JP-96-001

AUDIT REPORT

CASSINI PROGRAM MANAGEMENT

JET PROPULSION LABORATORY

February 22, 1996

National Aeronautics and Space Administration

OFFICE OF INSPECTOR GENERAL

National Aeronautics and
Space Administration

Headquarters
Washington, DC 20546-0001

Reply to Attn of: W

FEB 22 1996

TO: S/Associate Administrator for Space Science

FROM: W/Assistant Inspector General for Auditing

SUBJECT: Final Report
Cassini Program Management
Assignment No. A-JP-94-003
Report No. JP-96-001

The NASA Office of Inspector General has completed an audit of Cassini Program Management. Nothing came to our attention to indicate that Cassini program management procedures and practices by NASA and JPL were not adequate for Cassini to meet its launch. date in 1997. There were, however, risk areas identified that could affect Cassini's launch. These risk areas are described in the enclosed report.

We discussed a draft of this audit report with your office and with JPL management on January 18, 1996. A written response was received from your office on January 23, 1996. Appropriate changes were made to the report as a result of your input. Additionally, management comments included in your written response showing key activities since our audit work completion were included in the Management Comments section of the report (page 9).

Robert J. Weglowski
for Debra A. Guentzel

Enclosure

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CASSINI PROGRAM MANAGEMENT

JET PROPULSION LABORATORY, CALIFORNIA

INTRODUCTION

The NASA Office of Inspector General (OIG) has completed an audit of Cassini program management. Cassini, whose objective is to explore Saturn and its moons, was first funded by Congress in Fiscal Year (FY) 1990 as part of "The Comet Rendezvous Asteroid Flyby (CRAF)/Cassini Program." In 1992, the CRAF program was canceled by Congress to reduce planetary exploration costs. NASA then restructured the Cassini program to reduce estimated development costs from $1.68 billion to about $1.46 billion. Total life cycle costs (e.g., development, launch, and operation costs) were also reduced from $3.79 billion to about $3.26 billion. The lack of required funding delayed the Cassini launch date by 18 months.

Mission. Cassini is now scheduled to launch in October 1997 aboard a Titan IV/Centaur launch vehicle. An extensive cruise period is required to reach Saturn, during which the spacecraft will fly by Venus (twice), Earth, and Jupiter to gain sufficient velocity to reach its destination. Upon arrival in July 2004, the spacecraft will begin a four-year study of the Saturnian system that will provide intensive, long-term observations of Saturn's atmosphere, rings, magnetic field, and moons. In conjunction with the observations conducted by the spacecraft, the Huygens Probe will be injected into the atmosphere of Saturn's moon Titan. The probe will conduct in-situ physical and chemical analyses of Titan's atmosphere. Further, the Cassini radar will map a significant portion of Titan's surface.

International Participation. Sixteen foreign countries and two U.S. Government agencies are participating in Cassini's development with NASA. The majority of the Cassini spacecraft and ground system is being developed at JPL. The major remaining Cassini components are being externally produced as follows: (1) the Titan IV/Centaur launch vehicle is being purchased by NASA from the Department of Defense (DOD) as part of an existing contract between the Air Force and Lockheed Martin; (2) the radioisotope heater units (RHUs) and radioisotope thermoelectric generators (RTGs) are being procured by

NASA from the Department of Energy; (3) the Huygens Probe is being provided by the European Space Agency (ESA); and (4) the high gain and one of the low gain antennas for the spacecraft are being contributed by the Italian Space Agency (ASI).

Outside Reviews. Since the restructuring of the Cassini program, there have been many outside reviews to provide assurance that the program is making progress in terms of cost, schedule, and technical performance. See Appendix A for additional information on these reviews.

Jet Propulsion Laboratory. The Jet Propulsion Laboratory (JPL) is a Federally Funded Research and Development Center (FFRDC) operated by Caltech under NASA contract NAS7-1260. The laboratory, staffed largely with Caltech employees, is a government-owned installation located in Pasadena, California.

Responsibilities. NASA has assigned JPL the overall program management responsibility for the Cassini program design and development. NASA's Cassini program oversight is provided by the Cassini Program Director and his staff, which are part of NASA Headquarters' Office of Space Science (Code S). This office ensures that the Cassini program is meeting NASA's program objectives.

OBJECTIVES, SCOPE, AND METHODOLOGY

OBJECTIVE

Our objective was to evaluate the adequacy of Cassini program management procedures and practices by NASA and JPL for Cassini to meet its launch date in 1997.

SCOPE AND METHODOLOGY

To evaluate program management, we interviewed key personnel at NASA Headquarters Office of Space Science, NASA Headquarters Launch Vehicles Office, Lewis Research Center, Jet Propulsion Laboratory, and the Air Force Titan IV System Program Office (SPO) located at the Los Angeles Air Force Station. In addition, we reviewed documentation supporting management decisions, practices and procedures for the period 1990 through 1995 that support current and future activities. We reviewed Cassini cost, schedule, and performance indicators, and identified potential risks to the Cassini 1997 launch date. Further, we evaluated the measures being taken to reduce the risks. We also reviewed outside evaluations and reviews of the Cassini program to minimize our duplication of prior reviews.

MANAGEMENT CONTROLS REVIEWED

Significant management controls were reviewed to determine whether cost, schedule, and performance indicators could be relied upon. The controls reviewed included the (1) budget process, (2) engineering change requests (ECR) process, (3) receivables/deliverables (REC/DEL) process, and (4) the monthly and quarterly management review process. See Appendix B for details on those management controls reviewed. No management control weaknesses were identified as a result of the audit .

AUDIT FIELD WORK

Audit field work was conducted from October 1994 through July 1995. The audit was performed in accordance with generally accepted government auditing standards.

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OBSERVATIONS AND COMMENTS

OVERALL EVALUATION

Nothing came to our attention to indicate that Cassini program management procedures and practices by NASA and JPL were not adequate for Cassini to meet its launch date in 1997. There were, however, risk areas identified that could affect Cassini's launch. These risks stem largely from areas outside NASA's and JPL's direct management control, but steps are being taken toward solving or eliminating these launch risks. At the time of the audit, the most critical launch risks were related to the launch vehicle, environmental impact, launch approval, foreign deliverables, and launch period.

LAUNCH VEHICLE

NASA is dependent on the Air Force for the Cassini launch vehicle that is still being developed. The Cassini spacecraft is scheduled to use a Titan IV/Centaur launch vehicle to lift it through Earth's atmosphere and onto its flight path. The vehicle consists of two major components, the Titan IV and the Centaur (see Figure 1). The Titan IV is the first stage of the launch vehicle and is necessary to lift Cassini off the ground and to a high enough point for the Centaur to take over. The Titan IV consists of a core vehicle and external solid rocket motors. A solid rocket motor upgrade (SRMU) is planned for Cassini. The Centaur is the upper stage of the launch vehicle and is necessary to move Cassini onto the proper flight path.

Solid Rocket Motor Upgrade. Lockheed Martin is currently upgrading the solid rocket motor for the Air Force. The solid rocket motor (SRM) upgrade has not yet been used and NASA would like the Air Force to have at least one other successful launch, with another payload, before it is used to launch Cassini. There is another SRMU launch scheduled before Cassini but launch schedules are known to change. This upgrade (the SRMU) is designed to increase reliability and performance over the SRM currently in use. The Cassini program is baselined using the solid rocket motor upgrade, but Cassini was designed to be able to use either the SRMU or the SRM. According to officials at the Air Force Titan IV SPO, the SRM assembly line has been closed and the remaining SRM components have all been assigned to other launches. It is technically feasible for Cassini to use the SRM, but it would require exchanging SRMU components with another program for its SRM components at a cost that could be $100 million. A decision to make a change to use the SRM would be required about 16 months (June 1996) before launch. Cassini program management officials at JPL

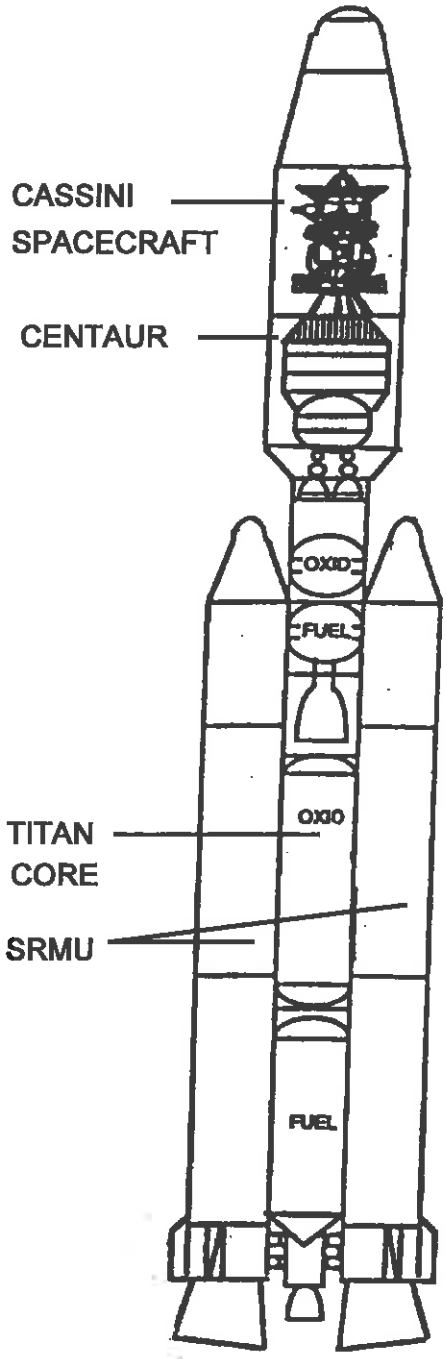

Figure 1 - Titan IV/Centaur Launch Vehicle with Spacecraft

are currently developing a decision package to support a commitment to one of the rocket motors.

Centaur. The assigned Cassini Centaur tank has questionable welds in a critical part of the assembly. The Air Force and its contractor feel that the Centaur tank is satisfactory and have not wanted to switch tanks for Cassini. To assure NASA of the tank's flight worthiness, the Air Force has agreed to conduct additional testing on the tank but cannot have the testing completed quickly enough to keep Cassini's schedule. During May and June 1995, NASA managers formalized their requests to the Air Force that Cassini be assigned a different Centaur tank. The Air Force informed NASA they will switch the Centaur tanks, but NASA would be required to pay the Air Force $8.6 million--the cost of a replacement tank. The Air Force does not believe it could assign the rejected tank to another customer; therefore, NASA should be responsible to pay for the replacement. NASA is currently negotiating the replacement tank costs with the Air Force.

ENVIRONMENTAL IMPACT

Concerns about impacts to the environment could cause environmental groups to attempt to stop the launch through the courts. Impacts to the environment are determined through a public process under the National Environmental Protection Act. This process includes preparing a draft environmental impact statement (EIS), objectively assessing potential environmental impacts, collecting and responding to comments from the public, and publishing a final EIS. The last step in this process is a record of decision to document the decision to complete the mission. In Cassini's case, the public's comments have been evaluated and responded to and the final EIS will be published in the near future. Legal challenges, if any, could come at any time but are most likely after the publication of the final EIS.

LAUNCH APPROVAL

Safety concerns could cause an outside safety panel to recommend launch disapproval. Launch approval is a critical decision for all launches and is based on how safe the launch and mission are anticipated to be. In the case of a spacecraft like Cassini which has nuclear materials on board, these safety concerns and review requirements are greater. An independent safety review, still to be completed, is being conducted by an Interagency Nuclear Safety Review Panel (INSRP). The launch approval decision, made by the President or his delegatee, will not likely be made until a few

months before launch since the launch request is not scheduled until April 1997. Presently, safety data is still being provided to the INSRP.

FOREIGN DELIVERABLES

The two main foreign deliverables, which have been concerns of NASA and JPL management, are the Huygens Probe, provided by the European Space Agency, and the high gain antenna system, provided by the Italian Space Agency (ASI) (see Figure 2). The probe has not experienced any significant problems but requires close management attention because of its overall importance to the Cassini mission. The probe's mission is to conduct in-situ studies of Titan's atmosphere and surface. These studies cannot be duplicated by instruments on the orbiter.

Several difficulties, however, have occurred with the high gain antenna system. For example, in January 1995 the dynamic test model suffered a structural failure during vibration testing in Italy. Also, paint adhesion problems have occurred with the antenna's main reflector. These two problems have been worked out sufficiently so that the dynamic test model has been shipped to JPL for further testing. An additional concern with the antenna has been the lack of signed contracts between ASI and its contractors. Without signed contracts there is no assurance that the antenna will be completed on time. Recently, the ASI Board of Governors approved the contract language and was due to meet on the financing plan. NASA and JPL management anticipate that the contracts will be signed soon.

LAUNCH PERIOD

Cassini has a critical launch period of nearly six weeks during October and November 1997 due to the fact that Cassini requires a specific alignment of planets in order to use gravity assists. According to the Cassini program office, if the primary launch period is missed, NASA would incur an additional $188 million in costs if Cassini is launched during December 1997, and $444 million in costs if launched during March 1999. Additionally, large amounts of science would be lost if either of these two alternative launch periods are used. Consequently, it is essential that the planned program remain intact to meet the critical launch period dates.

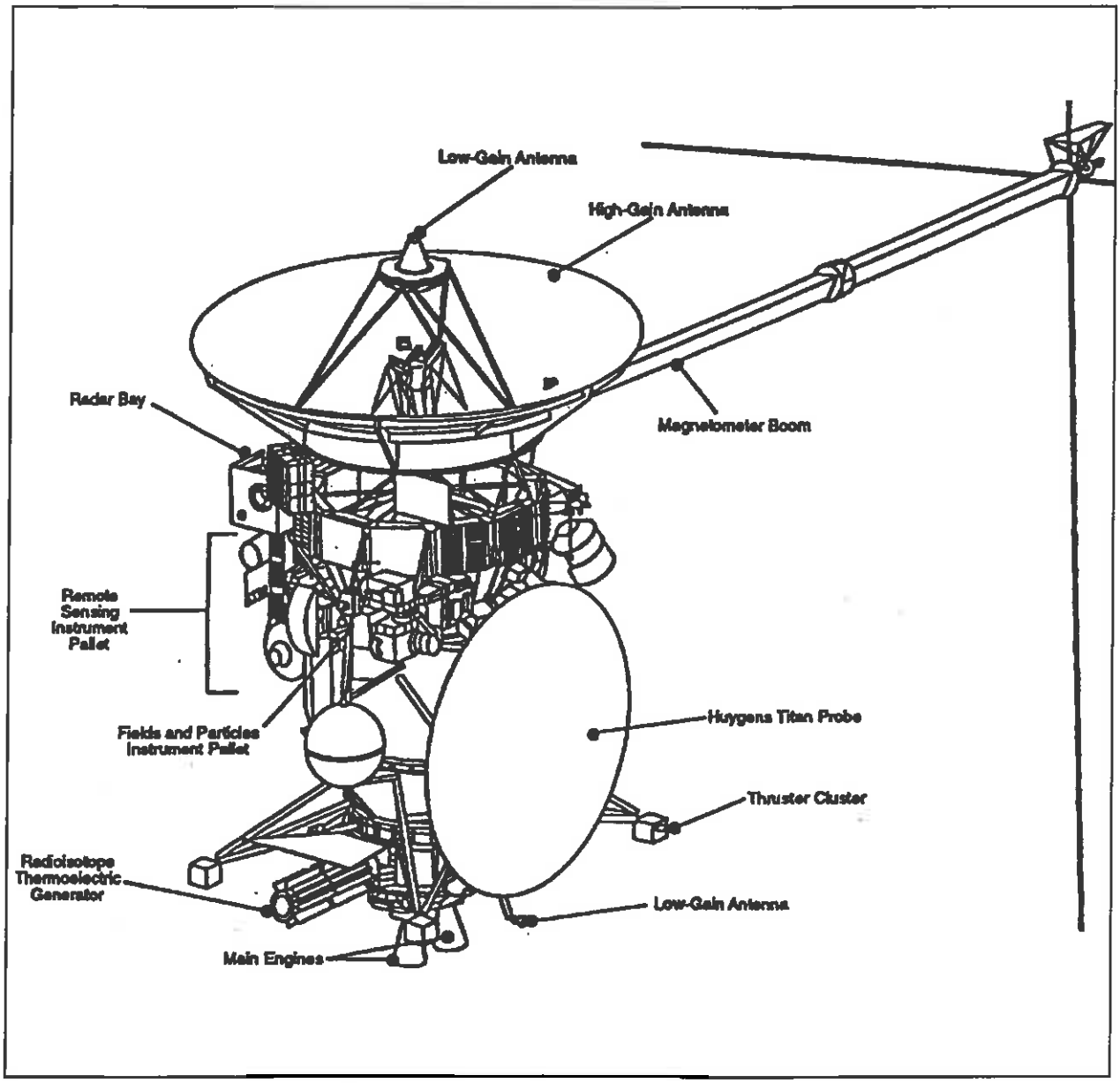

Figure 2 - Cassini Spacecraft

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AUDIT COMMENT

NASA Headquarters Office of Space Science should continue to aggressively manage all potential areas of concern and continue to negotiate the additional Centaur costs with the Air Force. Continued effort to manage those concerns should help to minimize the risks to Cassini's launch.

MANAGEMENT COMMENTS

Management concurred with the overall conclusions of the audit. However, they did offer the following comments to update the status of several risk areas identified in this report. These comments generally are based upon events that occurred after we had completed our audit work.

Comment 1. Adds to the first paragraph of the Introduction, page 1. "The mission operations cost was further reduced by creating a new architecture of the missions operation organization and different risk approaches, and later changes which reduced the cost to $755M during the Recertification Review No. 3 in June 1994. These changes reduced the total life cycle costs to $2.68 billion."

Comment 2. Refer to Launch Vehicle, Solid Rocket Motor Upgrade, page 4. "After the July 1995 completion of this audit, NASA and JPL agreed to use the Solid Rocket Motor Upgrade (SRMU). Additionally, NASA and JPL with Air Force cooperation are closely monitoring the first Titan IV SRMU launch vehicle's progress and taking management action as appropriate."

Comment 3. Refer to Launch Vehicle, Centaur, page 6. "After the July 1995 completion of this audit, the Air Force agreed to swap Centaur tanks for a cost to NASA of approximately $900K to cover engineering and administrative costs associated with this change."

Comment 4. Refer to Environmental Impact, page 6. "After the July 1995 completion of this audit, the Final EIS was distributed to the public on July 20, 1995 and the Record of Decision was published on October 20, 1995."

Comment 5. Refer to Foreign Deliverables, page 7. " After the July 1995 completion of this audit, the Italian phase C/D contracts were signed by all parties near the end of September 1995."

EVALUATION OF MANAGEMENT COMMENTS

Management Comments are responsive to issues discussed in this report.

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MAJOR CONTRIBUTORS TO THIS REPORT

JET PROPULSION LABORATORY	Roger W. Flann, Audit Manager Robert L. Williams, Auditor-in-Charge Jimmy A. Walker, Auditor

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Summary of Independent Reviews

Since the restructuring of the Cassini program in 1992, there have been many independent reviews to provide assurance that the program is making adequate progress in terms of cost, schedule, and technical performance. We evaluated these reviews to minimize duplication. The reviews include the following:

- GAO Report, "Space Science: Causes and Impacts of Cutbacks to NASA's Outer Solar System Exploration Missions," December 1993.
- GAO Report, "NASA Budgets: Gap Between Funding Requirements and Projected Budgets Has Been Reopened," May 1995.
- GAO Report, "Cassini Mission: Estimated Launch Costs for NASA's Mission to Saturn," May 1995.
- Cassini Independent Review Board Recertification Task Review Report, Task #1, Mission Robustness, September 1994.
- Cassini Independent Review Board Recertification Task Review Report, Task #2, Cassini-Huygens Reliability, January 1995.
- Cassini Independent Review Board Recertification Task Review Report, Task #3, Mission Operations and Data Analysis Costs, January 1995.
- Independent Annual Review Panel Report, October 1994.
- Independent Annual Review Panel Report, June 1995.

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Discussion of Management Controls Reviewed

The following provides a detailed discussion of the management controls reviewed during our audit. We reviewed these management controls to determine whether cost, schedule, and performance indicators could be relied upon. No management control weaknesses were identified as a result of our audit. See the Management Controls Reviewed section of the audit report.

BUDGET

The budget process provides a method for JPL to request funding on a quarterly basis. The funds requests are initiated by the Cassini Resource Manager. Funding is provided in accordance with the funding guidelines as approved in the Program Operating Plan (POP). We traced a judgmental sample of three types of transactions to determine that accounting is consistent with other NASA programs being managed by JPL. We also verified that funds reporting is performed through the JPL institutional accounting processes, independent of the Cassini program.

ENGINEERING CHANGE REQUESTS

The engineering change requests (ECRs) approval process is a Cassini management control to ensure all engineering changes are proper, necessary, and that proper funding is available. We reviewed a sample of ECRs at JPL to determine their adequacy.

RECEIVABLES/ DELIVERABLES

For scheduling, the REC/DEL system is the major management control. It is used to track milestones for any activity where two parties are involved. We reviewed JPL's controls built into the system to assess their adequacy and independently tried to bypass the access controls.

MONTHLY/ QUARTERLY REVIEW

Monthly and quarterly reviews are conducted at all levels of management through the NASA Deputy Associate Administrator for Space Science to monitor progress of the Cassini project with respect to cost, schedule, and performance. Problems are discussed and resolved as a result of the monthly management review meetings. Follow-up on the resolution of problem areas is also discussed in subsequent monthly management reviews until a solution is complete. Further, every six months a project status report is prepared for Congress. We selectively reviewed information contained in the monthly management reviews and compared to other sources of information to judge its reliability and completeness.

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National Aeronautics and
Space Administration
Headquarters
Washington, DC 20546-0001

JAN 29 1996

Reply to Attn of: S

TO: W/Acting Deputy Assistant Inspector General for Auditing

FROM: S/Associate Administrator for Space Science

SUBJECT: Draft Report on Cassini Program Management (Assignment No. A-JP-94-003)

In response to your request, we have completed our review of the draft report. Review comments were jointly discussed between Dr. Earle Huckins (Cassini Program Director), Mr. Richard Spehalski (Cassini Program Manager), and Mr. Ronald Draper (Deputy Cassini Program Manager). The comments were relatively minor, and have no real impact on the overall conclusions of the audit. A consolidation of these comments has been transmitted to Mr. Roger Flann, the Audit Manager in the NASA Office of Inspector General at JPL and is enclosed. I do not feel that an exit conference will be required.

for

Wesley T. Huntress, Jr.

Enclosure

cc:
S/Dr. Huckins
JPL/264-441/Mr. Spehalski
Mr. Draper

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