IG-00-005

AUDIT REPORT

X-38/CREW RETURN VEHICLE PROJECT MANAGEMENT

February 9, 2000

National Aeronautics and Space Administration

OFFICE OF INSPECTOR GENERAL

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Acronyms

CRV	Crew Return Vehicle
ISS	International Space Station
NPG	NASA Procedures and Guidelines

W February 9, 2000

TO: A/Administrator

FROM: W/Inspector General

SUBJECT: INFORMATION: Audit of X-38/Crew Return Vehicle Project Management Report Number IG-00-005

The NASA Office of Inspector General has completed an audit of the X-38/Crew Return Vehicle (CRV) Project management. We found that X-38/CRV Project management has been generally effective, but the Project's strategy entails significant risk in return for a potentially high payoff. The X-38/CRV Project is responding to a challenge by the NASA Administrator to demonstrate that human-rated spacecraft can be developed faster and for a fraction of the cost of previous projects. The X-38/CRV Project is relying on a high degree of concurrency among design, development, test and engineering/evaluation activities and a highly optimistic schedule for accomplishing development and production of the CRV. The Project's reliance on a high degree of concurrency among design, development, test, and engineering/evaluation activities warrants a greater emphasis on risk and performance management than is required by NASA Procedures and Guidelines (NPG) 7120.5A and warrants the use of performance metrics and criteria for key Project phases.

Background

The United States is committed to providing a crew return capability for the International Space Station (ISS) in the event of crew injury/illness, ISS failure, or Space Shuttle unavailability. The X-38/CRV is NASA's project to meet this commitment. The Johnson Space Center is the lead for the X-38/CRV. The purpose of this project is to develop an operational CRV for the ISS for a fraction of the cost of previous human spacecraft projects. This goal is to be achieved through a series of low-cost, rapid prototype vehicles that are designated X-38. NASA is designing, building, and conducting the initial flight tests of the X-38 and will use a contractor to build the CRV. As of January 2000, the Project's budget was $124.3 million for the X-38 segment and $952 million for the CRV segment.

Recommendation

We recommended that NASA management develop and document entry/exit criteria for progressing through the major Project phases, as required by NPG 7120.5A and as warranted by the high risk and importance of the X-38/CRV Project.

Management Response and OIG Evaluation

Management concurred with the finding and recommendation. The X-38/CRV Project has developed criteria for progressing through major Project phases. These criteria will be approved in February 2000 at the ISS Integration Control Board and documented in April 2000 in the X-38/CRV Project Plan Update.

The actions taken and planned by management are responsive to the recommendation. Developing, approving, and documenting the entry/exit criteria for progressing through the major Project phases help assure that technical, schedule, and cost goals will be met.

[Original signed by]

Roberta L. Gross

Enclosure
Final Report on Audit of X-38/Crew Return Vehicle Project Management

FINAL REPORT
AUDIT OF X-38/CREW RETURN VEHICLE PROJECT MANAGEMENT

W February 9, 2000

TO: M/Associate Administrator for Space Flight
AA/Director, Lyndon B. Johnson Space Center

FROM: W/Assistant Inspector General for Auditing

SUBJECT: Final Report on the Audit of X-38/Crew Return Vehicle Project Management
Assignment Number A9900201
Report Number IG-00-005

The subject final report is provided for your information and use. Please refer to the Results in Brief for the overall results. Our evaluation of your response is incorporated into the body of the report. Your comments on a draft of this report were responsive to the recommendation. The recommendation will remain open for reporting purposes until corrective action is completed. Please notify us when action has been completed on the recommendation.

If you have questions concerning the report, please contact Mr. Dennis E. Coldren, Program Director, Human Exploration and Development of Space Audits, at (281) 483-4773, or Mr. Len Diamond, Audit Program Manager, at (321) 867-4531. We appreciate the courtesies extended to the audit staff. The final report distribution is in Appendix E.

[Original signed by]

Russell A. Rau

Enclosure

cc:
B/Chief Financial Officer
B/Comptroller
BF/Director, Financial Management Division
G/General Counsel
JM/Director, Management Assessment Division

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NASA Office of Inspector General

IG-00-005
A9900201 **February 9, 2000**

X-38/Crew Return Vehicle Project Management

Introduction

The NASA Office of Inspector General performed this audit during an early part of the X-38/Crew Return Vehicle (CRV) Project (the Project), specifically, during the X-38[1] phase and before the CRV phase. Critical parts of each phase of the Project are being accomplished concurrently. Johnson Space Center (Johnson) is the lead center for the Project. As of January 2000, the Project's budget was $124.3 million for the X-38 segment and $952 million for the CRV segment.[2]

Our overall objective was to evaluate the effectiveness of Project management (see Appendix A). We have issued a report on the need for planning an operational test of the CRV.[3]

Results in Brief

X-38/CRV Project management has been generally effective, but the Project's rapid prototyping strategy entails significant risk in return for a potentially high payoff as compared to the traditional approach of sequential design, development, test, and engineering/evaluation. To reduce risk and increase assurance of meeting the crew return capability commitment, Johnson should develop criteria by which to measure readiness to progress through major Project phases. The criteria should include performance metrics and alternative actions or strategies. Absent such criteria, the Project risks not achieving the maturity necessary to move to subsequent Project phases. Management concurred with the recommendation. The X-38/CRV Project Office developed entry/exit criteria for progressing through the major Project phases. The ISS Program Manager will approve the criteria at the Space Station Integration Control Board and document it in the X-38/CRV Project Plan Update.

Our overall audit results related to specific subobjectives are summarized in Appendix B.

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[1]The X-38 is NASA's in-house activity to develop an experimental CRV using a lifting body spacecraft.

[2]The X-38 is funded by the Space Flight Advanced Projects appropriation ($92.3 million) and the International Space Station (ISS) appropriation ($32 million). The CRV is funded by the Space Flight Advanced Projects appropriation ($6 million) and the ISS appropriation ($946 million). This budget represents an increase of $26 million for the X-38 and a decrease of $189 million for the CRV compared to the August 1999 budget referenced in our draft audit report. This budget also represents a reduction of $94 million from the Project's fiscal year 2000 budget request of $148 million, additional X-38 work to be performed, and spending limitations by the Office of Management and Budget. On December 23, 1999, NASA reported to the Committee on Science that the spending limitations may result in delays to CRV Phase 1 contract awards and delivery of the CRV to the ISS and that additional steps may be taken to alleviate the delays.

[3]Report Number IG-99-036, "X-38/Crew Return Vehicle-Operational Testing," September 20, 1999.

Background

The United States is committed to providing a crew return capability as part of the international memorandum of understanding for the International Space Station (ISS). The crew return capability is to be used in the event of crew injury/illness, ISS failure, or Space Shuttle unavailability. The X-38/CRV is NASA's project to meet the commitment using a lifting body concept. The concept includes a reusable deorbit module for atmospheric entry to 23,000 feet and a parafoil for the final descent and landing of up to seven crew members. NASA is designing, building, and conducting the initial flight tests of the X-38 and will use a contractor to build the CRV. Two significant vehicle changes have taken place. Specifically, the vehicle capacity has been increased to accommodate seven rather than four crew members, and the vehicle height has been reduced to allow for possible modification to a crew transfer vehicle[4] or an orbital transfer vehicle.[5]

Johnson's X-38/CRV lead Center responsibility is supported by NASA's Ames Research Center, Dryden Flight Research Center, Glenn Research Center, Goddard Space Flight Center, Kennedy Space Center, Langley Research Center, and Marshall Space Flight Center for testing, launch, components, analysis, and consultation. The Department of the Army, Department of the Air Force, Department of Energy, European Space Agency, and German National Space Agency are providing test support, simulation access, consulting, components, software, and structural parts. The X-38/CRV funding covers the acquisition of four X-38 vehicles, four CRV's, two berthing/docking modules, and one set of spare parts; the funding does not include the costs of Space Shuttle launches or logistics.

Project Management and Risk

Finding. The X-38/CRV Project strategy, known as "rapid prototyping,"[6] responds to a challenge by the NASA Administrator to demonstrate that human-rated spacecraft can be developed faster and for a fraction of the cost of previous projects.[7] As a result, the X-38/CRV Project is relying on a high degree of concurrency among design, development, test, and engineering/evaluation activities and a highly optimistic schedule to accomplish development and production of the CRV. While this Project approach offers potential high payoff, the approach negatively affects the ability to accurately adhere to project cost and schedule. Therefore, Johnson needs to focus additional attention on risk and performance management including the use of performance metrics and criteria needed for key Project decision points.[8] The Project's high concurrency warrants more risk management than current NASA policy requires.

[4]A crew transfer vehicle would transfer a replacement crew member(s) from Earth to a vehicle in space and/or return a retiring crew member(s) from a vehicle in space to Earth.

[5]An orbital transfer vehicle would transfer a crew member(s) from one vehicle in space to another vehicle in space.

[6]Rapid prototyping allows project maturation through fault detection and analysis during system development rather than after system development.

[7]The Administrator termed this approach "faster, better, cheaper."

[8]The documented support needed to exit from and enter each Project phase.

Faster, Better, Cheaper Projects' Failure Rates. In August 1999, the Aerospace Corporation[9] issued a technical paper that analyzed the faster, better, cheaper approach compared to the traditional project approach in the area of small satellites. The technical paper stated that the faster, better, cheaper projects were more effective in terms of time, total cost, flight rate, and cost-effectiveness as compared to the traditional projects. However, the faster, better, cheaper projects had higher full and partial failure rates of 28 percent and 44 percent, respectively, in comparison to full and partial failure rates of 10 percent and 30 percent, respectively, for traditional projects.[10]

Assessment Office Review of the X-38/CRV. NASA's Independent Program Assessment Office (the Assessment Office)[11] determined that the X-38/CRV Project rapid prototyping approach offers great promise to save up to $1 billion[12] over the traditional approach. The Assessment Office identified five rapid prototype projects[13] it characterized as failures and attributed the failures to a lack of project maturity. The Assessment Office review of the X-38/CRV Project identified 102 risk items of which 51 were characterized as high-risk items. The Assessment Office characterized the Project schedule as high risk but achievable and concluded that the high-risk items raise concern that achieving the maturity needed to enter production would not be achieved within the Project schedule. The Project Office is addressing the risk items. On March 15, 1999, the Assessment Office recommended the commercial practice of establishing a maturity gate[14] prior to Phase 1 – contract awards. The Associate Administrator for Space Flight and the Project Manager are ensuring that the risk items are resolved or scheduled for resolution prior to Phase 1 contract awards.

Evaluation Requirement. NASA Procedures and Guidelines (NPG) 7120.5A, "NASA Program and Project Management Processes and Requirements," April 3, 1998, addresses the evaluation subprocess. The evaluation subprocess supports the initial approval and continues to provide project progress assessment by the customer, experts, and stakeholders. The evaluation subprocess is an assessment of the project's ability to meet commitments and recommendations for proceeding with, modifying, or terminating the project. The evaluation subprocess is to occur throughout the life cycle of the project to ensure the successful completion of each phase.

NASA Team Assessing Need for Guidance. The NASA Administrator has established a team[15] to study the nontraditional faster, better, cheaper approaches such as rapid prototyping for programs and

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[9]The Aerospace Corporation is a private, nonprofit corporation that is exclusively scientific and provides research, development, and advisory services to the Space and Missile Systems Center of the Air Force Materiel Command and other agencies, international organizations, and governments in the national interest.

[10]NASA was not required to and did not comment on or respond to the Aerospace Corporation technical paper.

[11]At the direction of the NASA Chief Engineer, the Assessment Office at Langley Research Center performs objective, nonadvocate reviews of NASA programs and projects.

[12]The amount is based on the Assessment Office-developed cost using its estimating model.

[13]The projects were Advanced Research and Global Observation Satellite, Space Technology Experiment Program, Miniature Sensor Technology Integration, Commercial Global Phone, and Pegasus.

[14]A "gate" is a term the Assessment Office uses to indicate an action that must be completed before proceeding to the next step (for example, contract award).

[15]The team includes NASA, industry, and university representatives.

projects. The team is studying the programs and projects that worked and those that did not in order to establish guidance that the Agency can institutionalize. The guidance would include recommended action for necessary changes to NPG 7120.5A to fulfill the Administrator's concept of doing business faster, better, and cheaper. The team's report is due to NASA Headquarters mid-February 2000.

Risk Management and Performance Management. NPG 7120.5A addresses the importance of executing projects "faster, better, cheaper" and correlates the use of special techniques with the Government's streamlined, new ways of doing business. The NPG requires program and project managers to identify, analyze, prioritize, mitigate, control, and assure communication of risks to all levels of a program/project. The NPG also requires program and project managers to establish effective mechanisms for tracking and maintaining successful performance, to include performance assessment, schedule management, and process metrics. The NPG does not currently differentiate between risk and performance management applicable to traditional programs and projects as compared to "faster, better, cheaper" ones. However, the higher full and partial failure rates of "faster, better, cheaper" programs and projects warrant a greater emphasis on risk and performance management than is generally required by the NPG so as to assure program and project success.

Major Project Decision Points. The Project Manager identified the following major or key decision points in the X-38/CRV Project life cycle:

- Award to the Phase 1 contractors.
- Certification of Flight Readiness of X-38 Vehicle 201 for the space flight test.
- Award to the Phase 2 contractor.
- Certification of Flight Readiness of the CRV for delivery to the ISS.

Development of criteria to support exit from and entry to each of these phases will facilitate the evaluation subprocess relative to the decision for proceeding with, modifying, or terminating the Project.

Management Action Necessary to Strengthen Evaluation Subprocess. The major project decision points constitute exit from and entry into particular project phases and are similar to the maturity gates referred to by the Assessment Office. To mitigate the Project risks, to track and maintain successful performance, and to support the evaluation subprocess, the Project Office should develop and document the major characteristics, criteria, and strategies relative to moving through the Project phases.

Recommendation, Management's Response, and Evaluation of Response

The Director, Johnson Space Center, should develop and document the major characteristics, criteria, and strategies for progressing through major Project phases, as required by NPG 7120.5A and as warranted by the high risk and importance of the X-38/CRV Project.

Management's Response. Concur. The X-38/CRV Project Office has developed specific criteria for progressing through the Project phases. These criteria will be approved in February 2000 at the Space Station Integration Control Board and will be documented in the April 2000 X-38/CRV Project Plan Update.

Evaluation of Management's Response. The actions planned by management are responsive to the recommendation. The recommendation is resolved but will remain undispositioned and open for reporting purposes until corrective action is completed. The complete text of management's comments is in Appendix D.

Appendix A. Objectives, Scope, and Methodology

Objectives

Our overall objective was to audit management effectiveness of the X-38/CRV Project. Specifically, we evaluated project approval, project plan feasibility, project plan scheduling, project testing and flight testing, project inclusion of program requirements, project consideration of the CRV for use as a crew transfer vehicle; and technology information export controls.[16] Details on our audit results for these areas are in Appendix B.

Scope and Methodology

Our audit included visits to Johnson X-38/CRV facilities, attendance at a Flight Readiness Review, and observance of a free-flight[17] test of an X-38 at Dryden Flight Research Center. We examined project records and documentation, dated August 1998 through October 1999, to evaluate whether plans and actions were reasonable. Specifically, we:

- Reviewed NASA policies and procedures, ISS program requirements, the Federal Acquisition Regulation, and Draft Requests for Proposal.
- Interviewed Project Office and various review team personnel.[18]
- Examined the review team's reports on the X-38/CRV Project and the ISS Program.

Management Controls Reviewed

We reviewed management controls relative to the Project. Specifically, we reviewed the controls established in NPG 7120.5A relative to project approval and the evaluation subprocess. Those management controls were effective except that the control related to the evaluation subprocess requires management attention and is addressed in this report.

Audit Field Work

We performed audit field work for this report from August through October 1999. We performed the audit work in accordance with generally accepted government auditing standards.

[16] We did not evaluate project-manifesting plans because it was too early for any substantive actions to have begun.
[17] Free-flight refers to an unpowered glide of an X-38 after it is carried and dropped from a B-52 aircraft.
[18] The personnel of the NASA Advisory Council/Cost Assessment and Validation Task Force, Independent Program Assessment Office, and Aerospace Safety Advisory Panel.

Appendix B. Audit Subobjectives Results

Project Approval. NPG 7120.5A provides guidance for the structure of the project plan. The X-38/CRV Project began in 1995 and because of its high visibility, was later made subject to review by the NASA Program Management Council[19] and the requirements of NPG 7120.5A. We reviewed the X-38/CRV Project Plan, which was approved in August 1998, and concluded it fulfilled the requirements of NPG 7120.5A with two exceptions, which had been noted by the Assessment Office. During March 1999, the Assessment Office identified a need for updating the current project status to begin September 1999 and for development of a Risk Management Plan to be completed by September 1999. Therefore, we are not making additional recommendations in this area.

Project Plan Feasibility. The X-38/CRV project approach contains risk in that it deviates from the traditional design, development, test, and engineering/evaluation approach. The traditional approach is a long, sequential process with flight testing being primarily performed on the operational vehicle. The X-38/CRV Project approach responds to a NASA Administrator challenge to demonstrate that human spacecraft could be developed for less cost than previous projects. Other reasons for the approach were ISS annual funding ceilings, receipt of Office of Management and Budget CRV Project approval and funding, and the required CRV delivery date to the ISS. The Project approach uses: (1) the proven characteristics of U.S. Air Force X-23/X-24A lifting body;[20] and (2) rapid prototyping, with testing and revisions in later prototypes. Project approaches and elapsed times are contained in the draft requests for proposals. Aerospace companies have reviewed the Phases 1 and 2 draft requests for proposals and have not questioned the Project approaches or elapsed time. We concluded that the approaches and projected elapsed times are reasonable and feasible.

Project Plan Schedule. As of June 1999, CRV #1 was scheduled for delivery to the ISS in May 2004. The Project schedule was proceeding on the following milestones:

- October 1999 – Award Phase 1 contracts to two or more contractors to assess X-38 capability and CRV design requirements, participate in development of ground tests, and develop cost proposals for Phase 2.
- September 2001 – Conduct X-38 space flight test from the Space Shuttle.
- January 2002 – Award Phase 2 contract to one contractor to design, develop, fabricate, test, and certify four CRV's, berthing/docking adapters, and one set of spare parts.
- January 2004 – Deliver first CRV to Kennedy Space Center.
- May 2004 – Launch CRV #1 aboard Space Shuttle and deliver to ISS.

[19]The NASA Program Management Council is NASA's Senior Management group, chaired by the Deputy Administrator, and is responsible for reviewing and recommending approval of proposed programs and for overseeing their implementation according to Agency commitments, priorities, and policies.

[20]The U.S. Air Force developed the lifting body concept in the 1960's and 1970's during its X-23 and X-24 Programs.

As of October 22, 1999, the latest budget actions would extend the referenced milestones by 8, 5, 9, 12, and 14 months, respectively.

Project Testing and Flight Testing. Testing has included captive-carry[21] and free-flight tests of scaled-down versions of the X-38 flown under the wing of a B-52 airplane and parafoil deployment testing. Testing disclosures of high Project importance have included vibrations, delaminating,[22] laser pyrotechnic[23] ineffectiveness, and parafoil operation. Project Office reports showed that testing was producing desired results in terms of proof of concept and identification of characteristics requiring study and revision. During this audit, we reported[24] a condition identified by three review teams that pertains directly to ISS crew safety and the lack of planning or provision for an operational CRV flight test.

Project Inclusion of Program Requirements. Space Station Program CRV Requirements Document 50306 identifies 16 CRV top-level requirements. See Appendix C for details. The Project addresses all 16 requirements. Fourteen of the requirements will be validated in both the X-38 and CRV project portions. The remaining two, all-attitude separation[25] and separation within 3 minutes, will be validated only in the CRV project portion.

Project Consideration of the CRV for use as a Crew Transfer Vehicle. The Project Office is developing the X-38/CRV to strictly meet the crew return requirements as opposed to any additional function, such as crew transfer. This best serves the Program and the Project success by not increasing complexity, schedule, and cost beyond what is necessary to meet the U.S. commitment and the ISS defined requirement. The Project Office has modified the X-38 design, including a reduction of vehicle height, so that consistent with the U.S. and European Space Agency agreement, the vehicle, with modification, can be attached to and launched on an expendable launch vehicle. A crew transfer vehicle or an orbital transfer vehicle may ultimately be derived from the X-38/CRV investment and technology but not in a manner that adversely affects the Program or the Project.

Technology Information Export Controls. NASA signed Memorandums of Understanding with German Aerospace Center and the European Space Agency for the X-38/CRV Project during February and July 1999, respectively. NASA staffed the requirements in the

[21]Captive-carry refers to a test in which the X-38 test vehicle is attached to a NASA B-52 aircraft for the entire flight test.
[22]Disengaging of layers that had been affixed to each other.
[23]Actuation by laser firing.
[24]Report Number IG-99-036, "X-38/Crew Return Vehicle-Operational Testing," September 20, 1999.
[25]CRV ability to separate from the ISS irrespective of the ISS position.

memorandums with the State Department and other Federal agencies. The memorandums require that notifications must accompany the transfer of technical data that are proprietary or subject to export controls and must specify the entities authorized to receive that data. The X-38/CRV Project and aspects that involve cooperation with other Government partners lend to the potential for technology gains to foreign partners. An X-38 Project Review Board Report, May 1998, states that the partnership is reducing near-term cost of the X-38 and CRV to NASA and the U.S. taxpayer. The report further states that with this gained knowledge and after human-rating[26] of the *Ariane 5*,[27] the Europeans would have an important crew transfer capability they have desired for years. NASA has implemented the requirement to protect technology information with respect to entities outside the cooperative agreement, while the parties to the agreement can yield significant technological gains with respect to a vehicle that will provide human access to space.

[26]A term used for a space system that incorporates design features, operational procedures, and requirements necessary to accommodate human participants.

[27]The *Ariane 5* is a French expendable launch vehicle.

Appendix C. X-38/CRV Top-Level Requirements

Requirement	X-38 and CRV	CRV Only
Minimum of Single Fault Tolerant[1] at the end of 3-year, on-orbit duration	X	--
Minimum Mission Reliability of .99	X	--
System Availability of 95 percent over 3-year, on-orbit mission	X	--
Capable of autonomous flight operations and landing	X	--
Dry Land Touchdown	X	--
Shirtsleeve Operation[2]	X	--
All Attitude Separation[3]	--	X
Separation within 3 minutes	--	X
Supports medical mission timeline	X	--
Operated in the English language	X	--
Supports 7 crew members of 95th percentile American male[4]	X	--
Peak sustained gravity forces of less than +/-4 gravity forces	X	--
Two-way communication with the ground	X	--
Minimum on-orbit life of 3 years	X	--
Landing accuracy of 5 nautical miles radius circular error probability	X	--
Launch aboard Space Shuttle	X	--

[1]Critical systems designed so that no single failure shall cause loss of the crew.
[2]Not requiring special, protective clothing.
[3]CRV ability to separate from the ISS irrespective of the ISS position.
[4]Able to accommodate seven persons of a size and weight up to that of 95 percent of the American male population.

Appendix D. Management's Response

National Aeronautics and
Space Administration
Lyndon B. Johnson Space Center
2101 NASA Road 1
Houston, Texas 77058-3696

Reply to Attn of: BD5

JAN 19 2000

TO: NASA Headquarters
Attn: W/Assistant Inspector General for Auditing

FROM: AA/Director

SUBJECT: Management Response to OIG's Draft Report on the Audit of X-38/Crew Return Project Management Assignment Number A9900201

We have reviewed the findings contained in the subject draft report, and thank you for the opportunity to provide our comments. We concur with the recommendation, and our planned actions are described in detail in the enclosure. This response has been coordinated with the Office of Space Flight.

Since the planned actions have timeframes which go into the out years, we ask that the audit assignment be closed for reporting purposes. If you have any questions regarding this response, please contact Ms. Pat Ritterhouse, Audit Liaison Representative, at 281-483-4220, or Mr. John Muratore at 281-483-4467 for technical content.

George W. S. Abbey

George W. S. Abbey

Enclosure

cc:
EX/J. Muratore
HQ/JM/H. Robbins
HQ/MA/J. Rothenberg
HQ/MX/G. Gabourel

Appendix D

Management Response to OIG's Draft Report on the Audit of X-38/Crew Return Project Management, Assignment Number A9900201

Auditor's Findings

"The X-38/CRV Project strategy, known as "rapid prototyping" responds to a challenge by the NASA Administrator to demonstrate that human-rated spacecraft can be developed faster and for a fraction of the cost of previous projects. As a result, the X-38/CRV Project is relying on a high degree of concurrency among design, development, test, and engineering/evaluation activities and highly optimistic success-oriented schedule to accomplish development and production of the CRV. While this Project approach offers potential high payoff, the approach negatively affects the ability to accurately adhere to project cost and schedule. Therefore, Johnson needs to focus additional attention on risk and performance management including the use of performance metrics and criteria needed for key Project decision points. The Project's high concurrency warrants more risk management than current NASA policy requires."

Recommendation

The Director, Johnson Space Center, should develop and document the major characteristics, criteria, and strategies for progressing through major Project phases, as required by NPG 7120.5A and as warranted by the high risk and importance of the X-38/CRV Project."

JSC Comments

We concur with the recommendation. The X-38/CRV Project Office has identified four major milestones in the future of the project where it is appropriate to specify exit/entry criteria. These are:

1. Start of Phase 1 Contracts (CRV Engineering Design through CDR) - currently planned for October 2000.
2. X-38 V201 Flight Readiness Review (FRR) - currently planned for January 2002.
3. CRV Production Start - currently planned for October 2002.
4. CRV Flight Readiness Review – currently planned for February 2005.

The specific criteria for each of these milestones will, of course, evolve with the project. However, the X-38/CRV Project Office will baseline the following initial criteria for each of these major milestones. This will be done at the next Space Station Integration Control Board, scheduled for February 2000, and your office will be provided a copy of the presentation and the minutes documenting that decision. These criteria will be documented in the X-38/CRV Project Plan Update currently scheduled for April 15, 2000.

Start of Phase 1 Contracts (October 2000)

The Phase 1 Contracts will be awarded to multiple contractors to perform design engineering and production planning through the Critical Design Review (CDR) point.

Enclosure

The Phase 1 Contracts are currently estimated at $112M and the start of these contracts represents a major commitment for the design of the CRV.

The criteria have been established by the Langley Research Center Independent Assessment (IA) Team and consist of 110 maturity gates. All gates must either be closed or a decision to "proceed at risk" must be approved prior to start of the Phase 1 Contracts. The status of these gates and the identification of "proceed at risk" will be made to the NASA agency level Program Management Council in March 2000, prior to selection of the Phase 1 contractors.

X-38 V201 Flight Readiness Review (January 2002)

The FRR for the X-38 represents a major milestone for the X-38/CRV design. The FRR will determine the readiness of the vehicle to perform its mission objectives in a safe and effective manner. The JSC Center Director with the ISS Program Manager will hold this review. The recommendation for launch will be made to the Office of Space Flight.

The criteria for this review are as follows:

1. All shuttle integration milestones complete.
2. All V201 integrated testing complete. This includes static structural, modal, thermal vacuum, mission simulation, MCC-H end-to-end testing and shuttle-payload integration testing. All anomalies resolved.
3. All V-201 mission simulation training complete.
4. New shape subsonic aerodynamic database established through a minimum of four V131R tests with at least one test along the space flight entry corridor
5. At least 4 successful 7500 square feet parafoil tests in a row are completed. This will include one test after storage at vacuum.
6. At least 5 hours of flight experience of the space flight Electro Mechanical Actuator (EMA) on the F-15 flying testbed.
7. Successful on orbit determination of attitude by Global Positioning Satellite (GPS) by the Space Integrated GPS Inertial (SIGI) unit or demonstration of manual attitude initialization on-orbit during a shuttle flight test.
8. At least one successful performance of entry navigation by SIGI during shuttle flight test.

CRV Production Start (October 2002)

The CRV Production phase represents the major financial commitment of the X-38/CRV Project. Over $400M will be spent in Phase 2 for procurement and testing of the CRV vehicles. At the start of Phase 2, NASA will downselect to a single contractor to perform the CRV production.

The criteria for entering the production phase revolve around the results of the X-38 space test and the maturity of the contractor design and cost proposal. These criteria are:

Appendix D

1. All data from X-38 test flight processed.
2. All anomalies from X-38 flight understood.
3. Aerodynamic and aerothermodynamic databases verified with space flight test data.
4. Any fixes for CRV configuration identified and included in contractor cost proposal.
5. Contractor's CDR complete, all issues dispositioned, and forward action plan identified.
6. Four (4) successful flights of the parafoil in a row in the final configuration.

Acquisition and production of long-lead materials or parts may occur prior to the start of the CRV production phase. The CRV Phase 2 Contract may be awarded prior to completion of all the criteria, however, actual production effort will not commence prior to completion of the criteria.

CRV Flight Readiness Review (February 2005)

The CRV flight readiness review represents the final production milestone identifying the CRV as a human-rated vehicle and ready for operational use. The exact reporting procedure for this human rating will be determined by a Code M, Office of Space Flight, appointed committee. This committee is currently writing a process section for the Human Rating Standard (JSC-28354) that will describe the steps to achieve a human rating. The criteria for this milestone are relatively independent of the process selected and are:

1. All shuttle integration milestones complete.
2. All CRV integrated testing complete. This includes static structural, modal, thermal vacuum, mission simulation, MCC-H end-to-end testing, and shuttle-payload integration testing. All anomalies resolved.
3. All CRV Master Verification Plan items complete (JSC-28227).
4. Twenty (20) successful flights of the parafoil in a row in the final configuration.
5. Twenty-Five (25) hours of EMA experience on the F-15 flying testbed.
6. Successful test of the common berthing (CBA) adapter on the ground with the CRV and on-orbit installation of the CBA.
7. All human rating criteria met per JSC-28354.
8. Successful demonstration of backup chute deployment from an atmospheric vehicle lifting body.

Appendix E. Report Distribution

National Aeronautics and Space Administration (NASA) Headquarters

A/Administrator
AI/Associate Deputy Administrator
B/Chief Financial Officer
B/Comptroller
G/General Counsel
H/Associate Administrator for Procurement
HK/Director, Contract Management Division
HS/Director, Program Operations Division
J/Associate Administrator for Management Systems
JM/Director, Management Assessment Division
L/Associate Administrator for Legislative Affairs
M/Associate Administrator for Space Flight

NASA Advisory Officials

Chair, NASA Aerospace Safety Advisory Panel
Chair, NASA Advisory Council
Chair, Advisory Committee on the International Space Station
Chair, Aeronautics and Space Transportation Technology Advisory Committee

NASA Centers

Director, Dryden Flight Research Center
Director, Lyndon B. Johnson Space Center
Director, John F. Kennedy Space Center
Chief Counsel, John F. Kennedy Space Center

Non-NASA Federal Organizations and Individuals

Assistant to the President for Science and Technology Policy
Deputy Associate Director, Energy and Science Division, Office of Management and Budget
Branch Chief, Science and Space Programs Branch, Energy and Science Division, Office Management and Budget
Associate Director, National Security and International Affairs Division, Defense Acquisitions Issues, General Accounting Office
Professional Assistant, Senate Subcommittee on Science, Technology, and Space

Appendix E

Chairman and Ranking Minority Member - Congressional Committees and Subcommittees

Senate Committee on Appropriations
Senate Subcommittee on VA, HUD, and Independent Agencies
Senate Committee on Commerce, Science, and Transportation
Senate Subcommittee on Science, Technology, and Space
Senate Committee on Governmental Affairs
House Committee on Appropriations
House Subcommittee on VA, HUD, and Independent Agencies
House Committee on Government Reform and Oversight
House Subcommittee on Government Management, Information, and Technology
House Subcommittee on National Security, Veterans Affairs, and International Relations
House Committee on Science
House Subcommittee on Space and Aeronautics, Committee on Science

Congressional Member

Honorable Pete Sessions, U.S. House of Representatives

NASA Assistant Inspector General for Auditing
Reader Survey

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Report Title: X-38/Crew Return Vehicle Project Management

Report Number: _____ **Report Date:** _____

Circle the appropriate rating for the following statements.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
1. The report was clear, readable, and logically organized.	5	4	3	2	1	N/A
2. The report was concise and to the point.	5	4	3	2	1	N/A
3. We effectively communicated the audit objectives, scope, and methodology.	5	4	3	2	1	N/A
4. The report contained sufficient information to support the finding(s) in a balanced and objective manner.	5	4	3	2	1	N/A

Overall, how would you rate the report?

Excellent Fair

Very Good Poor

Good

If you have any additional comments or wish to elaborate on any of the above responses, please write them here. Use additional paper if necessary. _____

_____

_____

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How did you use the report? _____

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How could we improve our report? _____

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How would you identify yourself? (Select one)

Congressional Staff	Media
NASA Employee	Public Interest
Private Citizen	Other: _____
Government: _____ Federal: _____ State: _____ Local: _____	

May we contact you about your comments?

Yes: _____ **No: _____**

Name:

_____

Telephone: _____

Thank you for your cooperation in completing this survey.

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