IG-99-016

AUDIT REPORT

AUDIT OF ADVANCED X-RAY ASTROPHYSICS FACILITY

March 24, 1999

National Aeronautics and Space Administration

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Acronyms

AXAF	Advanced X-ray Astrophysics Facility
COQ	Certificate of Qualification
IAR	Independent Annual Review
NHB	NASA Handbook
NPG	NASA Procedures and Guidelines
PMR	Project Management Report
TRW	TRW Space and Electronics Group

W March 24, 1999

TO: AE/Chief Engineer

FROM: W/Assistant Inspector General for Auditing

SUBJECT: Final Report on the Audit of Advanced X-ray Astrophysics Facility
Assignment Number A-HA-98-025
Report Number IG-99-016 Redacted Report*

The subject final report is provided for your use and comment. Please refer to the Executive Summary for the overall audit results. Our evaluation of your response is incorporated into the body of the report. In response to management's comments, we revised recommendation 2. Recommendations 1 and 2 are resolved but will remain undispositioned and open for reporting purposes. Please notify us when action has been completed on these recommendations, including the extent of testing performed to ensure corrective actions are effective.

If you have questions concerning the report, please contact Mr. Daniel J. Samoviski, Program Director for the NASA Earth/Space Science Audits, at 301-286-0497, or Mr. Robert Williams, Program Manager, at 818-354-9769. We appreciate the courtesies extended to the audit staff. See Appendix F for the final report distribution.

[Original signed by]

Russell A. Rau

Enclosure

cc:
B/Chief Financial Officer
G/General Counsel
S/Associate Administrator for Space Science
JM/Director, Management Assessment Division
MSFC/DA01/Director

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NASA Office of Inspector General

IG-99-016 **March 24, 1999**
A-HA-98-025

Audit of Advanced X-ray Astrophysics Facility

Executive Summary

Introduction. The Advanced X-ray Astrophysics Facility[1] (AXAF) is the third of the four "Great Observatories" intended to observe the universe in four electromagnetic spectrum regions: visible, infrared, gamma ray, and x-ray. AXAF is intended to provide unique information based on observations in the x-ray band, on the nature of objects ranging from nearby stars like our Sun to quasars at the edge of the observable universe.

The AXAF program is under the purview of the Office of Space Science. Marshall Space Flight Center (Marshall) has responsibility for managing the day-to-day operations of the AXAF Program including supervision of design, development, prelaunch verification, launch, and orbital verification of the AXAF. The current development cost of the program is about $1.5 billion.

Originally, the AXAF was to be launched during August 1998. In November 1997, the prime contractor informed the AXAF Program Manager that the contractor was not going to meet the scheduled launch date.

Objectives. The overall objective was to evaluate the management response to the initial AXAF launch delay, including procurement and contract administration functions. Specifically, we determined whether:

- NASA oversight is sufficient to ensure that schedule, cost, and quality control impacts are minimized because of late delivery of the AXAF.

- Contractor performance is adequately monitored and evaluated, and award fees reflect actual performance.

Details on the scope and methodology are in Appendix A.

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[1] NASA renamed AXAF the *Chandra X-ray Observatory*, in honor of the late Indian-American Nobel Laureate Subrahmanyan Chandrasekhar, in December 1998.

Results of Audit. Overall, NASA responded adequately to the initial AXAF launch delay and has focused additional attention on contractor performance. The AXAF launch delay will increase contract costs by an estimated $28.8 million. The initial delay was caused by problems in software development and inadequate time scheduled for integration and test activities for the AXAF flight and ground software. When software development was identified as a high risk, the AXAF Risk Management Plan was not updated because NASA policy did not require the plan to be updated. Also, NASA did not assign personnel with software expertise at the contractor location. However, when the delivery delay became known, NASA management took action to minimize the impacts and adjusted the contractor award fee to reflect actual performance.

Other Matters of Interest. The prime contractor had not been efficiently processing Certificates of Qualification[2] (COQs), which document hardware certification approval and problem reports, prior to shipping the AXAF. The prime contractor had completed only about 44 percent (30 of 67) of the known COQs and 48 percent (135 of 279) of the known problem reports as of February 1998. The AXAF launch could be further delayed if these reports are not processed before shipment. After we brought this issue to management's attention, management placed greater emphasis on processing COQs and problem reports. Therefore, we are making no recommendation on this issue (see Appendix D).

Recommendations. We recommended that management revise the NASA policy to require program managers to update Risk Management Plans as high-risk issues arise, and if NASA management designates software development as a significant risk to a program, management should consider having personnel with software expertise on-site at the contractor's location.

Management's Response. The NASA Chief Engineer forwarded the recommendations to the Program/Project Management Working Group to deliberate and revise NASA policy. The Group will reconvene in late April 1999 and plans to finalize the modification by late summer 1999. If software is identified as a significant management risk, and as part of the risk management plan developed under NASA policy, management may consider on-site software expertise at the contractor's location.

Evaluation of Response. Management's planned actions are responsive to the recommendations. In response to management's comments, we revised the recommendation relating to having personnel with software expertise on site when software-driven programs are designated a significant management risk because it would not be necessary or practical in all cases to assign personnel with software expertise on-site at contractor locations.

[2] The COQ is a form which lists the configuration of the hardware and the documentation required to verify that the flight hardware or program critical ground support equipment is qualified for its intended use.

Introduction

The AXAF Observatory has three major parts:

- the X-ray telescope, which contains mirrors that will focus X-rays from celestial objects;

- the science instruments that record the X-rays so that images and spectral data can be produced and analyzed; and

- the overall spacecraft, which as it orbits the earth will provide the environment necessary for the telescope and the instruments to perform.

NASA issued letter contract NAS8-37710 to TRW Space and Electronics Group (TRW), Redondo Beach, California, in January 1989 to initiate work on the AXAF. Modification 25 to the contract, dated February 28, 1990, definitized the work. However, in 1992, NASA restructured the program. To reduce cost, NASA decreased the number of mirrors from 12 to 8, and only 4 of the 6 scientific instruments were used. At that time, the planned orbit was changed from low- to high-earth orbit to preserve the AXAF scientific capability.

The three major subcontractors to TRW are:

- Raytheon Optical Systems (formerly Hughes Danbury) - mirror development
- Eastman Kodak - High Resolution Mirror Assembly
- Ball Aerospace - Science Instrument Module

The NASA Space Shuttle *Columbia* will launch the AXAF from John F. Kennedy Space Center in Florida. The *Columbia* is the only shuttle with a long enough payload bay to carry the AXAF.

The AXAF was originally scheduled to be launched during August 1998. In November 1997, the prime contractor informed senior management of the NASA Office of Space Science that TRW was not going to meet the June 1, 1998, AXAF delivery date.

Finding and Recommendations

Finding. Integration and Test Activities Schedule

The contractor did not schedule sufficient time for integration and test activities for the AXAF flight and ground software. Scheduling was inadequate because TRW and NASA management believed that the software development was routine in nature due to the contractor's past performance with that type of activity. However, even after the AXAF software development had been identified as high risk, the Risk Management Plan was not updated because NASA policy does not require that it be amended. In addition, NASA did not have oversight personnel on site, at TRW, with the software expertise to help recognize the magnitude of potential software-related problems. As a result, the AXAF launch date needed to be rescheduled, affecting the Space Shuttle manifest. Postponing the AXAF launch will increase contract cost by $28.8 million.

AXAF Risk Management Plan Requirements

NASA Handbook (NHB) 7120.5, "Management of Major System Programs and Projects," November 3, 1993, required that "all major programmatic and technical risks should be identified along with the planned approach to reduce the risks to acceptable levels." On April 3, 1998, NASA Procedures and Guidelines (NPG) 7120.5A superseded NHB 7120.5. In addition to the previous requirements, NPG 7120.5A specified:

> For each primary risk, the program/project shall develop and maintain the following information . . . in the Program/Project Plans . . . or in the Program Commitment Agreement:
>
> (1) Description of the risk
> (2) Primary consequences
> (3) Estimate of the probability
> (4) Significant cost impacts
> (5) Significant schedule impacts
> (6) Potential additional mitigation measures
> (7) Characterization of the risk as 'acceptable' or 'unacceptable' with supporting rationale.

However, NPG 7120.5A does not specifically require the Risk Assessment portion of a Program/Project Plan to be amended when program management identifies another issue as a primary or high risk. According to one of the drafters of NPG 7120.5A, the term "maintain" was used to "imply" that the plans should be updated as needed. He stated that the meaning of "maintain" is ambiguous and should be clarified.

The AXAF Program Plan, signed by the AXAF Program Manager and the Marshall Center Director in September 1996, included the Program's Risk Assessment. The Program Plan stated that "the key technical risks that threaten the program involve degradation in image quality (mirror shape and smoothness, mirror alignment, telescope alignment and stability, aspect camera/image reconstruction errors, detector alignment or noise problems." The AXAF Risk Assessment did not identify software development as high risk.

Software Development and Verification Testing

The Work Breakdown Structure, within the AXAF Statement of Work, requires the contractor to perform various activities during the planning and software development phases (see Appendix B). Historically, in the experience of TRW software engineers, software development takes about 1 year; however, TRW scheduled about 5 months for software development. One software development schedule, dated February 1995, for the AXAF indicated about 5 months (March 15, 1996, through August 7, 1996) for software development.

AXAF development and construction of flight hardware had been ongoing since 1992. AXAF program management emphasized the solution of hardware problems, which needed to be completed before software development could advance**.** In July 1997, TRW began to have problems with software integration and testing. TRW software engineers advised that the integration and testing process, ideally, consists of the development of flight software, then the ground software, followed by the integration of the two. But, because the AXAF schedule became compressed due to hardware slippages, the flight software, ground software, and integration were occurring simultaneously. Because of the time TRW required to resolve problems in this process, the AXAF completion was delayed.

TRW did not complete software development until October 1997, taking more than the 5 months scheduled, and causing the AXAF launch to be delayed. The delay will increase the AXAF cost overrun by $28.8 million, based on a December 1998 launch date.[3]

The Marshall AXAF Program Manager told us that TRW's past performance, with regard to spacecraft development, was viewed as routine when compared to developing the AXAF. Therefore, Marshall considered software development (as a part of spacecraft development) to be a low-risk area. Consequently, when TRW identified spacecraft development problems in integration and testing, Marshall relied on the contractor's past performance and did not ensure the problems were given adequate attention. Additionally, AXAF program management had not assigned personnel with software expertise to the TRW site. The AXAF resident office at TRW had five personnel, who reviewed hardware-driven activities and did not have the backgrounds necessary to fully recognize the magnitude of software-related problems. When TRW recognized Automated Test Sequence[4] development to be a significant problem, there was not sufficient time in the schedule to fix the problem and meet the launch date. Most of the planned contingency time had been used earlier in the program to solve hardware (including telescope and science instrument) problems.

[3] After completion of our fieldwork, NASA revised the AXAF launch date several times because of hardware problems and a launch conflict with the International Space Station. The current launch date is July 1999. The Fiscal Year 2000 Budget Submission showed about $49 million in cost increases based on a May 1999 launch date.
[4] A set of commands, sent to a vehicle or spacecraft, which the vehicle sends to hardware or hardware elements, to ensure that the hardware operates properly.

Software Development Identified as High Risk

We reviewed the Marshall AXAF Program Office-issued Program Management Reports (PMRs) to the NASA Office of Space Science, from June 1996 through February 1998. These reports included information on program accomplishment, risks to the programs, and estimated costs. AXAF Program personnel prepare portions of these reports, and the AXAF Program Manager reviews the reports before they are forwarded to NASA Headquarters. The reports identified software development as a high risk beginning in December 1996, 11 months before the November 1997 contractor announcement of late delivery. Although the PMRs identified software development as a high-risk issue, the Marshall AXAF Program management did not include or amend software development into the AXAF Risk Assessment.

Independent Annual Reviews

The NASA Office of the Chief Financial Officer conducts Independent Annual Reviews (IARs), to evaluate NASA programs, using personnel from outside the reviewed program. The IAR members may be, but are not required to be, the same personnel from year to year, and they need not be all NASA employees. Generally, the IAR members review technical and cost and schedule issues. The Chief Financial Officer directed IARs on the AXAF program, and the IAR team wrote reports on its findings. The 1994 IAR report stated that the "integration and testing schedule appears very short for a flight system of this complexity . . . and recommended the integration and testing schedule be evaluated for realism." The optimistic integration and testing schedule issue remained "open" until the 1997 IAR "closed" the issue.

Factors Affecting Launch Delay

Although the contractor addressed the integration and testing problems, it did not react quickly enough to eliminate the need for the launch delay. For example, in December 1997, TRW revised its AXAF organizational structure by (1) separating the integration and testing function from the spacecraft department to ensure adequate TRW AXAF project management attention and (2) selecting a person with expertise in integration and testing to emphasize these functions. In addition, at that time, the TRW AXAF project manager scheduled meetings with key personnel twice daily on status and planning. If TRW had contacted NASA management as early as July 1997, the delay may have been averted as discussed above.

As of August 1996, lower-level contractor employees were aware of the inadequate Automated Test Sequence schedule and informed their supervisors about the schedule. However, the TRW lower-level supervisors did not communicate the information to their superiors, or to NASA management**,** until mid-November 1997. One contractor employee advised us that as early as

February 1997 TRW showed a 5-day workweek schedule, although TRW was working weekends. TRW issued monthly Program Management Reports[5] to its TRW project manager. These reports identified integration and testing problems during July through September 1997. Therefore, we concluded that early indicators were evident, but TRW upper management was not cognizant of the indicators.

We conferred with 11 NASA AXAF Program personnel at Marshall and 3 NASA AXAF personnel located at TRW to determine when they became aware of the software development problems. AXAF personnel told us that the contractor told them of the delivery delay in mid-November 1997. In December 1997, NASA instituted detailed metrics to control software and Automated Test Sequence development on the contractor, which helped contractor management more closely track its progress and delays.

Other problems[6] occurred impeding AXAF progress. Because the contractor was addressing these problems, it did not give full attention to flight software and Automatic Test Sequence development.

Revised Recommendation. In response to management's suggested addition for Recommendation 2 relating to the designation of "significant management risk," we revised the recommendation accordingly.

Recommendations, Management's Response, and Evaluation of Response

The NASA Chief Engineer should:

1. **Update NPG 7120.5A to require that Risk Management Plans be amended as high-risk issues are identified.**

2. **Require program managers to place sufficient emphasis on future software-driven programs, starting with initial design. If this area is designated as a significant management risk, the program manager should consider having personnel with needed software experience on-site at contractor locations.**

Management's Response. The NASA Chief Engineer forwarded the recommendations to the Program/Project Management Working Group to deliberate and revise NPG 7120.5A. The Group will reconvene in late April 1999 and plans to finalize the NPG modification by late summer 1999. If software is identified as a significant management risk, and as part of the risk

[5] Examples of selected portions of TRW Program Management Reports are in Appendix C.

[6] Other problems experienced by AXAF included the following:

- Redacted pursuant to Exemption 4 of the Freedom of Information Act, 5 USC 552(b)(4).
- All hardware should be completed, according to the Marshall AXAF Chief Engineer, prior to flight software development. However, the contractor was developing flight software without all hardware components.

management plan developed under NPG 7120.5A, management may consider on-site software expertise at the contractor's location. The complete text of the comments is in Appendix E.

Evaluation of Response. The actions planned are responsive to the recommendations.
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Appendix A. Objectives, Scope, and Methodology

Objectives

The overall objective was to evaluate whether NASA is properly managing the AXAF contract. Specifically, we determined whether:

- NASA oversight is sufficient to ensure that impact to the schedule, cost, and quality control are minimized because of the late delivery.

- Contractor performance is adequately monitored and evaluated and award fees reflect actual performance.

Scope and Methodology

We performed audit fieldwork from March 1998 through January 1999. We interviewed NASA Headquarters, Marshall, Johnson Space Center, and prime contractor personnel. The audit was performed in accordance with generally accepted government auditing standards.

We reviewed:

- NASA Headquarters annual IARs dated from 1994 through 1997 for the AXAF Program

- Marshall-issued AXAF Monthly Program Management Reports dated June 1996 through February 1998

- Marshall-awarded fees to the prime contractor for Evaluation Periods Number 14 and Number 15, dated October 1996 through September 1997

- Space Shuttle launch schedules for FY 1998 through FY 2000

- Statement of Work of NASA's contract with TRW, originally issued January 20, 1989, and modifications through February 1998 for the design, development, pre-launch verification, launch, and orbital verification of the AXAF

- Prime contractor records tracking COQs and Problem Reports for January 1997 through August 1998

- Prime contractor monthly Program Management Reports, issued to the prime contractor's program manager, for July through September 1997

- A prior General Accounting Office report on the AXAF dated February 1992

Appendix A

Management Controls Reviewed

The relevant management controls for this program are:

- NHB 7120.5, "Management of Major System Programs and Projects," dated November 3, 1993, and its successor
- NASA Procedures and Guidelines 7120.5A, "Management of Major System Programs and Projects," dated April 3, 1998
- Requirements in the Statement of Work of NASA Contract NAS8-37710 with TRW, effective January 20, 1989

Overall, NASA management was complying within the management controls as written. However, as discussed in the finding, NPG 7120.5A does not address management actions needed when management identifies high program risks after management issues a Program Commitment Agreement.

Prior Audit Coverage

In February 1992, the General Accounting Office issued audit report GAO/NSIAD-92-77, **"**SPACE PROJECTS Status and Remaining Challenges of the Advanced X-ray Astrophysics Facility." The report's principal points included:

- Unanticipated NASA effort and budget constraints cause cost and schedule increases to the AXAF program
- Schedule risks increased
- Further cost increases were possible
- Mirrors passed feasibility demonstration test
- Difficult challenges remain

The report made no recommendations and did not discuss software integration and testing.

Appendix B. Contract Statement of Work Requirements

Planning for Verification Testing

Listed below are selected requirements related to, or that impact, integration and test activities:

Work Breakdown Structure 2.1, Project Management, requires that "the contractor shall integrate management disciplines, functions, and systems into an overall management activity to achieve cost-effective planning, organizing, staffing, budgeting, directing, controlling, and reporting of technical and programmatic achievement, schedules, resources, and time relationships to attain project objectives."

Work Breakdown Structure 2.1.1, Planning and Control, states that "the contractor shall plan, execute, administer, and report the contracted efforts utilizing management systems which efficiently control technical performance, cost, and schedule."

Work Breakdown Structure 2.3.5.2, Flight Software, states that "this element shall include all effort for the observatory onboard computer software," and "analyze requirements, design, develop code, integrate, verify, validate, and document the flight software." The contractor can ensure that various aspects of integration and test activities can be completed on time and within schedule so as not to negatively impact completion of the entire contract.

Work Breakdown Structure 2.3.4.2, AXAF Verification, states that "the contractor shall provide all the requirements necessary to demonstrate that the AXAF will perform to the requirements of the Verification Requirements and Specifications Document (VRSD). As a minimum, verification shall . . . perform verification planning."

Section 5.2.3, Acceptance Verification, states that "acceptance verification shall be conducted to verify that flight hardware and software performs in accordance with design/manufacturing documentation."

Section 5.2.4 Qualification/Acceptance Verification, states that "Qualification/acceptance verification of the AXAF integrated system shall be performed to verify that the flight hardware, flight software, and support equipment meet the design and performance requirements under anticipated operational regimes and environments."

Section 5.2.12, Software Verification and Validation, states that "software verification and validation shall be performed by the Software Development Facility (SDF). Procedures shall be generated and implemented to exercise the flight software, to the extent necessary to satisfy all AXAF system hardware/software requirements."

Appendix C. Examples of Selected Portions of TRW Program Management Reports

Examples of selected portions of TRW Program Management reports:

Variance Explanation in the Avionics and Software section for July 1997 states, "Software - Code and Debug - Unit and Computer Software Configuration Item (CSCI) testing taking much longer than originally anticipated."

Variance Explanations in the Assembly and Verification section for July 1997 state, A&V crew - Volume II integration, Inertial Reaction Unit/Reaction Wheel Assembly (IRU/RWA) polarity test, RWA installation, software debug, and spacecraft functional test have slipped due to ATS [Automatic Test Sequence] development and software interface problems."

For Assembly and Verification - August and September 1997 - the Variance Explanation for the Assembly and Verification Crew states, "(a) More support than planned to Volume II integration due to ATS development and software interface problems and (b) more support than planned to software debug due to ATS development and software interface problems."

Appendix D. Other Matters of Interest

Certificates of Qualification and Problem Reports Need Processing

The prime contractor was not processing COQs and problem reports in an efficient manner to ensure completion prior to shipping the AXAF. The prime contractor had completed only about 44 percent (30 of 67) of the known COQs and 48 percent (135 of 279) of the known problem reports as of February 1998. This condition occurred because NASA and contractor program personnel were emphasizing the resolution of AXAF hardware and software problems and were placing a much lower priority on the backlog of COQs and problem reports. The AXAF launch could be further delayed if these reports are not processed before the AXAF is shipped to the Kennedy Space Center.

Although no NASA or Federal regulation exists regarding COQs, the AXAF program office described its system for processing COQs.

> The COQ process requires that the contractor provide COQs, for selected hardware and/or subsystems, upon successful completion of qualifications testing. Upon completion of the qualification testing, a Configuration Inspection (CI) is conducted on the hardware item. The Marshall engineer responsible for the specific piece of hardware participates in the CI. Results from the analysis of the qualification test data are presented and all discrepancies are dispositioned. Action items are assigned to resolve issues resulting from the CI. Upon completion of all action items, the COQ is generated and submitted to Marshall. At Marshall, an official file is created. Errors are corrected by and missing data obtained from the contractor. The Marshall responsible engineer signs the COQ indicating acceptance. In the event that the hardware experiences a failure during the acceptance of functional testing after the COQ has been approved, the COQ is reopened if the failure requires a redesign or other significant activity which would dictate additional qualification testing.

Similarly, the AXAF program office described its system for processing problem reports.

> The contractor is also required to report nonconformances which occur during hardware qualification and/or acceptance testing. Reportable nonconformances are defined as all problems of criticality categories 1, 2, and 3. The initial report is required within 24 hours of the occurrence. Upon receipt of the report, the nonconformance is entered into the problem reporting system and the AXAF project manager and the Marshall Systems & Engineering Directorate are notified. The Marshall responsible engineer begins to track the nonconformance resolution. A fully documented report from the contractor is due within 5 days of the occurrence, and a resolution report is due within 21 days of the occurrence or upon completion. When the resolution report is received, the data is entered into the problem reporting system. If the criticality assessment is 3, the Marshall Resident Office at the contractor is assigned the action. If the criticality assessment is 1 or 2, the action is assigned to the AXAF Chief Engineer's Office. The Chief Engineer forwards the failure resolution report to the appropriate responsible engineer for action and approval within 3 weeks. After errors are corrected and any missing data obtained,

the responsible engineer forwards his approval to the AXAF Chief Engineer. The Chief Engineer then approves the failure resolution report and forwards it to the Marshall Safety and Mission Assurance Office for concurrence, and then to the Project Manager for final disposition.

NASA Management Actions

In late February 1998, when we expressed concern about the backlog of COQs and problem reports, the NASA Program Office called TRW to place emphasis on the backlog. As of February 1998, NASA needed to verify 37 open COQs. By August 1998, 27 remained open. This progress was made while the AXAF program office increased the required 67 COQs to 83 and the contractor-submitted COQs increased from 53 to 79. During the same period, problem report processing improved. Marshall approved 48 percent (135 of 279) in February 1998 and approved 90 percent (299 of 334) as of the beginning of August 1998. We concluded that NASA and the prime contractor are making progress in eliminating the backlog. Therefore, we are making no recommendation at this time

Appendix E. Management Response

National Aeronautics and
Space Administration
Office of the Administrator
Washington, DC 20546-0001

MAR 19 1999

TO: W/Assistant Inspector General for Auditing
Attn: Russell A. Rau

FROM: AE/Chief Engineer

SUBJECT: Draft Report on the Audit of Advanced X-ray Astrophysics Facility (AXAF)
Assignment Number A-HA-98-025
Dated: February 16, 1999

We are in receipt of the subject draft report and offer the following response to your recommendations:

Recommendations (Page ii):

We recommend that management revise the NASA policy to require program managers to update Risk Management Plans as high-risk issues arise, and that NASA assign personnel with software expertise to be on site at the contractor's location.

Recommendations for Corrective Action: (Page 5)

The NASA Chief Engineer should:

1. Update NPG 7120.5A, "NASA Procedures and Guidelines," to require that Risk Management Plans be amended as high-risk issues are identified.

2. Require program managers to place sufficient emphasis on future software-driven flight programs, starting with the initial design, to include ensuring personnel with software expertise are on site at the contractors' locations.

Response:

1. We have forwarded the recommendations to revise NPG 7120.5A to the Chairperson of the Program/Project Management Working Group (PPMWG) for consideration and action. The next PPMWG meeting is scheduled for late April 1999, with the goal to complete the revision of the NPG by late summer 1999.

Appendix E

2. The recommendation to have on-site software expertise at the contractors' locations is a program/project implementation function and, as such, is the responsibility of the Center involved in implementation. As part of the risk management plan developed under NPG 7120.5A, the requirement for on-site software expertise can be considered if software is identified as a significant management risk.

/s/ Daniel R. Mulville

Daniel R. Mulville

cc:
NASA HQ/S/Dr. Huckins
SD/Mr. Huddleston
MSFC/DD01/Ms. Griner (PPMWG)
CR01/Mr. McBrayer (PPMWG)

Appendix F. Report Distribution

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Appendix F

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Congressional Member

Honorable Pete Sessions, U.S. House of Representatives, Texas

Major Contributors to this Report

Daniel J. Samoviski, Program Director for Earth/Space Science Audits

Robert L. Williams, Program Manager for Earth/Space Science Audits

Clara Lyons, Auditor

Eugene R. Bauer, Auditor

Nancy Cipolla, Report Process Manager

Iris Purcarey, Program Assistant