National Aeronautics and
Space Administration

Office of Inspector General
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FROM: W/Assistant Inspector General for Auditing

SUBJECT: Status of NASA Office of Inspector General Review of Space Shuttle Imaging Audit Assignment A-04-007-00

The Office of Inspector General (OIG) has been reviewing NASA's progress in responding to the Columbia Accident Investigation Board (CAIB) recommendations concerning imaging of the Space Shuttle. The CAIB concluded that deficiencies in NASA's imaging capabilities impeded the Agency's ability to adequately identify foam losses on the external tank and to assess damage to the Columbia Space Shuttle during the STS-107 mission. The CAIB issued four recommendations aimed at providing:

1) three useful views of the Space Shuttle from liftoff to at least solid rocket booster separation, along any expected azimuth (recommendation 3.4-1),
2) a capability to obtain and downlink high-resolution images of the external tank after it separates (recommendation 3.4-2),
3) a capability to obtain and downlink high-resolution images of the Orbiter's Thermal Protection System (recommendation 3.4-3), and
4) imaging of each Space Shuttle flight while on orbit (recommendation 6.3-2).

NASA has agreed to implement corrective actions that address these recommendations before returning the Space Shuttle to flight. We initiated the subject review at the Kennedy and Johnson Space Centers in November 2003. In general, NASA's plans, briefly described below, appear to satisfy the intent of the CAIB recommendations. (We do not include any specific details on recommendation 6.3-2 because of its sensitive nature.) While these plans have not been fully implemented, we concluded that NASA is effectively working to improve shuttle imagery in accordance with the CAIB recommendations. As a result, we are suspending audit activities on this assignment. However, we will continue to monitor NASA's progress in implementing imagery plans and reactivate our review as necessary and report results. In addition, we plan to review the transition of imaging services to the new

contractor in October 2004 to determine whether the contractor has secured and trained qualified staff necessary for the expanded camera sites and equipment before the anticipated return-to-flight launch in March 2005.

OIG Review Approach

To evaluate NASA's planned corrective actions, we interviewed Space Shuttle Program and Project officials responsible for ground-based camera equipment and imaging equipment on the Orbiter, solid rocket boosters, and external tank. We studied camera locations and viewed imaging equipment such as trackers, cameras, and imaging analysis tools at Kennedy and Johnson Space Centers. We obtained briefings and conducted interviews of NASA personnel on the types and positioning of cameras and sensors on the Orbiter, solid rocket boosters and external tank. We examined the capability and process for downlinking, storing, and disseminating imagery data to Kennedy, Johnson and Marshall Space Flight Center. We also met with a member of the CAIB to clarify the intent of the imaging recommendations. We discussed plans with the respective contracting officer's technical representatives for transitioning imaging services at Kennedy from an Air Force contract to a new NASA contract in October 2004.

We also reviewed relevant briefings presented to the Return-to-Flight Planning Team, the Program Requirements Control Board, and the Stafford/Covey Return-to-Flight Task Group (Task Group). We noted the Task Group's assessment of NASA's response to the imaging recommendations in its Interim Report, dated January 20, 2004. The Task Group reported that NASA is making solid progress on corrective actions for the imaging recommendations.

NASA's Planned Corrective Actions

NASA's plans for additional and upgraded or refurbished ground-based camera equipment, lenses, and camera site changes appear to provide three useful views of the Space Shuttle from liftoff to solid rocket booster separation as discussed by the CAIB in Recommendation 3.4-1. NASA used computer simulations to assess the usefulness of each new camera site's view. In addition, NASA is considering changes to the Launch Commit Criteria to ensure that sufficient cameras are operational and that the weather is suitable at the time of launch. NASA is also exploring the use of NASA aircraft for additional views of the Shuttle during ascent.

In response to CAIB Recommendation 3.4-2, NASA plans to install a digital camera in the Orbiter umbilical well that will provide images of the external tank after it separates. The new camera will require modifying the orbiter with improved wiring from the camera to computers in the cockpit for downlinking. NASA expects this modification to be complete by the revised launch date in March 2005. Using a hand-held digital camera, NASA plans to have the astronaut crew obtain images of the external tank as it falls away from the Space Shuttle.

To provide a capability to obtain and downlink high-resolution images of the Orbiter wing leading edge and forward section of both wings' Thermal Protection System (CAIB

Recommendation 3.4-3), NASA plans to install cameras on the external tank, solid rocket boosters, and the Orbiter. Camera locations were chosen for the least impact to Shuttle environments (aerodynamics, heat, debris), ease of implementation, and the optimal field of view. NASA has developed the Orbiter Boom Sensor System that allows laser scanning and imaging for on-orbit inspection of the Thermal Protection System. Finally, NASA is developing procedures for a pitch maneuver that would allow imaging, with existing camera equipment, of the Orbiter's underside as it approaches the International Space Station (ISS). The maneuver can be performed without accepting any more risk than a normal rendezvous.

NASA's capability to downlink Space Shuttle imagery data is sufficient to satisfy the CAIB recommendations. NASA is utilizing an established infrastructure with industry standard transmission methods to address the transfer of data from the Space Shuttle or the ISS to Earth. These methods are capable in terms of both bandwidth and reliability. In addition, there are backup systems that can store the data so that if transmission of imagery data is disrupted or corrupted, the data will still be retrievable and subsequently available for analysis. The current system offers ample bandwidth to sufficiently transfer the increased amount of data transmitted.

Regarding CAIB Recommendation 6.3-2, NASA is taking steps to establish protocols with other Federal agencies and departments to image the Space Shuttle on orbit.

We appreciate the courtesies and cooperation provided to the staff during this review. If you have questions, or would like to discuss this matter further, please contact Mr. Dana Mellerio, Director, Strategic Enterprises, at (202) 358-0271, or me at (202) 358-2572.

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