Assistant Secretary of Defense (Command, Control, Communications, and Intelligence, Surveillance, Reconnaissance, and Space Systems)
Deputy Chief Information Officer and Deputy Assistant Secretary of Defense (Chief Information Officer Policy and Implementation)
Principal Deputy-Y2K

Joint Staff

Director, Joint Staff

Department of the Army

Chief Information Officer, Army
Inspector General, Department of the Army
Auditor General, Department of the Army

Department of the Navy

Assistant Secretary of the Navy (Financial Management and Comptroller)
Auditor General, Department of the Navy
Inspector General, Department of the Navy
Inspector General, Marine Corps

Department of the Air Force

Assistant Secretary of the Air Force (Financial Management and Comptroller)
Auditor General, Department of the Air Force
Inspector General, Secretary of the Air Force
Program Manager, Joint Global Positioning System
Commander, 50th Space Wing

Unified Combatant Commands

Commander in Chief, U.S. European Command
Commander in Chief, U.S. Pacific Command
Commander in Chief, U.S. Atlantic Command
Commander in Chief, U.S. Southern Command
Commander in Chief, U.S. Central Command
Commander in Chief, U.S. Space Command
Commander in Chief, U.S. Special Operations Command
Commander in Chief, U.S. Transportation Command
Commander in Chief, U.S. Strategic Command

Other Defense Organizations

Director, Defense Information Systems Agency
Inspector General, Defense Information Systems Agency
Director, Defense Contract Audit Agency
Director, Defense Logistics Agency
Director, National Security Agency
Inspector General, National Security Agency
Inspector General, Defense Intelligence Agency

Non-Defense Federal Organizations and Individuals

Office of Management and Budget
Office of Information and Regulatory Affairs
General Accounting Office
National Security and International Affairs Division
Technical Information Center
Director, Defense Information and Financial Management Systems, Accounting and Information Management Division, General Accounting Office

Congressional Committees and Subcommittees, Chairman and Ranking Minority Member

Senate Committee on Appropriations
Senate Subcommittee on Defense, Committee on Appropriations
Senate Committee on Armed Services
Senate Committee on Governmental Affairs
Senate Special Committee on the Year 2000 Technology Problem
House Committee on Appropriations
House Subcommittee on Defense, Committee on Appropriations
House Committee on Armed Services
House Committee on Government Reform
House Subcommittee on Government Management, Information, and Technology,
Committee on Government Reform
House Subcommittee on National Security, Veterans Affairs, and International Relations, Committee on Government Reform
House Subcommittee on Technology, Committee on Science

Department of the Air Force Comments



OFFICE OF THE ASSISTANT SECRETARY

DEPARTMENT OF THE AIR FORCE
WASHINGTON DC

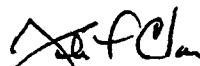
14 July 1999

MEMORANDUM FOR ASSISTANT INSPECTOR GENERAL FOR AUDITING
OFFICE OF THE INSPECTOR GENERAL
DEPARTMENT OF DEFENSE

FROM: SAF/AQS
1060 Air Force Pentagon
Washington D.C. 20330-1060

SUBJECT: Draft Audit Report on Preparation of the Global Positioning System for Year
2000, 24 May 1999, DoD(IG) Project No. 8AL-0041.05

This is in reply to your memorandum to the Assistant Secretary of the Air Force (Financial Management and Comptroller) requesting the Air Force provide comments on the subject report. The Air Force concurs with the DOD(IG) findings and recommendations and the attachment describes the actions that the GPS Program Office and 50th Space Wing have taken in response to the recommendations.


JOHN L. CLAY, Brig Gen, USAF
Director, Space & Nuclear Deterrence
Assistant Secretary of the Air Force (Acquisition)

Attachment
AQS Responses

**SAF/AQS RESPONSES TO THE RECOMMENDATIONS IN
THE DRAFT AUDIT REPORT ON
PREPARATION OF THE GLOBAL POSITIONING SYSTEM FOR YEAR 2000
24 MAY 1999, DoD(IG) PROJECT No. 8AL-0041.05**

RECOMMENDATION 1.

The DoD(IG) recommends that the Commander, 50th Space Wing, update the 2nd Space Operations Squadron's operational contingency plan to include: a) Start dates for pre-contingency actions and the identity of personnel responsible for executing those actions, b) Point of contact lists with 24-hour telephone numbers for both internal and external support staff, and c) End-of-Week rollover procedures, detailing the actions to be taken if End-of-Week rollover does not work, and the personnel responsible for executing the procedures.

SAF/AQ OR 50th SW RESPONSE 1A.

Concur. The quarterly update to the operational contingency plan during June 99 includes start dates for various pre-contingency actions and identifies the individuals who are executing those actions. CLOSED 30 Jun 99.

SAF/AQ OR 50th SW RESPONSE 1B.

Concur. A point of contact list has been added to the operational contingency plan during the June 99 quarterly update. CLOSED 30 Jun 99.

SAF/AQ OR 50th SW RESPONSE 1C.

Concur. The quarterly update to the operational contingency plan, completed during Jun 99, contains detailed End-of-Week rollover procedures. These written procedures include workarounds and fix actions to overcome the possibility of the End-of-Week rollover not working. The plan also includes a listing of personnel responsible for executing all actions. CLOSED 30 Jun 99.

RECOMMENDATION 2A.

The DoD(IG) recommends that the Global Positioning System Program Manager update the programmatic contingency plan for the Operational Control Segment to include: 1) Start dates for pre-contingency actions and the identity of personnel responsible for executing the actions; and 2) Point-of-contact list with 24-hour telephone numbers for both internal and external support staff, ground antenna support personnel, and space vehicle vendor personnel.

SAF/AQ OR SMC/CZ RESPONSE 2A.

Concur. The OCS Programmatic Contingency Plan has been significantly updated and improved, and addresses these concerns. The latest release is Version 3.0, April 1999.

RECOMMENDATION 2B.

The DoD(IG) recommends that the Global Positioning System Program Manager develop, document, and test workaround procedures for the Mission Operations Support Center and implement the procedures if the Integrated Mission Operations Support Center is not completed, tested, and installed and functioning appropriately by December 31, 1999.

SAF/AQ OR SMC/CZ RESPONSE 2B.

Concur. The Mission Operations Support Center (MOSC) workaround has been developed and is currently being tested. The GPS JPO has already witnessed a demonstration on the workaround where 80% of the MOSC capabilities were shown to function in the year 2000. The final demonstration is scheduled for September 1999.

RECOMMENDATION 2C.

The DoD(IG) recommends that the Global Positioning System Program Manager determine and document whether additional training and resources are needed to execute Year 2000 workaround procedures

SAF/AQ OR SMC/CZ RESPONSE 2C.

Concur. The upgrades and workaround procedures for the Space Segment's support equipment will not require any additional training or resources. The upgrades for the Operational Support System (OSS) and the workarounds for the MOSC have been designed to be transparent to the operational user. Therefore, they will continue to operate with the resources and procedures that are in place today.

RECOMMENDATION 2D.

The DoD(IG) recommends that the Global Positioning System Program Manager develop contingency plans for the Space Segment, which includes contingency actions and workaround procedures for Year 2000 and End-of-Week rollover issues.

SAF/AQ OR SMC/CZ RESPONSE 2D.

Concur. The Space Segment Program Management Plan (PMP), which contains the contingency actions and workaround procedures, has been significantly updated and improved, and addresses these concerns. The latest release is dated June 1999.

ADDITIONAL ADMINISTRATIVE COMMENTS

1. Management comments for subject audit are as follows:

a. BACKGROUND

(1) Page 2, paragraph 6, End-of-Week Rollover. "Universal Time Code" should read "Universal Time Coordinated."

b. PROGRAM STATUS COMPLIANCE

(1) Page 4, paragraph 4, System Description. States "The GPS Program Office is responsible for developing the programmatic contingency plan for the GPS Operational Control Segment and the operational and programmatic contingency plans for the GPS Space Segment." Should state the 50th Space Wing and 2d Space Operations Squadron has responsibility for the operational contingency plans.

(2) Page 5, paragraph 1, Satellite Vehicles. The statement, "Two Block IIR satellite vehicles are scheduled to be launched this year" should be deleted.

(3) Page 10, paragraph 1, GPS Time and End-of-Week Rollover. "Universal Time Code" should read "Universal Time Coordinated."

Revised

Revised

Revised

50th Space Wing Comments



DEPARTMENT OF THE AIR FORCE
50TH SPACE WING (AFSPC)



14 JUL 99

MEMORANDUM FOR INSPECTOR GENERAL, DEPARTMENT OF DEFENSE

FROM: 50 SW/CC
300 O'Malley Ave Ste 20
Schriever AFB, CO 80912-3020

SUBJECT: Management Comments for Audit Report, Preparation of the Global Positioning System for Year 2000, 50th Space Wing, Schriever AFB, CO (Project 8AL-0041.05)

1. Management comments for subject audit are as follows:

a. BACKGROUND

Revised

(1) Page 2, paragraph 6, End-of-Week Rollover. "Universal Time Code" should read "Universal Time Coordinated."

b. PROGRAM STATUS COMPLIANCE

Revised

(1) Page 4, paragraph 4, System Description. States "The GPS Program Office is responsible for developing the programmatic contingency plan for the GPS Operational Control Segment and the operational and programmatic contingency plans for the GPS Space Segment." Should state that the 50th Space Wing and 2d Space Operations Squadron has responsibility for the operational contingency plans.

(2) Page 5, paragraph 1, Satellite Vehicles. The statement, "Two Block IIR satellite vehicles are scheduled to be launched this year" should be deleted.

Revised

(3) Page 10, paragraph 1, GPS Time and End-of-Week Rollover. "Universal Time Code" should read "Universal Time Coordinated."

c. RECOMMENDATIONS

(1) Recommendation 1a. Concur. The quarterly update to the operational contingency plan during June 99 includes start dates for various pre-contingency actions and identifies the individuals who are executing those actions. CLOSED 30 Jun 99.

(2) Recommendation 1b. Concur. A point of contact list has been added to the operational contingency plan during the June 99 quarterly update. CLOSED 30 Jun 99.

Golden Legacy. Boundless Future... Your Nation's Air Force

(3) Recommendation 1c. Concur. The quarterly update to the operational contingency plan, completed during Jun 99, contains detailed End-of-Week rollover procedures. These written procedures include workarounds and fix actions to overcome the possibility of the End-of-Week rollover not working. The plan also includes a listing of personnel responsible for executing all actions. CLOSED 30 Jun 99.

2. Questions may be directed to Lt Col McLaughlin, 2 SOPS/CC, at DSN 560-2400.

R15LUM

RICHARD H. WEBBER
Colonel, USAF
Commander

Audit Team Members

The Acquisition Management Directorate, Office of the Assistant Inspector General for Auditing, DoD, prepared this report.

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