National Aeronautics and
Space Administration
Office of the Administrator
Washington, DC 20546-0001

June 9, 2005

The Honorable Scott J. Bloch
U.S. Office of Special Counsel
1730 M Street, NW, Suite 300
Washington, DC 20036-4505

Re: OSC File No. DI-04-2524

Dear Mr. Bloch:

I am writing in response to your April 18 correspondence regarding a "whistleblower disclosure" alleging inadequacies in the method by which the National Aeronautics and Space Administration (NASA) plans to inspect the integrity of the Space Shuttle Thermal Protection System (TPS) while the Shuttle is on orbit.

The allegation concerns the imaging resolution of the cameras NASA plans to use to inspect the Orbiter's TPS in accordance with the recommendation of the Columbia Accident Investigation Board (CAIB). The CAIB recommended (Report Recommendation R3.4-3) 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' Thermal Protection System" and (Report Recommendation R6.4-1) "develop a practicable capability to inspect and effect emergency repairs to the widest possible range of damage to the TPS, including both tile and Reinforced Carbon-Carbon (RCC)."

NASA determined that two-dimensional, high-resolution photographs, film, or video would not meet our requirements for determining the extent of damage to the wing-leading edge TPS. The Space Shuttle Program Manager determined that the depth as well as width and breadth of potential damage is of such importance when assessing a potential TPS damage site that we require three-dimensional imaging capability. In addition, the need to ascertain the depth of tile damage is essential for determining the severity. Two-dimensional imaging from video or still digital cameras could not provide this depth measurement without optimal lighting and the need to space two cameras a few feet apart at a precisely known distance from the damage site. For these reasons, NASA has acquired laser scanning imaging capability to accurately determine the depth, width, and breadth of identified TPS damage locations.

Due to the high criticality placed on inspection, two different laser systems, the Laser-Camera System (LCS) and the Laser Dynamic Range Imager (LDRI), will fly on

STS-114 to inspect for and measure possible damage. These systems were selected because previous versions of both laser systems have flown in space before, and each demonstrated excellent performance in all lighting conditions on orbit and a capability to identify damage in the RCC wing-leading edge and nose cone TPS (the TPS elements that experience the highest temperatures upon reentry). In addition, unlike today's highest resolution, two-dimensional imaging systems, the LDRI and LCS are not dependent on ambient lighting to provide the necessary three-dimensional imaging capability.

The LCS and LDRI will be installed on the end of our newly designed Orbiter Boom Sensor System (OBSS), a 50-foot extension boom that will be grappled by our existing robotic arm. Low-resolution video cameras will be used with both the LCS and LDRI to control a pan and tilt mechanism on which the LDRI is mounted; the LCS comprises a laser and video camera. The LDRI flew in this same configuration with video cameras on a previous mission. The video cameras will also provide additional situational awareness for the crew during robotic operations of the OBSS. The low-resolution video cameras are not intended to be used for inspection purposes.

Initially, in the aftermath of the Columbia accident, the smallest size of catastrophic damage expected for the lasers to detect on RCC was a quarter-inch diameter hole. The NASA community was confident about the detection of holes of that size with these systems. As impact tolerance testing of RCC continued throughout 2004, it became apparent that catastrophic damage could be as small as 20-thousands of an inch by two-inch crack, or coating loss of the RCC without a through hole. Recent testing of the LDRI demonstrates that it is capable of detecting flaws down to 15-thousands of an inch. The LCS is still in testing, but is expected to detect similarly small damage.

I believe that NASA has 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. Both systems were tested and proven to accurately identify potential critical damage to Orbiter wing-leading edge RCC and tile. This capability provides the best assurance that NASA will have a clear understanding of the Orbiter TPS prior to committing our crew to reentry.

I thank you for bringing this concern to my attention. I am available at your convenience to answer any questions that might arise from this response or to further clarify our response.

Cordially,

Michael D. Griffin
Administrator

National Aeronautics and
Space Administration

Headquarters
Washington, DC 20546-0001

July 6, 2005

Reply to Attn of: Space Operation Mission Directorate

Ms. Catherine McMullen
Chief, Disclosure Unit
U.S. Office of Special Counsel
1730 M Street, NW, Suite 300
Washington, DC 20036-4505

Re: OSC File No. DI-04-2524

Dear Ms. McMullen:

I am writing this supplemental letter in response to your inquiry concerning our response to a "whistleblower disclosure" alleging inadequacies in the method by which the National Aeronautics and Space Administration plans to inspect the integrity of the Space Shuttle Thermal Protection System (TPS) while the Shuttle is on orbit.

In our initial response, we neglected to comply with the requirement of 5 U.S.C §1213(d)(2) to provide a description of the conduct of the investigation. Our investigation was conducted by Mr. William C. Hill, Senior Integration Manger for Space Shuttle in our Office of Space Operations. Mr. Hill conducted interviews with the Orbiter Project Manager, Mr. Steve M. Poulos, Jr., and the Space Shuttle Program (SSP) Manager, Mr. William W. Parsons. Through these interviews, Mr. Hill ascertained the background and technical rationale for the decision made to not select two-dimensional visual technology for the primary means to inspect the Space Shuttle TPS on orbit. Mr. Hill also gathered the presentation material provided by the SSP Manager in his decision-making process, as well as technical reports on the laser sensors. In addition, Mr. Hill independently determined that the nature of the two-dimensional, high-resolution imagery does not provide the third dimension of depth that is so critical in assessing the critical nature of potential damage to Orbiter TPS. The use of laser technology provides the capability to determine length, width, and depth of a potential TPS damage site and is not dependent upon ambient lighting conditions, which the high-resolution photographic or video technologies require, to provide the necessary three-dimensional imaging capability.

In our original response, we noted that the Laser Camera System (LCS) was still being tested for detection capability. Since our response, the LCS has completed flaw detection capability testing and has a demonstrated capability to detect flaws down to 15-thousands of an inch. Operationally, the LCS and the Laser Dynamic Range Imager (LDRI) have demonstrated the capability to detect flaws smaller than the 20-thousands of an inch by two-inch catastrophic damage that was determined through impact testing of Reinforced Carbon-Carbon (RCC) and subsequent entry survivability testing. Although the LDRI and LCS are not certified to this detection level, under certain flight conditions and planned scan rates, both have been demonstrated to detect flaws to 15-thousands of an inch. Also, to help insure we detect any potential damage to the TPS, we intend to inspect the RCC hardware twice using two different viewing angles. Because of differing capabilities among the LDRI and LCS, the LDRI will be employed to conduct the RCC inspection on Space Shuttle flight day 2, and the LCS will be used to perform focused inspection of damaged tile to determine depth on flight day 4, if needed.

I have recently conducted the Flight Readiness Review (FRR) for the upcoming Space Shuttle mission, STS-114, at which the operational use and capabilities of the LDRI and LCS were presented. I concur that use of the lasers is the only viable technology available to meet the requirement for acquiring critical three-dimensional images of potential damage to Orbiter TPS, RCC, and tile. The FRR Board reached a unanimous agreement that STS-114 is ready for flight.

If you have any questions concerning the information contained in this supplemental letter to our original response, please contact Mr. Hill at (202) 358-0571, directly. I am also available at your convenience to answer any questions that might arise from this supplemental response.

Sincerely,

William Readdy

William F. Readdy
Associate Administrator
for Space Operations

National Aeronautics and
Space Administration
Office of the Administrator
Washington, DC 20546-0001

July 25, 2005

The Honorable Scott J. Bloch
U.S. Office of Special Counsel
1730 M Street, NW
Suite 300
Washington, DC 20036-4505

Re: OSC File No. DI-04-2524

Dear Mr. Bloch:

I am writing in response to your July 21, 2005, correspondence regarding a whistleblower allegation. The statement alleged that, "NASA management opted to rely on existing, low-resolution imaging technology and suppressed the implementation of a technically feasible, superior imaging system to inspect the Thermal Protection System (TPS)." This letter addresses the concerns delineated in your correspondence.

Throughout our return to flight process, NASA has evaluated and tested a variety of TPS imaging technologies. Drawing on the results of these evaluations, we selected laser imaging as the best method for operational implementation on STS-114 and subsequent Space Shuttle flights. We selected laser imaging, in part, because we had previous on-orbit experience with the technology. More importantly, however, we selected it because it provides the capability to acquire critical depth measurements that two-dimensional photographic imaging does not. Our testing and analysis clearly demonstrates that knowing the depth as well as the size of damage is crucial to determining whether or not it poses a threat to the integrity of the TPS and, therefore, a threat to the safety of the Shuttle and her crew during re-entry. NASA continues to evaluate additional imagery capabilities to enhance our TPS inspection capabilities in the future. For instance, a high-resolution camera will be added to the Laser Camera System (LCS) suite of sensors by the third Space Shuttle flight. Additionally, we are evaluating thermal imagery techniques to identify the presence of subsurface delamination in the Reinforced Carbon-Carbon (RCC) components.

RCC coupon tests in simulated entry heating conditions have demonstrated that a surface flaw as small as or smaller than 0.020 inch by 2.0 inches will not deteriorate to TPS failure. Although the Laser Dynamic Range Imager (LDRI) is only certified to detect a 0.25 inch through hole in RCC coupons, 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. If a flaw is detected during the RCC scan on Space Shuttle flight day 2 or photography by the International Space Station crew, a more focused, static laser and video inspection of the suspect area will be performed using the view angles and ambient lighting conditions that have been demonstrated during ground tests to yield the best imagery results.

NASA has performed a risk assessment of our TPS damage detection capability and has determined that it is acceptable to proceed with the Space Shuttle mission. We understand the limitations with using the Orbiter Boom Sensor System (OBSS) on the end of the Remote Manipulator System (RMS) to position the LCS and can manage the LCS inspection within proven view angles and sensor distance to the flaw. Although the primary function of the LCS will be to conduct focused inspections of tile damage that is identified through other imagery (i.e., digital photographs taken by the International Space Station crew as the Orbiter approaches), flight controllers have determined suitable view angles and defined the correct RMS/OBSS trajectories to properly position the LCS and acquire the needed three-dimensional images of potential damage sites on all of the left-hand wing and nose cap RCC, as well as the high-heat regions of the right-hand wing RCC and the majority of the TPS tile. For those known areas where the LCS cannot be properly positioned, the LDRI will be used. In addition, an EVA crew member can be positioned with a digital still camera system, which has been certified to back-up the LDRI and LCS, to complete wing leading edge RCC inspection or perform point inspection of damaged tile.

With regard to the comment concerning degradation of images that are downlinked, NASA has demonstrated the capability to acquire laser images and evaluate flaws down to 0.015 inch for both the LDRI and LCS through simulations and tests. Because the LCS images are digitized at the sensor, there will be no degradation of the downlinked images.

NASA does not agree with the assertion that "the LDRI does not function properly in the sunlight." However, we acknowledge that there are limitations when inspecting surfaces at certain view angles. From our certification and test program, we understand the limitations with regard to view angles and will work within those limits when using the LDRI. The LDRI has been demonstrated to work well during inspection of RCC surfaces in all ambient lighting conditions, both in lightness and in darkness. There is some degradation in three-dimensional measurement accuracy using the LDRI to measure depth in tile in direct sunlight; however, we plan to use the LCS to measure tile damage depth. In those areas where the LDRI will be needed to measure tile damage due to inaccessibility by the LCS on the RMS/OBSS, we believe the ambient lighting conditions can be managed by conducting the inspection in darkness. Unlike other imagery technologies, laser imagery has been demonstrated to work well in darkness. Approximately 45 minutes of every 90-minute Shuttle orbit is in darkness.

Thank you for bringing these concerns to my attention. We remain committed to flying safely, and welcome suggestions that improve our capabilities. If you have any questions concerning the information contained in this supplemental letter, please contact Mr. William Hill at (202) 358-0571 or by e-mail at william.c.hill@nasa.gov. I am also available at your convenience to answer any questions that might arise from the information contained in this letter or to further clarify our response.

Sincerely,

Michael D. Griffin
Administrator