National Aeronautics and Space Administration

Office of the Administrator
Washington, DC 20546-0001

October 26, 2009

Dr. Kenneth M. Ford
Chairman
NASA Advisory Council
Washington, DC 20546

Dear Dr. Ford:

Enclosed are NASA's responses to the recommendations from the July 16, 2009, meeting of the NASA Advisory Council and the Council meeting on April 16, 2009. Several of the recommendations have led to productive dialogue, coordination, and planning across multiple organizations at NASA. In particular, the Agency's efforts to capture and incorporate "lessons learned" involve not only our Mission Directorates, but also, the Offices of the Chief Engineer, Safety and Mission Assurance, and Human Capital Management at NASA Headquarters, as well as our Centers. We will be providing the responses to the remaining Council recommendations within the next couple of weeks.

Please do not hesitate to contact me if the Council would like further background on the information provided in the enclosures.

I appreciate your recommendations and advice in this and all areas.

Sincerely,

Charles F. Bolden, Jr.
Administrator

5 Enclosures:
1. AF-09-01
2. SC-09-06
3. SC-09-07
4. SO-09-02, Table 1, Attachment 1
5. SO-09-03

Tracking Number: AF-09-01
Effective Financial Management, Accounting, and Stewardship of NASA Resources

NASA Advisory Council Recommendation:

The National Aeronautics and Space Administration's Advisory Council recommends that the new Administrator of NASA continue placing the high priority on effective financial management, accounting, and stewardship for NASA resources that have led to the valuable advances made in recent years in these matters at NASA.

Major Reasons for Recommendation:

Ensure leadership places a high priority on these matters to preserve valuable advances made in recent years in financial management, accounting, and stewardship.

NASA Response:

The NASA Administrator intends to place a high priority on effective financial management, accounting, and stewardship. The Administrator fully supports Agency operations, including financial management, to ensure that organizational priorities are met. As part of this ongoing effort, the Administrator has already held discussions with key financial management leadership and stakeholders to review and consider best practices for preserving and furthering valuable advances made in NASA's financial management arena during recent years.

Tracking Number: SC-09-06
Extend Bilateral Cooperation with ESA to Include Earth Science

NASA Advisory Council Recommendation:

Recommend that NASA collaborate with the European Space Agency (ESA) to plan coordinated Earth science, applications and observation goals. Based on these goals and plans, identify specific opportunities for coordination of and collaboration on missions, research programs, and for data archival, distribution, and exchange policies. The planning should involve corresponding operational agencies where appropriate.

Major Reasons for Recommendation:

NASA and ESA have each advanced technical capabilities for space-based Earth observation and seek to meet similar observing requirements. The expectations of both Agencies' stakeholders exceed each Agency's capacity (not capability), and yet the two Agencies fly similar missions. The data exchange policies are uneven and lead to underutilization of the collected data. A substantial potential for synergy exists if organizational and policy barriers can be overcome.

NASA Response:

NASA agrees with this recommendation. It is worth noting that NASA has engaged in bilateral Earth science cooperation with ESA for many years. NASA and ESA have regular bilateral meetings to review and consider new cooperation. The next NASA-ESA Earth Science Bilateral meeting is scheduled for November 16, 2009, at NASA Headquarters. Likewise, both NASA and ESA engage in extensive cooperation with operational agencies; ESA has a longstanding working relationship with the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), and NASA has extensive relationships with the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Geological Survey (USGS), to name just two. Finally, NASA and ESA interact frequently, and both have leadership roles in international coordination groups such as the Committee on Earth Observing Satellites (CEOS), which is the space coordination body for the international Group on Earth Observations/Global Earth Observation System of Systems (GEO/GEOSS). NASA will assume the Vice Presidency of the CEOS Strategic Implementation Team (CEOS-SIT) in November 2009.

NASA's Earth Science Division appreciates and embraces the value of international partnership. Earth science is of global interest, and NASA's Earth Science Division has partners all over the world. In addition to the breadth of its capabilities, NASA's open data policy makes the Agency an extremely attractive partner. NASA's Earth science missions that involve international collaboration include Terra, Aqua, Aura, Tropical Rainfall Measuring Mission (TRMM), Jason-1, Ocean Surface Topography Mission

(OSTM)/Jason-2, Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO), Cloud Satellite (CloudSat), and Gravity Recovery and Climate Experiment (GRACE), which are currently in operation, as well as, Aquarius and Global Precipitation Measurement (GPM), which are in development. NASA-developed instruments have flown on partner spacecraft, and international collaborations on Earth science field campaigns and research efforts are extensive. Just a few examples of NASA Earth science partners in spaceflight hardware development include France, Argentina, Brazil, Canada, Finland, Germany, Japan, the Netherlands, and the UK, and scientific collaborations in Earth science are active in dozens of countries.

International cooperation is possible when the activities proposed are mutually beneficial and the organizations have the leadership and resources to actively pursue these opportunities. NASA and ESA bilateral cooperation has progressed more rapidly on the space science side, in large, part due to the high degree of symmetry between European and U.S. science priorities in astrophysics, heliophysics, and planetary science. NASA's Earth science program focuses on basic research and, while ESA's Earth science program has similar interests, ESA also has other priorities including those set by the European Union. The close working relationship that defines NASA-ESA cooperation in space science is a model for future cooperation in Earth science. In November 2009, NASA and ESA Earth science staff will meet again to see what opportunities exist for future cooperation. We look forward to building a closer relationship with ESA's Earth science staff and to finding those opportunities for future cooperation that are mutually beneficial.

Tracking Number: SC-09-07
Managing Mars Science Laboratory (MSL) Technical and Cost Challenges

NASA Advisory Council Recommendation:

Recommend that NASA not allocate additional funds for MSL beyond the current level, pending planned reviews in fall 2009.

Additionally, the NAC recommends that NASA document the lessons learned from MSL history relative to cost growth and technology issues to inform future developers of large, complex missions.

Major Reasons for Recommendation:

MSL has faced significant technical and schedule issues that resulted in its delay from its original 2009 launch opportunity to its current planned launch in 2011 (which was initially estimated to add $400M to the cost of this flagship mission). There is considerable uncertainty around the costs associated with handling the remaining technical challenges, with estimates ranging from an additional $15M to $115M (above the $400M mentioned above) needed to adequately fund reserves. NASA's Science Mission Directorate is closely monitoring the technical and schedule progress of MSL and anticipates that technical reviews in fall 2009 will provide greater clarity to key technical challenges facing MSL and will enable a more precise estimate of the additional reserve funds needed to complete this vital mission. Until the full extent of the additional reserves is known, it is difficult for the NAC to advise on the proper trades between funding alternatives.

The Planetary Science Division has compiled a very informative history (in PowerPoint slides) of MSL's technical challenges, programmatic decisions, and cost estimates. It is important to repackage this historical information into a narrative white paper that can properly capture this information for future developers of complex science missions. This will serve until the fuller lessons learned exercise planned by the Division for 2010 is complete. This white paper should be made a public document.

NASA Response:

NASA agrees with this recommendation and plans the following actions:

1. A "Readiness to Proceed" review is planned for November 2009. At which time, the full extent of the reserve needs should be known and reviewed by the Standing Review Board. Additional reserve funding to the MSL project will be held until the potential trades have been presented to the NAC.

2. The Planetary Science Division will prepare a white paper on MSL's cost history that will be made available to the NAC after the November 2009 review is completed.

3. Initial discussions and planning are underway for a more detailed lessons learned study that is currently scheduled for completion in June 2010. This study will be jointly conducted by the Science Mission Directorate, the Office of the Chief Engineer, and JPL.

Tracking Number: SO-09-02
Documentation and Teaching of Human Spaceflight Lessons Learned

NASA Advisory Council Recommendation:

A portion of the NASA training program should focus on lessons learned from the human spaceflight missions in order to retain historical knowledge, as many older employees will be retiring. NASA should document specific major operational lessons learned from human spaceflight programs. These lessons learned should be written/presented in a format to facilitate ease of training for the next generation of space workers.

Major Reasons for Recommendation:

Concerns exist where the labor force may turn over in sufficient quantity to permit loss of knowledge and experience. Although the Orion missions will differ from the Shuttle missions, there are many generic lessons from which new employees can learn. By documenting certain incidents which are good case studies, both new employees and veterans can be better prepared to operate the Orion launch and flight system. Some examples could be: Gemini-Titan 8, Skylab Rescue Capability, Mir-Progress collision, STS-49 Intelsat retrieve, STS-47 tethered satellite loss, STS-80 jammed EVA hatch, STS-51A Palapa/Westar retrieval, STS-87 Spartan mission loss, STS-83 fuel cell anomaly, STS-93 electrical short and LOX low-level cut-off, etc. These lessons should also include major ground processing, launch countdown, and personnel incidents.

NASA Response:

NASA agrees that using lessons learned and case studies that reflect historical knowledge from older workers helps retain knowledge to share with the next generation of space workers. NASA also agrees that standardization of knowledge-sharing activities is important to the extent that it focuses on the foundational aspects of knowledge sharing (e.g., lesson and case study development methodology) without compromising the flexibility required for addressing local learning strategies and knowledge-sharing needs, which often differ based on the circumstances at a given point in time.

Knowledge-sharing activities such as lessons learned and case studies serve as tools that promote organizational learning and preserve corporate knowledge. Several NASA Centers have taken steps to institutionalize these activities. The Johnson Space Center (JSC) and the Goddard Space Flight Center (GSFC) have a Chief Knowledge Officer, and the Jet Propulsion Laboratory (JPL) has a Chief Knowledge Architect to coordinate and facilitate knowledge sharing, including collaborations with other Centers. The Kennedy Space Center (KSC) and the Glenn Research Center (GRC) also have developed knowledge-sharing programs that are fostering collaboration across Centers. The NASA Academy of Program/Project & Engineering Leadership (APPEL) in the Office of the Chief Engineer (OCE) serves as an Agency-wide resource for the creation

and dissemination of lessons learned through its training courses, knowledge-sharing fora, and publications. Similarly, the Office of Safety and Mission Assurance (OSMA), using the NASA Safety Center (NSC), develops and distributes a variety of publications including system failure case studies, cases of interest, and mishap warning action reports to ensure that important learning opportunities are documented and shared across the Agency. The Agency will continue to support and promote these efforts that are already in place and benefiting from active participation and cooperation.

The Agency also currently has several rich collections of lessons learned and case studies that are easy for NASA personnel to find, access, and search from their desktops. These databases include specific major operational lessons learned from human spaceflight programs as well as lessons about NASA's robotic and aeronautics programs. Table 1 lists the sources identified in the OCE survey of existing case studies and lessons learned. The list does not necessarily include all of the rich collections available, but provides an overview of what is available today for all NASA employees.

The diversity of knowledge-sharing activities and offerings available to date reflects three main points. First, users have differing needs. Much of the knowledge that can benefit an engineer or project manager tends to be local, not fully universal. Second, organizations across the Agency use multiple learning strategies that use lessons learned and cases as training instruments. These include (but are not limited to) training courses, knowledge-sharing fora, short workshops, electronic publications, videos, and databases. Finally, the range and variety of topics covered (which include: mission/project failures and successes; close calls; technical lessons learned; project leadership decisions; design cases; safety reminders; and personal insights based on experience) lend themselves to different lengths and formats.

The common denominator among NASA's knowledge-sharing activities is the basis in practitioner experience coupled with the shared commitment to cultivating reflective practitioners, building communities of practice, and improving NASA's performance as a learning organization. Case studies and written lessons learned are typically developed from a combination of the following sources: personal interviews with practitioners; source documents such as briefings and engineering memos; historical or archival documents; first-person articles; academic or technical publications by practitioners; databases of lessons learned; and oral histories or video archives. The finished product is a narrative that conveys key knowledge, insights, and learning objectives while illustrating the complexity of the tradeoffs and decisions that practitioners faced.

NASA disseminates lessons learned and case studies through several channels. These include (but are not limited to): training sponsored by APPEL, the NASA Engineering Safety Center (NESC) Academy, OSMA through the NSC, and Center training and knowledge-sharing organizations; the annual two-day Project Management Challenge training event, which features over a dozen case study sessions each year; the APPEL Masters Forums and Principal Investigator Forums; publications such as APPEL's Academy Sharing Knowledge (ASK) Magazine and the ASK the Academy e-newsletter, OSMA's Safety Messages, and Center newsletters such as JSC Today; and methods such as the Exploration Systems Mission Directorate's practice of having project risk managers link lessons learned to specific project

knowledge-based risks in a continuously updated project risk record. Attachment 1 provides a further description of each.

A plan for preparing new operational lessons learned from human spaceflight programs will encourage continuation of the strong grassroots efforts already in place that have produced the volume of rich knowledge sharing materials currently serving NASA's workforce. OCE's future efforts will include creating a centralized resource on the NASA Engineering Network (NASA only) and the APPEL Web site (public) that offers links and enhanced searches for as many identified knowledge-sharing resources as possible without duplicating any of the source data. The OCE will continue to implement all current OCE-funded work on lessons learned and case study development. In addition, the OCE plans to add, pending OCE budget authority, an annual data call to all NASA Centers to develop approximately ten additional cases per year specifically focused on, but not limited to, human spaceflight knowledge sharing and professional development. GSFC has created a document entitled "Creating Case Studies in NASA Project Management: A Methodology for Case Writing and Implementation" (see Table 1), which will serve as the standard methodology for the products created under this plan. This will ensure that cases added through this data call share a common approach while meeting the local knowledge needs of the Centers. Once new case studies are developed, they will be made available as training instruments to APPEL and all other training and development organizations across the Agency. In addition to the data call, OCE will continue to encourage Center management to familiarize themselves with the knowledge sharing work already underway (e.g. ongoing efforts at JSC, GSFC, JPL, KSC, and GRC) and to adopt those best practices that work best for their respective Centers.

Table 1 – Lessons Learned and Case Study Resources at NASA

Name	Web Address
JPL Flight Anomaly WIKI*	https://jplwiki.jpl.nasa.gov:8443/display/JPLFAD/Home
JSC Case Studies	http://knowledge.jsc.nasa.gov/index.cfm?Event=CaseStudies
GSFC Case Studies	http://library.gsfc.nasa.gov/public/cspub.htm
APPEL Case Studies	http://www.nasa.gov/offices/oce/appel/knowledge/publications/32.html
Masters Forums video and PM Challenge video clips and podcasts	http://www.nasa.gov/offices/oce/appel/knowledge/multimedia/multimedia.html
PBMA Safety Messages	http://pbma.nasa.gov/index.php?fuseaction=pbma.main&cid=584
Systems Engineering Leadership Development Program	http://www.nasa.gov/offices/oce/appel/seldp/index.html
PBMA Video Nuggets	http://pbma.nasa.gov/index.php?fuseaction=videolibrary.results
PBMA Case Studies	http://pbma.nasa.gov/index.php?fuseaction=casestudies.main&cid=511
CxP ICE Case Studies*	https://ice.exploration.nasa.gov/ice/site/km/cs/
NSC Mishap Alert Cases	http://nsc.nasa.gov/MISO.mvc/Mwar
NSC System Failure Cases Studies	http://nsc.nasa.gov/KMO.mvc/SFCS
NSC Cases of Interest	http://nsc.nasa.gov/KMO.mvc/COI
SMA Technical Excellence Program	http://nsc.nasa.gov/TEO.mvc/STEP/
NESC Reports	http://www.nasa.gov/offices/nesc/reports/index.html
NESC Technical Bulletins	http://www.nasa.gov/offices/nesc/technicalbulletins/index.html
NESC Special Features	http://www.nasa.gov/offices/nesc/home/index.html
NESC Online Courses	http://www.nescacademy.org/catalog/current_courses.aspx
JSC Knowledge Case Files	https://lldb.jsc.nasa.gov/index.cfm?event=CaseFiles
NASA Lessons Learned Information System	http://nen.nasa.gov/portal/site/llis/LL
GSFC Case Development Methodology	http://www.nasa.gov/centers/goddard/about/organizations/OCKO/casestudies/index.html
Design, Development, Test, and Evaluation Considerations for Human Rated Spacecraft Systems	http://ntrs.nasa.gov/
Human Spaceflight Lessons Learned in the "Apollo Experience Report" collection.	http://ntrs.nasa.gov
JSC Engineering Academy	http://ea.jsc.nasa.gov/Ea_web/html/emplsrv/academy/index.asp
US Air Force Center for Systems Engineering Case Studies	http://www.afit.edu/cse/cases.cfm
US Space and Rocket Center Archives	http://www.ussrc.uah.edu/

Table 1. This list of existing sources of lessons learned and case studies identified in the OCE survey provides an overview of what is available today for all NASA employees inside the NASA firewall. (* Note that these links are not directly accessible without a password.)

Attachment 1
Description of Formal Knowledge-Sharing Activities

NASA's Academy for Program/Project & Engineering Leadership (APPEL): APPEL develops the Agency's technical workforce through a competency-based model that identifies learning experiences and activities that need to take place at each career level. APPEL provides leadership, advice, direction, and support to meet the learning and development objectives of the NASA program/project managements and engineering community. The Academy facilitates dissemination of lessons learned and best practices through knowledge sharing activities, including conferences, forums, workshops, publications, case studies, and communities of practice.

NASA Engineering Safety Center (NESC) Academy: The NESC Academy was established to ensure that the vast body of knowledge of retiring NASA scientists and engineers remains viable and accessible to the current community of NASA professionals. The NESC Academy provides the forum through which teams of technical experts, called Technical Discipline Teams (TDT), led by a Technical Fellow (TF), can teach the critical competencies required to meet the NASA mandate. Experienced senior scientists and engineers guide the next generation of NASA scientists and engineers in developing and refining their technical expertise and problem-resolution skills. Hundreds of years of experience-literally--are represented by the TFs and TDTs, Agency-wide, who offer courses such as Flight Sciences, Fluids and Life Support, Satellite Attitude Control Systems, Human Factors, Human Flight Operations, Materials, Mechanical Analysis, Mechanical Systems, Nondestructive Evaluation, Power and Avionics, Propulsion, Robotic Flight Operations, Software, Structures, and Systems Engineering.

NASA Safety Center SMA Technical Excellence Program (STEP): STEP is NASA's discipline-focused, career-oriented, professional development path for individuals working in the Safety and Mission Assurance (SMA) disciplines. Participants hone their skills by first completing a series of SMA implementation/core/domain courses followed by immersion in discipline-specific course work, immersion in relevant case study-based group activities, and hands-on rotational assignments side-by-side with experienced senior technical experts. The Technical Excellence Office at the NASA Safety Center works with representatives from the NASA Centers to build curricula that are doable and relevant to the SMA community.

Program Management (PM) Challenge: PM Challenge is one of NASA's premier training events. It brings together the best speakers, discussion panels, case studies, and networking opportunities in program/project management, systems engineering, safety and mission assurance, team building, business management, and many others. PM Challenge is sponsored by APPEL in association with the OCE and OSMA.

APPEL's Masters with Masters: NASA "Masters with Masters" is a series of Web-based learning videos that brings together two NASA experts to share insights, lessons learned, and best practices. Its primary objectives are: 1) to help create a cohesive community of project management and engineering practitioners across NASA; 2) to enhance NASA's ability to function as a learning organization that cultivates reflective practice; and 3) to extend the sharing

of lessons learned and best practices across borders (organizational, sectoral, and geographical). The emphasis is on storytelling in an informal atmosphere that encourages candid discussion and reflection.

APPEL's ASK Magazine: *ASK Magazine* grew out of the Academy and its Knowledge-Sharing Initiative and is designed for program/project managers and engineers to share expertise and lessons learned with fellow practitioners across the Agency. *ASK* includes articles about meeting the technical and managerial demands of complex projects, as well as insights into organizational knowledge, learning, collaboration, performance measurement and evaluation, and scheduling. ASK shares stories recounting the real-life experiences of practitioners and communicates important practical wisdom and best practices that readers can apply to their own projects and environments. By telling their stories, NASA managers, scientists, and engineers share valuable experience-based knowledge and foster a community of reflective practitioners. The stories that appear in *ASK* are written by the "best of the best" project managers and engineers, primarily from NASA, but also from other government agencies, academia, and industry.

OSMA Safety Messages: The OSMA safety message archive contains the OSMA monthly safety presentation along with a case study and other related media. These stories are written as summaries of system failures from which all can learn. While many of these cases are not NASA related, each has certain aspects that are applicable to NASA.

JSC Today: JSC Today is a daily e-mail notification service designed as a management tool to provide time-sensitive news and information of an official nature which affects or applies to a majority of JSC employees. Any JSC organization or employee may contribute; however, only those submissions that meet certain requirements will be considered for publication. Special advisories from Center management or NASA Headquarters are provided through JSC Special Notices and Headquarters Special Notices, respectively.

Systems Engineering Leadership Development Program (SELDP): SELDP provides a year-long training experience where home and assignment Center advocates and engineering directors share their knowledge and expertise to provide oversight and guidance to participants on assignments, training, and development options and strategies. Lessons learned are communicated by NASA engineering leadership who engage in frequent discussions with participants during workshops throughout the year. Industry and other government agency systems engineering leaders are invited as speakers to share their experiences with the SELDP participants. Workshops also provide a number of opportunities for participants to share experiences and lessons learned. On assignment, participants are matched with a technical mentor who has experience in the area the participant is striving to learn. Participants may also have a developmental assignment supervisor who is responsible for sharing expertise with the participant. SELDP participants all attend the PM Challenge during their developmental year and may access the NASA Engineering Network lessons learned on-line information.

Tracking Number: SO-09-03
NASA Cost-Benefit Study of Possible Active Methods for Orbital Debris Removal

NASA Advisory Council Recommendation:

We recommend that NASA conduct an in-house study of the current and projected orbital debris situation in order to evaluate the costs and benefits of developing a form of debris removal technology. The study should compare the costs of operating in the ever-expanding debris population with those of developing a selective debris-removal method, and how those compare with long-term savings from actively reducing the threat of future collisions. We also recommend that the NASA study identify to the U.S. Air Force possible enhancements to the Nation's debris detection, tracking, and prediction capabilities that will improve spacecraft protection.

Major Reasons for Recommendation:

The growing debris population, expanded significantly by recent Anti-Satellite (ASAT) tests and random collisions, poses a continuing and increasing threat to operational spacecraft. Despite international protocols on preventing the creation of future debris, the debris population will continue to expand for decades, well past the middle of the century. Recognizing that the Department of Defense (DoD) has primary responsibility for the tracking mission, some gaps exist in U.S. detection capabilities, especially at smaller debris sizes that can still cause catastrophic damage to spacecraft. The projected debris population will, over decades, result in additional damage to or loss of spacecraft, and poses a growing threat to spacecraft. NASA may be able to offer methods to actively reduce the debris population. The benefits of reducing the debris population will accrue to commercial, military, and NASA spacecraft.

NASA Response to Recommendation:

NASA concurs with the intent of this recommendation and has taken preliminary actions toward it. During the past decade, the NASA Orbital Debris Program Office has evaluated numerous concepts for the removal of debris in Earth orbit. At the recommendation of the NASA Chief Scientist for Orbital Debris, in late 2006, the International Academy of Astronautics (IAA) accepted a proposal for a comprehensive study of techniques to remove both small and large debris in altitudes ranging from low Earth orbit to geosynchronous orbit. This study, now nearing completion, examines the technical, economic, and legal challenges of remediation of the near-Earth space environment. NASA will carefully review the findings of this study as it considers potential further work on this topic. NASA will provide a copy of the study to the NAC for review.

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In 2009, NASA and the Defense Advanced Research Programs Agency (DARPA) initiated discussions on joint investigations concerning techniques to remove debris from Earth's orbit, culminating in a U.S. Government interagency meeting in July. Meeting participants agreed to host an international conference on debris removal that will be open to all interested parties with an emphasis on industry, academia, and legal experts. This meeting will be held in December 2009 and will be co-hosted by NASA and DARPA. NASA's Orbital Debris Program Office also agreed to conduct a new analysis to quantify future risks to specific DoD space systems, as well as other systems discussed. This analysis was provided to DARPA in September 2009 and may be briefed to the NASA Advisory Council, as well.