



Office of Inspector General
Washington, DC 20546-0001

November 2, 2006

TO: Associate Administrator for Institutions and Management
Director, Glenn Research Center

FROM: Assistant Inspector General for Auditing

SUBJECT: Final Memorandum on Observations on the Review and Approval of
Glenn Research Center's Relocation of the Altitude Combustion Stand
Facility (Report No. ML-07-001)

The purpose of this memorandum is to notify NASA management of an issue we found during audit fieldwork in response to a complaint. We received, through the Office of Inspector General (OIG) hotline, a complaint alleging that NASA grossly mismanaged Space Act Agreements (SAAs) between Glenn Research Center (Glenn) and the City of Cleveland, Ohio (the City), relating to Cleveland's airport expansion project. We initiated an audit of a memorandum of understanding and 12 supplementary SAAs issued between Glenn and the City. We are addressing the complainant's allegations of mismanagement of the 12 supplementary SAAs in a separate report.

Executive Summary

We found that Glenn did not adequately justify the requirement for construction, under SAA 12, of the Altitude Combustion Stand (ACS facility), as required by NASA Procedural Requirements (NPR) 8820.2E, "Facility Project Implementation Guide," October 7, 2003. In particular, while Glenn cited an Exploration Systems Mission Directorate (ESMD) requirement for the rocket engine propulsion testing capability to be provided by the ACS facility,¹ we found that no such requirement existed at the time Glenn committed to proceeding with construction. In addition, Glenn did not obtain ESMD signature on NASA Form 1509, "Facility Project-Brief Project Document," showing the Directorate's approval for authorizing construction of the ACS facility. NASA's decision to construct a facility without a firm mission requirement violates NASA policy and is not an effective use of resources.

Our August 22, 2006, draft of this memorandum recommended that the Associate Administrator for Institutions and Management immediately assess and determine, in accordance with NASA Procedural Requirements, whether there is a valid mission need

¹ The ACS facility provides the capability to test rocket engines and engine components at a simulated altitude of 130,000 ft (0.03 psia [pounds per square inch absolute]), chamber pressure of 40 to 1,000 psia, and thrust levels up to 2,000 lbf (pounds of force).

for the ACS facility. We also recommended that the Associate Administrator for Institutions and Management consider halting further construction until a determination is made in accordance with applicable criteria that the facility supports a valid mission need.

In commenting on a draft of this memorandum, the Associate Administrator for Institutions and Management concurred with our recommendations but did not fully agree with the findings that led to the recommendations (see the Enclosure). The Associate Administrator's comments on the recommendations were not fully responsive. We consider Recommendation 1 resolved but open pending receipt of the reexamination of the need for the ACS facility. We consider Recommendation 2 open and unresolved.

Background

In May 1997, Glenn and the City entered into a memorandum of understanding for the transfer of land ownership. The City considered expansion of its airport vital to the economic development of the City and Northeastern Ohio and requested that NASA transfer part of Glenn to the City: a 40-acre parcel of land, referred to as the "South 40." NASA agreed to the transfer if the City would pay all necessary costs to relocate various storage buildings and loose equipment and rebuild five facilities located on the South 40. NASA further entered into 12 supplementary SAAs, which provide details for the relocation of certain facilities and equipment located on NASA property, relating to the airport expansion project.

NASA stipulated that the five rebuilt facilities were to be in operational condition prior to transfer of ownership of the South 40 to the City. One of the facilities the City agreed to rebuild for Glenn was the Rocket Engine Test Facility, which consisted of three discrete test stands. Glenn requested, however, that the City rebuild only one of the test stands (the B-stand, to be called the ACS facility). In July 2004, Glenn and the City entered into SAA 12 to rebuild the facility. Paragraph V.A.1 of that SAA states that the City will transfer \$21.7 million to NASA for reimbursement of costs incurred to complete the ACS facility. On December 19, 2005, Glenn awarded a firm-fixed-price construction contract (NNC06CB59C) for \$16.5 million² for construction of the facility. In April 2006, the contractor started site preparation work and broke ground for the facility.

NPR 8820.2E, chapter 3, provides guidance for establishing the requirements for planning and development of a facility project. Specifically, NPR 8820.2E, section 3.3.4, requires a functional requirements statement. This statement must define the capability; evaluate options to meet the need; and identify the mission, operations, or research and development or institutional tasks requiring the capability.

The Associate Administrator for Institutions and Management serves as the principal integrator and advisor to the Administrator and Deputy Administrator on policy and management of real property assets and institutional operations. The Assistant

² As of September 28, 2006, the contract value was \$17.2 million; a pending modification for \$175,000 will raise the value to \$17.4 million.

Administrator for Infrastructure and Administration and the Director, Facilities Engineering and Real Property (FERP) Division, serve as the strategic advisors to Agency and Center management on real property issues, to include approval of all Construction of Facilities projects.

Inadequate Justification to Construct the ACS Facility

FERP requested that Glenn prepare a business case analysis to justify construction of the ACS facility, instead of a functional requirements statement as required. Glenn prepared an Executive Summary Report, dated November 3, 2005, that included a business case analysis. The summary report included the ACS facility project description/objective, list of stakeholders and customers, summary of alternatives, and full life-cycle costs. Although the summary report stated that ESMD required the rocket engine propulsion testing capability that the ACS facility would provide, Glenn did not have adequate support for that conclusion. Glenn also did not provide a thorough assessment of NASA requirements for a similar capability and of resources available to NASA.

Requirement for Construction Not Supported. FERP directed Glenn to prepare a business case analysis instead of a functional requirements statement. NPR 8820.2E, paragraph 3.3.4.3, states that the functional requirements statement must clarify the capability requirement details, such as what mission, operation, or research and development or institutional tasks require the capability. The objective of the business case analysis was essentially the same as for the functional requirements statement. Glenn identified ESMD as the primary mission directorate requiring the ACS facility's rocket engine testing capabilities. We contacted ESMD Program Executives and Glenn managers in February and May 2006 and found that ESMD had not made a commitment to perform any testing in the proposed ACS facility. ESMD will not know what testing capabilities will be required until after completion of the Systems Requirements Review. As of October 31, 2006, that review had not been completed.

Alternatives to Construction Not Adequately Assessed. According to NPR 8820.2E, paragraph 3.3.4.2, the functional requirements statement also defines the required capability and evaluates options to meet the stated need; paragraph 3.3.4.3 requires that a functional requirements statement identify which nonconstruction alternatives for satisfying the requirements were analyzed and the disposition of the alternatives. To determine whether existing capabilities are adequate, NASA directs its Centers to leverage the resources (fiscal and physical) of other NASA facilities as well as other Federal agencies, industry, and academia. In addition, NASA's strategic planning document for making real property decisions, the NASA Real Property Asset Management Plan, states in paragraph 2.1 that NASA should construct and operate new real property to meet mission requirements only when existing capabilities cannot be effectively used or modified.

Glenn did not assess all existing facilities available to provide the rocket propulsion testing capability similar to the testing capability that the ACS facility would provide. Glenn performed an assessment of construction and nonconstruction alternatives, which

included new construction, leasing a facility, and using contractors' facilities. The result of the Glenn assessment identified only one testing facility, the NASA facility located at White Sands, New Mexico, as having capabilities similar to the ACS facility. The assessment showed the White Sands facility had capabilities complimentary to, but not replicating, those of the ACS facility.³

We contacted the Program Executive, Advanced Capability, ESMD, to determine whether other facilities existed that could conduct testing comparable to the ACS facility. The Program Executive identified, in addition to White Sands, the Arnold Engineering Development Center in Tennessee, the Air Force Research Laboratory Propulsion Directorate at Edwards Air Force Base in California, and one contractor in Florida as having comparable testing capability. A NASA OIG technical advisor further verified that the four facilities cited by the ESMD Program Executive could conduct tests comparable to the ACS facility.

Therefore, existing facilities could perform the rocket propulsion testing capability that the ACS facility would provide, making the requirement for the ACS facility questionable.

Mission Directorate Approval Not Obtained. NASA Real Property Asset Management Plan, paragraph 3.1.2, requires that Construction of Facilities projects have mission directorate and FERP approval. Although Glenn, in the Executive Summary Report for the ACS facility, identified ESMD as the primary customer for the ACS facility project, Glenn did not obtain ESMD signature on NASA Form 1509, "Facility Project-Brief Project Document," which is used to authorize construction projects. However, Glenn did obtain FERP approval and signature on NASA Form 1509. The FERP Director told us that Glenn officials verbally stressed the need for the ACS facility, leading the FERP Director to conclude that the facility was essential to NASA's missions. In addition, FERP officials stated that Glenn was under time constraints to approve the construction of the ACS facility or risk losing funding that the City provided for the ACS facility under the airport expansion project. SAA 12, paragraph V.A.1, states that the City will transfer \$21.7 million to NASA for reimbursement of costs incurred to complete the ACS facility, and paragraph VII states that NASA has until August 3, 2007, to complete construction of the ACS facility. FERP approved construction of the ACS facility without the appropriate mission directorate signature authorizing mission directorate approval.

Management's Comments on the Finding and Evaluation of Management's Comments

Management's Comments on the Finding. In response to a draft of this memorandum, the Associate Administrator for Institutions and Management stated that all appropriate issues were addressed. The Associate Administrator stated that FERP required Glenn to

³ Glenn's business case analysis did not include the information that six test stand facilities exist at White Sands with altitude testing capability similar to that of the ACS facility.

assess whether there was a valid mission need. The FERP Director delayed the award of the construction contract, to December 2005, until he was satisfied that a thorough assessment had been made. The decision did not rely on Glenn “verbally stressing the need for the ACS” as stated in the draft memorandum, relying instead on the following information:

- From 1998 to 1999, during facility relocation requirements definition studies, the requirements for the existing Rocket Engine Test Facility complex, comprising three separate test facilities with common infrastructure, were assessed. The studies determined that one of the three existing test facilities—the B-stand (ACS capability)—had a valid mission need and the other two test facilities were no longer required.
- The Associate Administrator stated that, in accordance with the National Environmental Policy Act (NEPA), the need to relocate the ACS capability was documented in a NASA Record of Decision signed by the Associate Administrator for Aerospace Technology in November 2000. At that time, the transfer of NASA’s South 40 property to the City for the airport expansion was conditional in part on the City meeting its obligation to relocate the ACS capability and make NASA whole as required by Title 49, United States Code, Section 47125 (49 U.S.C. 47125) and the memorandum of understanding between Glenn and the City.
- In November 2000, prior to the start of the facility’s final design, a rigorous independent assessment of the Agency’s need for the ACS capability was completed. That assessment, chartered by the NASA Administrator, was in response to a congressional inquiry. According to the Associate Administrator, the results of the assessment strongly endorsed the need for the ACS facility.
- The project was briefed to appropriate Headquarters organizations throughout facility planning, requirements definition, and final design phases, including the Office of General Counsel, FERP, the Environmental Management Division, and the appropriate program authority at that time, the Office of Aerospace Technology. As a result, Glenn obtained full concurrence from all cognizant Headquarters organizations, as evidenced by NASA Form 1509, executed on May 20, 2002.
- Before issuing the construction contract, the FERP Director requested that a business case analysis be prepared, which Glenn completed in November 2005. The FERP Director determined that the business case analysis, in addition to meetings held with Glenn that included program and project managers, satisfactorily answered the question of the mission need for the facility. As a result, on December 13, 2005, the NASA Form 1509 was updated.

SAA 12 documented NASA’s legally binding commitment to the City to relocate the ACS capability in satisfaction of the City’s obligation to make NASA whole. NASA’s

failure to complete the ACS project as promised under SAA 12 would have compromised the City's own commitments under NEPA.

Evaluation of Management's Comments. The weight of management's comments are directed at establishing that, by May 2002, there were firm requirements for the ACS facility, as evidenced by an executed NASA Form 1509, dated May 12, 2002, appropriately concurred in by the "appropriate program authority at that time, the Office of Aerospace Technology . . ." and, further, that the 2005 business case analysis confirmed the mission need for the facility. In our view, while the basis for the 2002 requirements are unclear, whatever requirements there may have been at that time were overtaken by events, in particular the announcement of "The President's Vision for U.S. Space Exploration" in January 2004. After the announcement and the subsequent reorganization of the Agency to accomplish the new vision, it was incumbent on the Agency to reevaluate whether requirements for facilities established under a prior paradigm were still valid. As we have indicated, the relevant mission directorate, ESMD, has not indicated that it has a requirement reflecting a need for the ACS facility.

In addition, before approving the December 2005 NASA Form 1509, NASA again had the opportunity to revalidate the operational requirement for the ACS facility via the November 2005 business case analysis but did not do so before issuing the construction contract. NASA's decision to construct a facility in anticipation of a future requirement that may or may not materialize is not an effective use of resources and does not comply with NPR 8820.2E, section 3.3.4.

We recognize that the ACS facility is part of a complex contractual arrangement with the City and that changing those arrangements to reflect the Agency's current needs presents many challenges. On the other hand, it would be wasteful if millions of dollars, whatever their origin, are being spent to build a facility that is fundamentally not needed.

We evaluated the documentation provided in response to a draft of this memorandum and made the following determinations:

- While the Associate Administrator referred to documentation supporting relocation alternatives, as of October 17, 2006, NASA was unable to provide us the facility relocation requirements definition studies from 1998 to 1999. Therefore, we are unable to determine whether NASA had a valid requirement for the ACS facility at that time.
- We reviewed the November 8, 2000, "Record of Decision for Proposed Replacement Runway, Runway Extension and Associated Development at Cleveland Hopkins International Airport, Cleveland, Ohio." That document states that relocation of the B-stand will be scheduled so that it can be activated within 6 months of facility closure. However, the B-stand, which was the only part of the Rocket Engine Test Facility to be rebuilt under the airport expansion project, had been shut down since 1995. In addition, while 49 U.S.C. 47125 states that a requested conveyance should be made without cost to the Government and that

the head of the agency shall decide whether the requested conveyance of land is consistent with the agency's needs, it does not contain a requirement for an agency to be "made whole."

- We reviewed the November 28, 2000, "NASA Independent Review Team Findings - Glenn Research Center Facility Relocation," which analyzed the relocation alternative for the ACS facility. The team recommended that Glenn seriously consider relocating the ACS facility to Plum Brook Station due to safety issues and the size of components that could be tested. The team was not tasked with providing environmental requirements or to validate the operational requirement for the ACS facility. The congressional inquiry, dated May 24, 2000, questioned why the ACS capability was being rebuilt given that the Rocket Engine Test Facility had been closed since 1995. The inquiry stated, "In some instances, it appears that NASA Glenn is asking to have replaced facilities that have previously been determined to no longer be necessary to your mission." The Glenn Director, in his June 29, 2000, response to the congressional inquiry, stated that NASA was not relocating the Rocket Engine Test Facility, but only the portion of the facility that had direct application to future work. As previously stated, NASA has been unable to provide documentation to support a valid requirement for the ACS facility.
- While the May 2002 NASA Form 1509 indicated that Glenn had concurrence from the former Office of Aerospace Technology and approval from FERP, the subsequent reorganization of the Agency to accomplish the President's vision made it necessary for the Agency to reevaluate whether requirements for the ACS facility were still valid.
- Our evaluation of the November 2005 business case analysis is addressed in the body of this memorandum.

With regard to NASA's characterization of SAA 12, we agree that SAA 12 is a legally binding commitment between NASA and the City. However, SAA 12 does not contain a requirement for the City to make NASA whole. Instead, SAA 12 shifted the project cost risk from the City to Glenn. Specifically, paragraph V.B.1 of SAA 12 states:

As of the date of this Agreement [July 13, 2004], NASA's cost estimate for performing all of its responsibilities under Section III(B) is \$21,700,000. This estimated cost includes, but is not limited to, all actual charges for civil service labor, contract support, design professionals, quality control, quality assurance, material charges, utilities, maintenance, travel, program support, overhead, contract administration, contingency, and construction management contract support, as applicable. NASA has agreed to assume full responsibility, financial and otherwise, for the construction of the ACS Project. NASA further agrees that the City is not responsible for any additional funding relating to the construction of the ACS Project, regardless of the cause therefore.

Under other SAAs, including SAA 7 for the Small-Scale Multi-Purpose Research Facility Project and SAA 10 for the Cryogenic Components Laboratory Project, the City was

responsible for managing the project—not Glenn—and was, therefore, responsible for managing project cost risk.

On September 29, 2006, Glenn issued SAA 13, which modified the City’s and NASA’s responsibilities regarding completion of SAA 12. Under paragraph III.A.2 of SAA 13, the City authorized Glenn to

... use all remaining funds transferred pursuant to SAA-12, across the respective Space Act Agreements addressed herein as necessary to complete the relocation of capabilities and facilities as previously defined in the respective SAA’s. Said right shall continue notwithstanding completion of SAA-12, the transfer of real estate pursuant to SAA-4 or the transfer of the South 40 pursuant to the MOU [memorandum of understanding].

SAA 13, paragraph III.B.2, modified NASA’s responsibilities to require that NASA “utilize reasonable efforts to complete the construction of the Altitude Combustion Stand (SAA-12) by September 30, 2008.” SAA 12, paragraph XIII, states that NASA may terminate the SAA for any reason. If NASA determines that the construction of the ACS facility is no longer necessary, then NASA has the right to terminate SAA 12 and to complete work remaining under other SAAs before returning the remaining funds to the City.

Recommendations, Management’s Response, and Evaluation of Management’s Response

Recommendation 1. We recommend that the Associate Administrator for Institutions and Management immediately assess and determine, in accordance with NASA Procedural Requirements, whether there is a valid mission need for the ACS facility.

Management’s Response. The Associate Administrator for Institutions and Management concurred, stating that NASA agrees that the mission need for the ACS should be reexamined immediately. The Associate Administrator provided an executive summary of a comprehensive facilities study completed in March 2006, which examined existing facility capability relevant to Crew Exploration Vehicle (CEV) program needs. According to the Associate Administrator, the study concluded that, while testing capabilities exist to conduct flight verification tests for the program’s systems, appropriately equipped component test facilities are still needed for developmental testing and to minimize schedule conflicts. The Associate Administrator stated that the executive summary supported the need for component testing for which the ACS facility was uniquely suited.

Evaluation of Management’s Response. While the Associate Administrator concurred with the recommendation, the comments are not responsive because they do not articulate a plan for conducting an assessment of the need for the ACS facility. We reviewed the comprehensive facilities study that the Associate Administrator referred to, “Crew Exploration Vehicle (CEV) Propulsion Plan - Volume 1

Development,” May 4, 2006, prepared by the Glenn CEV Project Office. That plan concluded that

[e]xisting NASA facilities have the capacity to plan and conduct most of the ground-based CEV propulsion tests (at both sea-level and altitude conditions). Thrust ranges, vehicle dimensions, system configurations, and propellant combinations can be accommodated in existing facilities without prohibitive investments . . . Refinement of CEV propulsion system design and test schedules will allow improved mapping of test articles to test facilities. In the event of a testing conflict, alternate NASA or DoD facilities offer backup capacity for many tests. [F]acilities for OME [orbital maneuvering engine] and RCE [reaction control engine] hot-fare testing at altitude conditions are fewer in number and may not be immediately available to all users. Test planners are encouraged to examine methods to safely reduce the number of altitude tests and transfer testing to sea-level test stands.

The plan does not specifically address the need for the ACS facility and does not evaluate the capabilities of the ACS facility related to CEV engine test requirements; therefore, it does not satisfy the intent of our recommendation. To date, the Agency has been unable to provide us with adequate documentation to support a valid requirement. We can only conclude that Glenn is constructing, operating, and planning to maintain a facility in anticipation of needs rather than for stated needs, as required. We request that the Associate Administrator for Institutions and Management provide a timeline and statement of objective for the reexamination of the need for the ACS facility in response to this final memorandum.

Recommendation 2. We recommend that the Associate Administrator for Institutions and Management consider halting further construction until a determination is made in accordance with applicable criteria that the facility supports a valid mission need.

Management’s Response. The Associate Administrator for Institutions and Management concurred, stating that NASA considered halting construction of the ACS facility; however, NASA determined that the ACS facility capability does support valid mission needs and that there is no benefit to be gained by halting construction. The impacts of delaying construction at this point are substantial. The Associate Administrator stated that the cost estimates for the ACS project demonstrate that the only responsible approach is to continue construction. According to the Associate Administrator, the ACS project is now more than 45 percent complete. To halt construction now would result in very significant contractor claims for delay and demobilization costs. If construction is temporarily halted, there would be significant costs to re-start construction. None of these costs can legitimately be charged to the City under the terms of SAA 12 and funding responsibility would be NASA’s. Any construction delay could seriously jeopardize completion of the project.

Evaluation of Management’s Response. The Associate Administrator’s comments are not responsive. According to an undated and unsigned Application and Certification for Payment provided by Glenn officials, the contractor has billed \$6.6 million (38.4 percent) of the \$17.2 million of the contract value (as of

September 2006) for work performed through September 30, 2006. Glenn project management officials provided an estimate of costs to stop construction of the ACS facility as of September 15, 2006, which showed that to suspend and subsequently re-start construction would cost about \$125,000 for a 1-month suspension and about \$1.1 million for 6 months; to discontinue construction of the facility would cost about \$13.2 million.⁴

As of August 31, 2006, Glenn officials had estimated total construction costs for the ACS facility to be about \$25.3 million. Because the City has only agreed to provide \$21.7 million, Glenn will have to provide the remainder of \$3.6 million to complete the project. However, if Glenn were to terminate the project, Glenn could return up to \$8.5 million to the City and avoid spending \$3.6 million to complete the ACS facility and also avoid estimated annual operating costs of about \$159,000. We did not validate the percentage-of-completion data or the cost data that Glenn provided.

We request that the Associate Administrator provide the documentation for Recommendation 1 and reconsider his position on Recommendation 2 and provide additional comments by November 20, 2006.

We appreciate the courtesies extended to the staff during our review. If you would like to discuss this memorandum in more detail, please contact Ms. Catherine Schreiber, Financial and Institutional Management Director, at 202-358-3789 (catherine.schreiber@nasa.gov), or Mr. Ashton Coleman, Project Manager, at 202-358-3860 (ashton.coleman@nasa.gov).



Evelyn R. Klemstine

Enclosure

cc:

Administrator
 Deputy Administrator
 Associate Administrator
 NASA Office of General Counsel
 Assistant Administrator for Infrastructure and Administration
 Director, Facilities Engineering and Real Property Division
 Director, Management Systems Division
 Chief Counsel, Glenn

⁴ About \$11 million to terminate the contract for convenience (\$6.6 million already paid and \$4.4 million that would have to be paid) and about \$2.2 million to restore the site, including demolition of partial structures.

Management's Comments

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



September 22, 2006

Reply to Attn of:

Facilities Engineering and Real Property Division

TO: Assistant Inspector General for Auditing

FROM: Associate Administrator for Institutions and Management

SUBJECT: Response to Draft Memorandum on Observations on the Review and Approval of Glenn Research Center's (GRC) Relocation of the Altitude Combustion Stand Facility (ACS) (Referral No. O-GL-06-00043-Z)

In response to your draft memorandum dated August 22, 2006 entitled "Observations on the Review and Approval of Glenn Research Center's Relocation of the Altitude Combustion Stand Facility," the Office of Infrastructure and Administration, Facilities Engineering and Real Property Division and GRC have reviewed the recommendations and are providing the consolidated agency response herein.

We concur with the Office of Inspector General (OIG) recommendations as set forth in the subject draft memorandum and, as detailed below; we have taken the necessary steps to implement those recommendations.

While we concur with the recommendations communicated in the draft memorandum, we do not fully agree with your findings that led to the recommendations. We believe that all appropriate issues were addressed prior to approval of the construction project and that halting construction at this point would be legally, financially, and logistically impractical.

We recognize and appreciate the efforts of the OIG in helping to improve NASA's program management activities, and in ensuring that scarce taxpayer resources are being utilized in the most efficient and effective manner.

Response to the OIG's Recommendations:

OIG Recommendation I: The Associate Administrator for Institutions and Management immediately assess and determine, in accordance with NASA Procedural Requirements, whether there is a valid mission need for the ACS facility.

Response: Concur. We agree that the mission need for the ACS be reexamined immediately. Exploration Systems Mission Directorate has not finalized their ground based testing requirements; however, the following excerpt supports the need for component testing for which ACS is uniquely suited:

The Enclosure is an Executive Summary of a comprehensive facilities study completed in March 2006, which examined existing facility capability relevant to Crew Exploration Vehicle program needs. This study concludes that while testing capabilities exist to conduct flight verification tests for the Orion/Ares systems, appropriately equipped component test facilities are still needed for development testing and schedule conflict minimization.

In the next few weeks, we believe the requirements will further justify the ACS facility is vital to satisfying NASA's mission requirements.

OIG Recommendation II: The Associate Administrator for Institutions and Management consider halting further construction until a determination is made in accordance with applicable criteria that the facility supports a valid mission need.

Response: Concur. We agree that consideration be given to halting construction, and report that we have considered it carefully. NASA has determined that the ACS facility capability does support valid mission needs and there is no benefit to be gained through halting construction. The impacts of delaying construction at this point are substantial. Our cost estimates demonstrate that the only responsible approach is to continue construction of the ACS facility.

The ACS project is now more than 45 percent complete. To halt construction now would result in very significant contractor claims for delay and demobilization costs. If the construction is temporarily halted, there would be significant restart costs. None of these costs can legitimately be charged to the City under the terms of Space Act Agreement (SAA-12) and funding responsibility would be NASA's. Any construction delay could seriously jeopardize completion of the project.

Substantive Comments on Auditor's Findings:

1. The draft memorandum indicates that the original complaint alleged gross mismanagement. NASA feels strongly that there was no evidence of gross mismanagement and the Final Memorandum should reflect that the OIG found no gross mismanagement in their investigation.
2. NASA records provided to the OIG demonstrated that all appropriate issues were addressed. The evidence submitted is summarized below with some additional background.

The Director of Facilities Engineering and Real Property required GRC to assess whether there was a valid mission need. The Director Facilities Engineering and Real Property delayed the award of the construction contract to December 2005, until he was satisfied that a thorough assessment was made. The decision did not rely on GRC "verbally stressing the need for the ACS" as stated in the draft memorandum. Instead, the decision was based on the following:

1. The existing Rocket Engine Test Facility complex, comprising three separate test facilities with common infrastructure, was assessed during facility relocation requirements definition studies from 1998 to 1999. One of the three existing test facilities was determined to have a valid mission need consistent with GRC's role within the Agency. The other two capabilities were determined to be no longer required, and allowed to be eliminated from National capabilities.
2. A rigorous independent assessment of the Agency need for the ACS capability was completed on November 28, 2000, prior to the start of the facility final design. The assessment was chartered by the NASA Administrator in response to a Congressional Inquiry. The results of this assessment again strongly endorsed the need for the ACS facility.
3. The determination to relocate the ACS capability was documented in a November 2000, NASA Record of Decision, signed by the Associate Administrator for Aerospace Technology in accordance with the National Environmental Policy Act (NEPA). At that time, the transfer of NASA's South 40 property to the City of Cleveland for the expansion of the Cleveland Hopkins International Airport as requested by the Federal Aviation Administration was in part conditioned on the City meeting its obligation to relocate the ACS capability and make NASA whole as required by 49 U.S.C. 47125.
4. The project was briefed to appropriate Headquarters organizations throughout facility planning, requirements definition and final design phases, including the Office of General Council, Facilities Engineering and Real Property Division, the Environmental Management Division, and the appropriate program authority at that time, the Office of Aerospace Technology. As a result, GRC obtained full concurrence from all cognizant Headquarters organizations as evidenced by NASA Facility Project-Brief Project Document (NASA Form 1509) executed on May 20, 2002.
5. The SAA-12 cleared the way for the opening of the new airport runway. SAA-12 documented NASA's legally binding commitment to the City to relocate the ACS capability in satisfaction of the City's obligation to make NASA whole. NASA's failure to complete the ACS project as promised under SAA-12 would compromise the City's own commitments under NEPA.

6. Although NASA Construction of Facilities funding was not involved, a Business Case Analysis (BCA) was requested by the Director of Facilities Engineering and Real Property Division and completed by GRC. The Director of Facilities Engineering and Real Property Division determined that the BCA, in addition to meetings held with GRC that included Program and Project Managers, satisfactorily answered the question of the mission need for the facility, evidenced by execution of an updated NASA Form 1509 on December 13, 2005.

The OIG is correct that Mission Directorate approval was not indicated on the NASA Form 1509. However, in this case, the Mission Directorate did not fund the project and therefore was not required to sign the NASA Form 1509.

Major facility projects are a long lead-time activity, normally taking 3 to 5 years from requirements definition to construction completion. Based upon the prior assessments of needed capability and the time limitations contained in SAA-12, NASA determined it was prudent to proceed. The alternative of further delay while the Exploration Systems Mission Directorate ground testing requirements were more fully developed would have delayed the Airport expansion and could have detrimentally impacted NASA's ability to accomplish its mission.

In addition, if construction was not approved, the City funding provided would have been jeopardized. The loss of City funding would have been irresponsible on NASA's part, since the underlying basis of the Memorandum of Agreement was that NASA was to remain whole as required by 49 U.S.C. 47125.

While it is true that other capable facilities exist and could be adapted, they have priority work (such as Air Force projects) that could supersede NASA requirements. This concern regarding availability of facilities has increased since the last assessment was completed.

If you have any questions or wish to discuss this response, please contact Steven C. Miley, Acting Director for Facilities Engineering and Real Property at 358-0493 or Albert S. Johnson, Acting Deputy Director for Facilities Engineering and Real Property, at 358-1834.


Charles H. Scales

Enclosure

cc:
Administrator/Dr. Griffin
Deputy Administrator/Ms. Dale
Associate Administrator/Mr. Geveden
Assistant Administrator for Infrastructure and Administration/Ms. Dominguez
• Mr. Werner
Glenn Research Center/Dr. Whitlow

Executive Summary

To mitigate risk to human life and to best achieve mission objectives, the Crew Exploration Vehicle (CEV) development will require an extensive set of ground-based development, certification, and acceptance tests at major facilities located throughout the United States.

To successfully deliver the CEV, a ground-based test program will be performed that will utilize many NASA test assets with diverse capabilities. A CEV Propulsion System Facility Review Team was established to study anticipated test needs and to examine relevant facility assets. This report summarizes the Team's investigation of test facility capability, availability, and readiness to test CEV propulsion system hardware.

The primary objective of the Facility Review Team was to conduct a comprehensive survey of existing, Government-owned, rocket propulsion test facilities with the fundamental capabilities to conduct the anticipated tests. The Team was to review operational status and condition and then make test assignment recommendations based on technical capability, facilitization costs, and schedule.

The Facility Review Team was chartered to address anticipated test needs of CEV propulsion systems and realized immediately that potential test conflicts could arise with other Exploration programs including the Crew Launch Vehicle and Heavy Lift Launch Vehicle as well as "non-Exploration" NASA programs (STS, ISS, etc). Therefore, the team attempted to remain cognizant of facility plans in other programs, noted the possible impact on facility availability, and considered options to avoid possible conflicts.

The facilities and skills needed to test CEV propulsion systems are diverse and broad, so the team tried to assure that facilities matched the test need. NASA facilities were of primary interest, but U.S. Department of Defense (DoD) facilities were also assessed. Private/commercial propulsion facilities were not seriously considered in this study.

The team included representatives from Glenn Research Center (GRC), Johnson Space Center, Marshall Space Flight Center, GRC Plum Brook Station, Stennis Space Center, and JSC White Sands Test Facility (WSTF). All Facility Review Team members were NASA civil servants, and each was experienced in management and/or operation of propulsion test facilities. Many members had experience with the NASA Rocket Propulsion Test Management Board and the Rocket Propulsion Test Level-II Program Office.

A total of 31 test facilities and/or test positions at seven locations in the United States were reviewed and assessed. The sites were considered relevant to anticipated CEV test needs and were individually scored by review team members.

Enclosure

The review resulted in an ability to broadly categorize the testing capabilities for CEV testing needs as follows:

Cryogenic Propellants: There are few established LOX/LCH₄ test facilities currently within the NASA or DoD inventory. In preparation for advanced development work, some sites have initiated design and build-up of LCH₄ storage and delivery systems, but most sites do not have confirmed expertise or direct LCH₄ experience.

Non-toxic Propellants: Plans to utilize gaseous oxygen and ethyl alcohol propellants for the Crew Module Reaction Control System do not create significant testing hardships. Though most facilities are not currently ready for immediate operation, modifications necessary to accommodate Gaseous Oxygen and ethyl alcohol are not considered significant.

Hypergolic Propellants: NASA expertise for testing hypergolic propulsion systems remains concentrated at the WSTF near Las Cruces, New Mexico. Fortunately for the CEV Project, the existing facilities are certified for hypergolic use and are in frequent operation supporting the Space Shuttle Program. In the event that CEV test needs exceed WSTF test capacity, options exist to develop overflow testing at other NASA test sites, expand the WSTF capability, or to employ DoD test sites.

Component Testing: It is assumed that components (valves, small tanks, lines, etc) developed for CEV systems will be tested at vendor locations and that there will be only a limited number of component-level tests directed to test facilities considered in this review. Component test requests (if any) should be handled on a case-by-case, non-interfering basis to retain availability for larger system tests. The review team acknowledged there are numerous small-scale test rigs available throughout NASA that could possibly accommodate component tests. The maturity of the component in the development cycle (development, qualification, acceptance) may also influence needs for alternate test locations.

Sub-system and Full-Scale Integrated Testing: Once an assembly reaches sufficient physical size, complexity, or performance level, it is more constrained in possible test sites. The greatest facility challenges occur when full-scale integrated stages (5.0-5.5 meter diameters) are prepared for hot-fire testing.

Cold-Soak to Hot-Fire Testing: One of the most challenging test scenarios for the CEV Propulsion System is a full-scale, integrated, long-duration, thermal-vacuum cold soak followed by Orbital Main Engine (OME) and Reaction Control Engine (RCE) hot fire. At the present time there are no facilities ready to conduct this test, but candidates at White Sands Test Facility and Plum Brook Station can be upgraded to meet test requirements. Issues associated with facility modifications are being studied in greater detail while CEV requirements are being refined.

At the present time, the CEV Facility Review Team believes that the anticipated CEV testing can be conducted effectively at NASA and DoD test sites. Different test requirements will dictate different test location preferences.

Existing NASA facilities have the capacity to plan and conduct most of the ground-based CEV propulsion tests (at both sea-level and altitude conditions). Thrust ranges, vehicle dimensions, system configurations, and propellant combinations can be accommodated in existing facilities without prohibitive investments; needed investments are, however, time-critical. Refinement of CEV propulsion system designs and test schedules will allow improved mapping of test articles to test facilities. In the event of a testing conflict, alternate NASA or DoD facilities offer backup capacity for many tests.

Many of the facilities proposed for CEV testing still remain in close to their original Apollo-era test configurations. Understandably, nearly every one of these facilities is in need of some form of refurbishment or modernization.

Test stands for sea-level hot-fire testing of OME and RCE systems are available in sufficient number to fulfill CEV testing needs according to the CEV test schedule. However, facilities for OME and RCE hot-fire testing at altitude conditions are fewer in number and may not be immediately available to all users. Test planners are encouraged to examine methods to safely reduce the number of altitude tests and transfer testing to sea-level test stands.