U.S. OFFICE OF SPECIAL COUNSEL
1730 M Street, N.W., Suite 218
Washington, D.C. 20036-4505
202-254-3600

Analysis of Disclosure, Agency Investigation and Reports, Whistleblower Comments, and Comments of the Special Counsel

OSC File No. DI-04-2524

Summary

The whistleblower, who requested anonymity, disclosed that contrary to the recommendation of Columbia Accident Investigation Board (CAIB), National Aeronautics and Space Administration (NASA) management opted to rely on existing, low-resolution imaging technology to inspect the Space Shuttle's Thermal Protection System (TPS) and suppressed the implementation of a technically feasible, superior imaging system. The Office of Special Counsel referred the whistleblower's disclosure to the Administrator of NASA for formal investigation pursuant to 5 U.S.C. § 1213(c) and (d).

The agency produced three reports in response to the whistleblower's disclosure. In sum, the agency found that the imaging systems upon which it planed to rely were superior to the high-resolution imaging system recommended by a NASA working group because they could measure the depth of suspected damage to the TPS. The agency further asserted that testing had demonstrated the ability of its TPS inspection systems to detect the smallest potentially critical defects in the TPS. While the agency acknowledged several limitations in its TPS inspection systems, it insisted that flight planners had developed protocols for using these systems that would avoid their shortcomings and maximize their efficacy. The whistleblower, however, disputed the agency's findings and provided technical documentation to support his critique of NASA's TPS inspection systems. Moreover, in supplemental comments, submitted after the completion of NASA's Return to Flight Mission, the whistleblower contended the "poor resolution, low dynamic range" images collected during the mission "demonstrate[d]" that NASA's TPS inspection systems are "inadequate to reliably detect critical damage."

Having reviewed the agency's submission and the whistleblower's comments, I have determined that the agency's reports, taken together, contain all of the information required by statute and that, despite the compelling critique presented by the whistleblower, the agency's findings appear to be reasonable.

The Whistleblowers' Disclosures

The whistleblower disclosed that the method by which NASA planed to inspect the TPS on the Space Shuttle Discovery during its Return to Flight Mission was not able to detect potentially catastrophic defects. The CAIB concluded that the Space Shuttle Columbia accident was caused by a breach in the Shuttle's TPS that occurred during launch and went undetected throughout the course of the flight. Columbia Accident Investigation Board, *Columbia Accident Investigation Board Report* vol. 1 at 49 (August 26, 2003). To avoid such accidents in the future, CAIB

recommended that NASA "provide a capability to obtain and downlink high-resolution images of the underside of the Orbiter wing leading edge and forward section of both wings' [TPS]." *Id.* at 226. The whistleblower alleged that contrary to the recommendation of CAIB, NASA management opted to rely on existing, low-resolution imaging technology to inspect the TPS in orbit and suppressed the implementation of a technically feasible, superior imaging system.

More specifically, the whistleblower alleged that an Advanced Technology TPS Inspection Working Group (ATTIWG), tasked with evaluating solutions to the problem of inspecting the TPS in orbit, determined that the existing Orbiter Boom Sensor System (OBSS), promoted by the Johnson Space Center Engineering Directorate (Engineering Directorate), was inadequate to detect potentially catastrophic defects in the TPS. The whistleblower explained that the OBSS was designed to collect images of the leading edge and forward section of both wings and relay those images to analysts on the ground so they could assess the continuing integrity of the TPS. As configured in anticipation of NASA's Return to Flight Mission, the OBSS used two imaging systems, a Laser Dynamic Range Imager (LDRI) and a Laser Camera System (LCS), but the whistleblower maintained that these systems were unable to detect small defects in the TPS that could prove catastrophic upon reentry of the Space Shuttle into the Earth's atmosphere. In addition, the whistleblower alleged that the OBSS would transmit the images it gathers to the ground using low resolution, analog video technology. According to the whistleblower, this method of transmission would further degrade the already low-resolution images collected by the OBSS, making them more even difficult to interpret.

The whistleblower further alleged that ATTIWG concluded that it was technically feasible to engineer a better system for inspecting the TPS than the OBSS configuration favored by the Engineering Directorate, but management in the Engineering Directorate discounted the ATTIWG's recommendations and decided not to develop an improved sensor system. As a result, the whistleblower contended, the Space Shuttle Discovery was scheduled to fly with inadequate, low-resolution sensors that could not detect the sort of breach in the TPS that gave rise to the Space Shuttle Columbia accident. In short, the whistleblower alleged that NASA management in the Engineering Directorate consciously disregarded the recommendation of the CAIB and ATTIWG even though there was a technically feasible, cost effective means of implementing those recommendations.

Given the gravity of the issues involved and the apparent technical expertise of the whistleblower, OSC referred the whistleblower's allegations to the Administrator of NASA for formal investigation by the agency pursuant to 5 U.S.C. § 1213(c) and (d). This matter was referred for investigation prior to the launch of the Space Shuttle Discovery.

The Agency's Investigation and Reports

Initial Report

On June 9, 2005, NASA Administrator Michael D. Griffin produced a report (Initial Report) concluding that NASA had "complied with the CAIB recommendation to provide the capability to obtain and downlink high-resolution images and data through the use of the LCS and LDRI

systems." The Initial Report maintained that the Space Shuttle Program Manager had determined that the LDRI and LCS systems would be better able to detect defects in the TPS than two-dimensional, high-resolution imaging systems. According to the agency, the LDRI and LCS were selected for the task of inspecting the TPS because "previous versions of both laser systems [had] flown in space before, and demonstrated . . . a capability to identify damage" to the TPS.

In addition, the agency explained that adequate inspection of suspected damage to the TPS would require a three-dimensional imaging capability because the depth of damage is an essential indicator of its severity. The Initial Report stated that two-dimensional imaging systems would be unable to measure the depth of suspected damage "without optimal lighting and the need to space two cameras a few feet apart at a precisely known distance" from the sited being inspected. The agency further asserted in its Initial Report that the LDRI and LCS are not subject to the limitations of two-dimensional imaging systems because they do not depend on "ambient lighting" to provide three-dimensional images. Consequently, NASA concluded that the LDRI and LCS are better suited to inspect the TPS for damage while the Space Shuttle is in orbit.

Finally, the Initial Report maintained that, contrary to the contentions of the whistleblower, the LDRI and LCS are able to detect the smallest defects in the TPS that present a danger of catastrophic failure. Specifically, the agency reported that cracks as small as 0.020 inches by 2 inches in the Reinforced Carbon-Carbon (RCC) coating on the TPS may prove catastrophic. The Initial Report stated that testing had confirmed the ability of the LDRI to detect flaws in the TPS down to 0.015 inches. According to the agency, similar testing of the LCS system was ongoing at the time that it submitted its Initial Report, but the LCS was expected to perform with similar precision. Thus, NASA expressed confidence in its ability to identify potentially critical damage to the TPS using the LDRI and LCS.

OSC reviewed the agency's Initial Report and determined that it was deficient because it did not contain a "description of the conduct of the investigation" as required by 5 U.S.C. § 1213(d)(2). OSC further determined that the Initial Report was incomplete insofar as it did not provide the results of ongoing testing of the LCS system. On June 30, 2005, OSC advised NASA of its concerns, and the agency agreed to prepare a supplemental report addressing them.

First Supplemental Report

On July 6, 2004, NASA submitted to OSC a supplemental report (First Supplemental Report). In addition to providing a description of the conduct of the agency's investigation, this First Supplemental Report summarized the results of completed testing of the LCS. According to NASA, the LCS "demonstrated a capability to detect flaws down to [0.015 inches]." The agency admitted that "the LDRI and LCS are not certified" to detect flaws as small as 0.020 inches, but it insisted that its tests had shown that "under certain flight conditions and planned scan rates" these systems could generate sufficiently precise images to adequately inspect the TPS. The First Supplemental Report also noted that NASA planned to "inspect the RCC . . . twice using different viewing angles" during the upcoming mission of the Space Shuttle Discovery in order to ensure detection of potential defects.

After reviewing the First Supplemental Report, OSC forwarded it, along with the agency's Initial Report, to the whistleblower for comments. OSC received the whistleblower's comments on July 18, 2005 (Initial Comments). These comments called into question several of the representations made by the agency. Furthermore, the whistleblower attached to his comments a number of documents containing technical data that appeared to support his contentions. Given the critical nature of the disagreement between the whistleblower and the agency, OSC contacted the agency's principle investigator to solicit a response to the whistleblowers contentions. Because the launch of the Space Shuttle Discovery was imminent, I also wrote to Administrator Griffin on July 21, 2005, to alert him to the disagreement. Finally, in response to a request from the NASA, OSC provided the agency with a redacted copy of the whistleblower's comments to facilitate further investigation of his allegations.

Second Supplemental Report

On July 25, 2005, one day prior to the launch of the Space Shuttle Discovery, Administrator Griffin submitted to OSC a response (Second Supplemental Report) to the whistleblower's Initial Comments. Administrator Griffin's Second Supplemental Report reiterated many of the representations made in NASA's Initial and First Supplemental Reports. Specifically, the Second Supplemental Report insisted that while the LDRI is "only certified to detect a 0.25 inch [holes in the TPS], the LDRI and the LCS have both been demonstrated through ground testing to detect surface flaws as small as 0.015 inch under certain flight conditions at planned scan rates."

According to the agency, a risk assessment of its TPS inspection capabilities determined that it was acceptable to rely on the LDRI and LCS during NASA's Return to Flight Mission. The Second Supplemental Report explained that NASA planned to use the LDRI and LCS systems in combination to compensate for the known limitations of each system in isolation. More specifically, the agency stated that it intended to scan the entire RCC coating on the leading edges of the Space Shuttle's wings with the more flexible, but less focused, LDRI system. Suspected flaws in the RCC detected by this scan would then be inspected using the more focused LCS system "at proven angels and sensor distance." Where the LCS could not be properly positioned, the LDRI would be used to re-inspect the site of suspected damage. As a back-up to the LDRI and LCS systems, the agency stated that "an [extravehicular activity] crew member [could be] positioned with a digital still camera system" to inspect suspected damage to the TPS.

The agency's Second Supplemental Report did acknowledge several limitations in the LDRI and LCS that had been identified in the whistleblower's Initial Comments. In particular, the Second Supplemental Report noted that the LDRI suffers "limitations when inspecting surfaces at certain view angles." The agency also admitted that "there is some degradation in the three-dimensional measurement accuracy using the LDRI to measure depth . . . in direct sunlight." According to the Second Supplemental Report, these limitations had been addressed by flight controllers who formulated protocols for using NASA's TPS inspection systems during flight that would maximized their effectiveness.

NASA disputed the whistleblower's assertion that images collected by the LDRI and LCS systems would be degraded when they were transmitted to analysts on the ground using analog

transmission technology. According to the agency, its "simulations and tests" demonstrated the ability to "acquire and evaluate flaws down to 0.015 inch" with both the LDRI and LCS systems even after the images captured by those systems are transmitted using the using analog transmission technology criticized by the whistleblower. In addition, the Second Supplemental Report noted that images collected by the LCS would be digitized by the sensor itself, thereby eliminating the risk of significant degradation in transmission.

The Whistleblowers' Comments

The whistleblower submitted written comments concerning all three reports prepared by NASA and consistently maintained that the LDRI and LCS systems were not capable of reliably inspecting the TPS for potentially catastrophic damage. Ultimately, the whistleblower concluded that "NASA managers [were] aware of the issues [he identified], but . . . elected to ignore these concerns and fly the Space Shuttle with systems that are known to be faulty and inadequate."

The whistleblower's Initial Comments, submitted to OSC on July 18, 2005, in response to the agency's Initial and First Supplemental Reports, disputed the adequacy of both the LDRI and LCS and attached technical documentation in support of the whistleblower's contentions. In particular, the whistleblower observed that while, as the agency admitted, damage to the RCC as small as 0.020 inches may prove catastrophic, the LDRI is certified to detect damage of 0.25 inches in diameter. In addition, the whistleblower asserted that the LDRI does not function properly when inspecting surfaces situated at certain angles to sunlight. According to the whistleblower, sunlight can "overwhelm" the laser light that the LDRI system uses for illumination and the measurement of distances, making the LDRI system "unusable in various lighting conditions." The whistleblower further asserted that even if the LCS were able to detect damage of a sufficiently small size, it could not be used to scan the TPS because it is not mounted on a pan and tilt unit. Nor, according to the whistleblower, would the use of the LCS to confirm suspected damage identified by the LDRI represent an adequate solution to the problem of inspecting the TPS because the LDRI cannot reliably determine where the LCS should inspect.

The whistleblower also stated in his Initial Comments that NASA planned to transmit images from the LDRI and LCS to analysts on the ground using low resolution technology. This method of transmission, the whistleblower maintained, would degrade images collected by NASA's TSP inspection system and make them difficult to read. Indeed, the whistleblower asserted that images routed through NASA's planned signal path would be of "poorer quality than broadcast quality [National Television System Committee] analog video." Along with other factors such as the compression and decompression of images, boom vibration, and ground disturbance, the signal path that NASA planned to use for its TPS inspection systems during its Return to Flight Mission would, according to the whistleblower, "cause a decrease in information content and overall image quality." The whistleblower concluded that the LDRI and LCS are unable to provide the high-resolution imaging capability recommended by CAIB.

Given the alleged inability of the LDRI to detect reliably damage to the RCC as small as 0.020 inches and the low quality of images transmitted from the LDRI to analysts on the ground, the whistleblower asserted that a high-resolution digital cameras would provide more information

regarding the condition of the RCC and a greater chance of successfully detecting potentially catastrophic defects than the LDRI. According to the whistleblower, the same conclusion was reached by NASA experts, and the recommendations of these experts were borne out by test photographs contained in Attachment J to his Initial Comments. The whistleblower further stated that working groups formulated methods for employing such digital cameras in the inspection of the TPS, but their efforts to develop a more reliable inspection system were "stopped by engineering management who [were] supplying the [LDRI and LCS] system[s]."

On August 11, 2005, the whistleblower submitted additional comments (Supplemental Comments) in response to the agency's Second Supplemental Report. In these Supplemental Comments, the whistleblower again disputed the reliability of NASA's TPS inspection systems. Because the whistleblower submitted his Supplemental Comments after the completion of the Space Shuttle Discovery's Return to Flight Mission, he was able to cite the performance of NASA's TPS inspection systems in support of his contentions. In particular, the whistleblower noted that an onboard video tape recorder used to record and downlink the TPS inspection failed during the TPS inspection in the same way it had failed on previous missions. The whistleblower also asserted that review of the imagery produced by NASA's TPS inspection systems revealed "poor resolution, low dynamic range" images of the RCC. According to the whistleblower, the performance of NASA's TPS inspection systems during the Return to Flight Mission "demonstrate[d]" that they are "inadequate to reliably detect critical damage."

In his supplemental comments, the whistleblower asserted that the agency's Second Supplemental Report contained an implicit admission on the part of NASA management that the LDRI and LCS were inferior to the two-dimensional, high-resolution camera system recommended by the NASA working groups tasked with finding a solution to the problem of inspecting the TPS. Specifically, the second paragraph of the agency's Second Supplemental Report stated that "a high-resolution camera will be added to the [LCS] suite of sensors by the third Space Shuttle flight" in order to "enhance [NASA's] TPS inspection capabilities." The whistleblower observed, however, that the high-resolution camera referred to in NASA's Second Supplemental Report is the same camera previously recommended by NASA's working groups and objected to by management of Engineering Directorate. Thus, the whistleblower concluded that "the addition of this camera demonstrates that NASA does not feel the LDRI is sufficient, and also begs the question as to why it will only be added at the third flight and why it was not added for the first flight."

Conclusion

Based on the representations made in the agency's reports and as stated above, I have determined that the these reports contain all of the information required by statute. Given the highly specialized nature of the disagreement between the agency and the whistleblower concerning the capacity of the LDRI and LCS to detect defects in the RCC, I am not in a position to dispute the reasonableness of the agency's technical assertions concerning its inspection systems.

Nevertheless, several of NASA's findings are troubling and may warrant further inquiry. Specifically, it is unclear how NASA can plausibly maintain that its decision to rely on inspection systems that predate the Space Shuttle Columbia accident "complied with the CAIB

recommendation" to "provide a capability to obtain and downlink high-resolution images," when CAIB expressly determined that such high-resolution images were not available on the Space Shuttle Columbia's final mission. *Compare Columbia Accident Investigation Board Report* vol. 1 at 68, 226 *with* NASA's Initial Report. Indeed, NASA's admissions that "a digital still camera system" operated by an extravehicular crew member could be used to "back-up" the LDRI and LCS during its Return to Flight Mission and that "a high-resolution camera will be added to the [LCS] suite of sensors by the third Space Shuttle flight" appear to suggest an awareness on the part of the agency that high-resolution, two-dimensional cameras can provide information about the TPS not available to the LDRI or LCS as currently configured. *See* Second Supplemental Report. The photographic evidence attached to the whistleblower's Initial Comments further supports the contention that a high resolution, two-dimensional camera system would provide more detailed images of the TPS than the inspection systems adopted by NASA. *See* Initial Comments, Attachment J. Finally, it is troubling that the agency appears to have discounted the recommendations of at least one working group comprised of its own experts.

Despite these reservations and the strong arguments presented in the whistleblower's comments, I find that the agency's reports, taken as a whole, are reasonable within the meaning of 5 U.S.C. §1213 (e). In particular, it appears that the NASA initially selected the LDRI and LCS systems on the basis of what was at the time a legitimate selection criterion, *i.e.*, the need to measure the depth of damage to the TPS, and that NASA's risk assessment and planning sought to minimize the known shortcomings of the selected systems. Therefore, the agency's conclusion that its selection and implementation of a TPS inspection system was adequate does not appear unreasonable.