Aerospace Safety Advisory Panel

Annual Report for 2006

NASA AEROSPACE SAFETY ADVISORY PANEL
National Aeronautics and Space Administration
Washington, DC 20546
VADM Joseph W. Dyer USN, (Ret.), Chairman

June 19, 2007

The Honorable Michael Griffin
Administrator
National Aeronautics and Space Administration
Washington, DC 20546

Dear Dr. Griffin:

The Aerospace Safety Advisory Panel is pleased to submit to NASA its 2006 Annual Report. The report documents the Panel's inquiries and analyses during that calendar year, all aimed at promoting the cause of safety throughout NASA. Through its efforts, the ASAP developed insights into aspects of NASA operations such as technical authority, workforce, safety culture and risk management. In these and other areas, the ASAP recognized NASA's safety achievements in 2006, but the Panel also identified further, vital measures that are needed to ensure the Agency's continued commitment to the highest safety standards. As detailed in the enclosed report, it is a particular challenge to maintain those standards in this time of program transition and budget constraints.

In compiling this report, the ASAP is fulfilling a Congressional mandate established through Section 106(b) of the National Aeronautics and Space Administration Authorization Act of 2005 (P.L. 109-155). As with so much that the ASAP undertakes, the cooperation of NASA's senior leadership and staff aided greatly in the completion of this document. Therefore, it is with both respect and appreciation that I submit our Annual Report for 2006.

Sincerely,

Joseph W. Dyer, VADM, USN (Ret.)
Chair
Aerospace Safety Advisory Panel

NASA AEROSPACE SAFETY ADVISORY PANEL
National Aeronautics and Space Administration
Washington, DC 20546
VADM Joseph W. Dyer USN, (Ret.), Chairman

June 19, 2007

The Honorable Richard B. Cheney
President of the Senate
Washington, DC 20510

Dear Mr. President:

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I would be pleased to discuss the contents of this report at your convenience.

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National Aeronautics and Space Administration
Washington, DC 20546
VADM Joseph W. Dyer USN, (Ret.), Chairman

June 19, 2007

The Honorable Nancy Pelosi
Speaker of the House of Representatives
Washington, DC 20510

Dear Madam Speaker:

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Aerospace Safety Advisory Panel

"The Panel shall review safety studies and operations plans referred to it, including evaluating NASA's compliance with the return-to-flight and continue-to-fly recommendations of the Columbia Accident Investigation Board, and shall make reports thereon, shall advise the Administrator and the Congress with respect to the hazards of proposed operations with respect to the adequacy of proposed or existing safety standards, and with respect to management and culture related to safety. The Panel shall also perform such other duties as the Administrator may request."

—Section 106(b) of the National Aeronautics and Space Administration Authorization Act of 2005 | Public Law 109-155, 42 U.S.C. 16601

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I. Executive Summary

Executive Summary

Since it was established in 1968, the Aerospace Safety Advisory Panel (ASAP) has been evaluating NASA's safety performance and advising the Agency on ways to improve that performance. The ASAP bases its advice on direct observation of NASA operations and decision-making. In the aftermath of the Shuttle *Columbia* accident, Congress required that the ASAP submit an annual report to the NASA Administrator and to Congress. The annual report is to examine NASA's compliance with the recommendations of the Columbia Accident Investigation Board (CAIB), as well as NASA's management and culture related to safety. In addition to safety culture, the NASA Administrator, Dr. Michael Griffin, has specifically requested advice from the ASAP on technical authority, workforce and risk management.

The following annual report addresses each of the above topics, along with a number of others. It documents the meetings and other activities of the ASAP in 2006, as well as the recommendations the Panel issued. Through this report, the ASAP recognizes NASA's extensive safety achievements in the past year, but also identifies areas where more progress is needed.

Safety Management: As the ASAP noted, NASA's overall number and severity of on-the-job accidents in 2006 was one of the lowest in the federal workforce. And NASA's commitment to workplace safety is reflected in the results of that year's Performance Evaluation Profile survey. Still, incidents and accidents did occur at NASA Centers. A few of these accidents involved serious injuries, including one fatality. The ASAP was notified immediately about each of the serious accidents and most of the other mishaps. Following the fatal accident, which occurred at the Kennedy Space Center (KSC), the ASAP met twice with members of the Mishap Investigation Board. The Panel expects to review the accident investigation report, which the Investigation Board issued only after what the ASAP considers an unwarranted delay. Beyond that timeliness concern, the ASAP's assessment indicates that NASA analyzes serious accidents in an orderly process, to ascertain causes and derive lessons learned. Occupational safety therefore appears to be well served within the Agency.

In its oversight of NASA's Safety and Mission Assurance (SMA) activities, the ASAP found encouraging developments—for example, a direct line of authority between the SMA Director and the Center Director at the Marshall Space Flight Center (MSFC). But the ASAP found that MSFC, and the rest of the Agency, could better gauge the likelihood of losses by developing leading indicators, rather than continuing to depend on lagging indicators.

As the ASAP observes, one of NASA's challenges is to maintain consistently high safety standards throughout its large and diverse contractor workforce. The Panel therefore advocates goals such as uniformity, transparency and continuous benchmarking with the private sector. One of the ASAP's 2006 recommendations spells out the need to leverage and align safety expertise among the Centers. Other recommendations in this area include one concerning the assignment of responsibility for incident investigations and another dealing with drug and alcohol testing.

Risk Management: In the years since the *Columbia* accident, the ASAP has observed as NASA instituted extensive design modifications and other safeguards aimed at diminishing risks to the Shuttle. This shows that NASA has come a long way in its understanding of failure modes in Shuttle operations. More generally, it indicates significant advances in the Agency's approach to risk. NASA has shown an appreciation of the persistence of risk associated with the Shuttle, and therefore the continuing need to properly assess it—so that appropriate measures can be taken to mitigate that risk through the remainder of the program. The ASAP is exercising oversight to ensure that these advances in risk management extend throughout the Agency, particularly to the International Space Station and the Constellation Program.

The ASAP has devoted particular attention to the Shuttle launch-decision process. Panel members observed all three flight-readiness reviews in 2006, and the ASAP issued recommendations to support decision-making concerning modifications to the Shuttle's External Tank (ET). One recommendation suggested a method for categorizing test and analytical results associated with ET modifications. Another one proposed reconstituting one mission, STS-121, as a test flight with minimum crew, because of unresolved foam-shedding issues with the ET.

The ASAP has observed that launch decisions are too regularly being elevated to the Administrator level, and the Panel noted the lack of an analytical risk-assessment process that is standardized, comprehensive and well understood throughout the Agency. The Administrator has requested that the ASAP provide advice on the most current techniques for handling risk issues.

Technical Governance: The CAIB called for several organizational changes within NASA, including establishment of an "independent Technical Engineering Authority," which would be responsible for technical requirements and all waivers to them. Under Administrator Sean O'Keefe, NASA proceeded to reorganize along those lines. But Administrator Michael Griffin is shifting the Agency's approach from a purely independent technical authority to one based on organic technical excellence.

Dr. Griffin has indicated his intention to maintain independent management paths for technical authority and safety. However, while keeping them separate, he is instituting changes in those paths. The Centers are to take on greater control. Lead engineers will still answer ultimately to the Chief Engineer, but the lines of authority will be channeled through the Centers' engineering directorates. A similar technical governance model will apply to Safety and Mission Assurance authority and to Health and Medical authority.

The ASAP sees merit in the new approach, but it is concerned about the amount of time needed for full implementation. The Panel has held off from extensive comment on the subject during 2006, to allow for completion of the transition, but it will look forward to seeing specific, successful results at the Center and program level in 2007.

Safety Culture: The CAIB identified systemic shortcomings in NASA safety culture that contributed to the *Columbia* accident. Among these were failures of decision-making, risk management and communication. NASA responded to the CAIB findings comprehensively, starting with a cultural assessment to establish a baseline. Efforts to address culture deficiencies followed at three NASA Centers, with plans to expand to nearly all of them. These group activities included: leadership coaching; multiple-rater feedback; skills training; cognizant-bias recognition; and behavioral observation and feedback.

Despite promising results and a survey in which 84 percent of participants said they found the training useful, Administrator Griffin decided not to continue with the approach. Instead, he opted to decentralize the focus of measuring and changing safety culture. He required Center Directors to undertake a number of initiatives to address the safety problems. For example, each Center is required to include ongoing safety culture activities as part of every institutional safety audit.

In response, the ASAP said it was concerned about NASA's shift away from an approach aimed at modifying safety culture to one that appeared to only monitor the status of culture. The Panel also noted that it was less confident than it had been that the issues identified by the CAIB were being addressed. According to the ASAP, NASA's new approach: lacks the metrics necessary to positively measure safety culture; lacks standardization within the Agency, thereby preventing Agency-wide comparisons; and does not systematically provide visibility of cultural changes to NASA's senior management. Despite these concerns, the ASAP does find signs of improving safety culture, particularly indications that communications have become more open within the Agency.

Workforce and Human Capital: As the ASAP said in a 2005 recommendation, "Having the right people with the right qualifications in the right jobs is central to all NASA endeavors, including safety." Maintaining the necessary workforce now presents a particular challenge to NASA, because of the large-scale transition it is undergoing, from the Shuttle Program to Constellation. The difficulties are compounded because of the technical and specialized nature of most of the Agency's work and because many of the most experienced employees are nearing or entering retirement.

In 2005, the ASAP urged NASA to develop a Strategic Workforce Plan and to consider obtaining outside verification and validation of a competency assessment that the Agency had completed. In 2006, the ASAP continued its examination of these issues, consulting extensively with the Office of Human Capital Management and OSMA. The ASAP has monitored NASA's development of a Shuttle Human Capital Plan, which includes surveys of the Agency's Civil Service employees. A new approach to strategic workforce planning is aiming for improved Agency guidance to Centers and planning beyond a one- or two-year horizon. Measures to maintain the appropriate skill base include recruitment efforts outside the Agency. For employees already on staff, NASA has an extensive professional development program, and the Agency has undertaken succession planning, focused on Senior Executive Service positions. Some contract workers are likely to be offered retention incentives, administered through their companies. To encourage employees to gain experience at more than one Center, NASA also plans to offer increasing numbers of rotational assignments.

The ASAP is encouraged by these initiatives. The Panel's chief concern is that needed measures might not be in place soon enough to meet growing needs. The Panel will also continue to look for confirmation that Headquarters and the Centers are working together effectively on these issues.

The Constellation Program: The ASAP recognizes the Constellation Program as an opportunity to advance safety culture throughout NASA. As new spacecraft to be developed, the Crew Exploration Vehicle (CEV), the Crew Launch Vehicle (CLV) and related equipment essentially serve as a clean slate, upon which the best techniques, concepts and processes in system safety can be applied and consequently embedded in the Agency.

The ASAP is concerned about the impact of Constellation's aggressive development schedule. For example, since the top-level requirements are still to be defined, even as some subsystem parameters and design options are being selected, program planners have lacked a clear indication of what risk levels they were designing to. The ASAP noted with approval a system adopted at KSC in which all requirements assumptions are documented and tracked, along with proposed design solutions. The Panel recommended that a similar system be implemented Agency-wide.

The transition from Shuttle to Constellation can serve as the occasion for a fresh evaluation of business practices, particularly their impact on safety. For example, as decisions are being made about explosives-related elements of the Constellation Program, the ASAP has recommended a re-examination of the hazards of placing personnel in close proximity to explosives at KSC's Vehicle Assembly Building.

Even while preparations are under way for Constellation and the manned exploration activities it will support, the ASAP has also continued to focus on advancements in robotics and the safety benefits of unmanned vehicles. The Panel has urged the Exploration Program to establish a formal process aimed at ensuring the optimum mix of manned and unmanned missions.

CAIB Recommendations and NASA Responses: The CAIB issued 29 recommendations, 15 of which, the Board indicated, should be implemented before Space Shuttle flights resumed. Another independent body, the Return to Flight Task Group (RTF TG) was chartered to assess NASA's response to those 15 recommendations.

The RTF TG determined that NASA had met the intent for 12 out of the 15 RTF recommendations. The remaining three dealt with: External Tank Debris Shedding; Orbiter Hardening; and Thermal Protection System Inspection and Repair. The RTF TG found that these recommendations "were so challenging that NASA could not comply completely with the intent of the CAIB," but the Task Group also took note of the extensive work NASA had undertaken in each of these areas. In July 2005, as Shuttle flights resumed with the launch of STS-114, the RTF TG issued its final report. The Task Group's responsibilities for monitoring NASA implementation of CAIB recommendations were transferred to the ASAP. The ASAP now monitors not only responses to the three open RTF recommendations, but also to other RTF recommendations, as well as the 14 non-RTF recommendations, known as the CAIB's continue-to-fly recommendations.

Overall, the ASAP has found NASA's efforts to be commendable and the progress it has made satisfactory. The ASAP has offered guidance to maintain safety standards, and it has observed the External Tank modifications. However, contrary to what NASA has requested, the ASAP does not feel it has the resources to make a final determination on the three open RTF recommendations, which would serve as the basis for closing those recommendations.

The ASAP recognizes that there are limits to how much additional effort NASA can and should devote to the three open recommendations. For the Space Shuttle, as with other programs, it is management's responsibility to set priorities and assess risk—and eliminating all risk is an unrealistic goal. The Agency and the Shuttle Program must guard against developing "tunnel vision" with respect to foam, which could distract them from potential problems developing in other areas.

Safety of NASA Aircraft: By all accounts, flight operations within NASA remain sound and well managed. Totals of mishaps involving NASA aircraft in CY 2006, like the figures for CY 2005, generally showed improvement over earlier years. The ASAP monitored Agency efforts to maintain this safety performance, such as updates to procedural requirements for airworthiness, mission management and other areas.

Panel members participated with NASA's Intercenter Aircraft Operations Panel (IAOP) as it conducted audits of flight operations at Agency facilities and at the University of North Dakota, which is home to a NASA DC-8. The IAOP developed recommendations to address deficiencies identified through the audits. One such recommendation was to standardize Center processes for conducting surveillance of contractors involved with NASA flight operations. The ASAP supports each of the IAOP's proposed corrective actions.

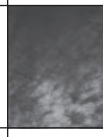
The ASAP notes proposals aimed at cutting costs within NASA by reducing infrastructure and consolidating aircraft operations. The Panel believes that before any changes are implemented, it is imperative that the flight-safety implications be fully considered, especially the possible impact on the oversight of chartered and unmanned aircraft.

Safety and Mission Assurance Resource Concerns: The ASAP views with alarm the budget constraints that are being imposed on NASA by the Administration and Congress. Because of those constraints, the Panel questions whether the Agency will have sufficient resources to live up to all of its program commitments without compromising safety. Furthermore, the ASAP has observed the NASA budget process used to fund safety initiatives, and the Panel is concerned that this process appears to be insufficient to the massive challenges now facing the Agency.

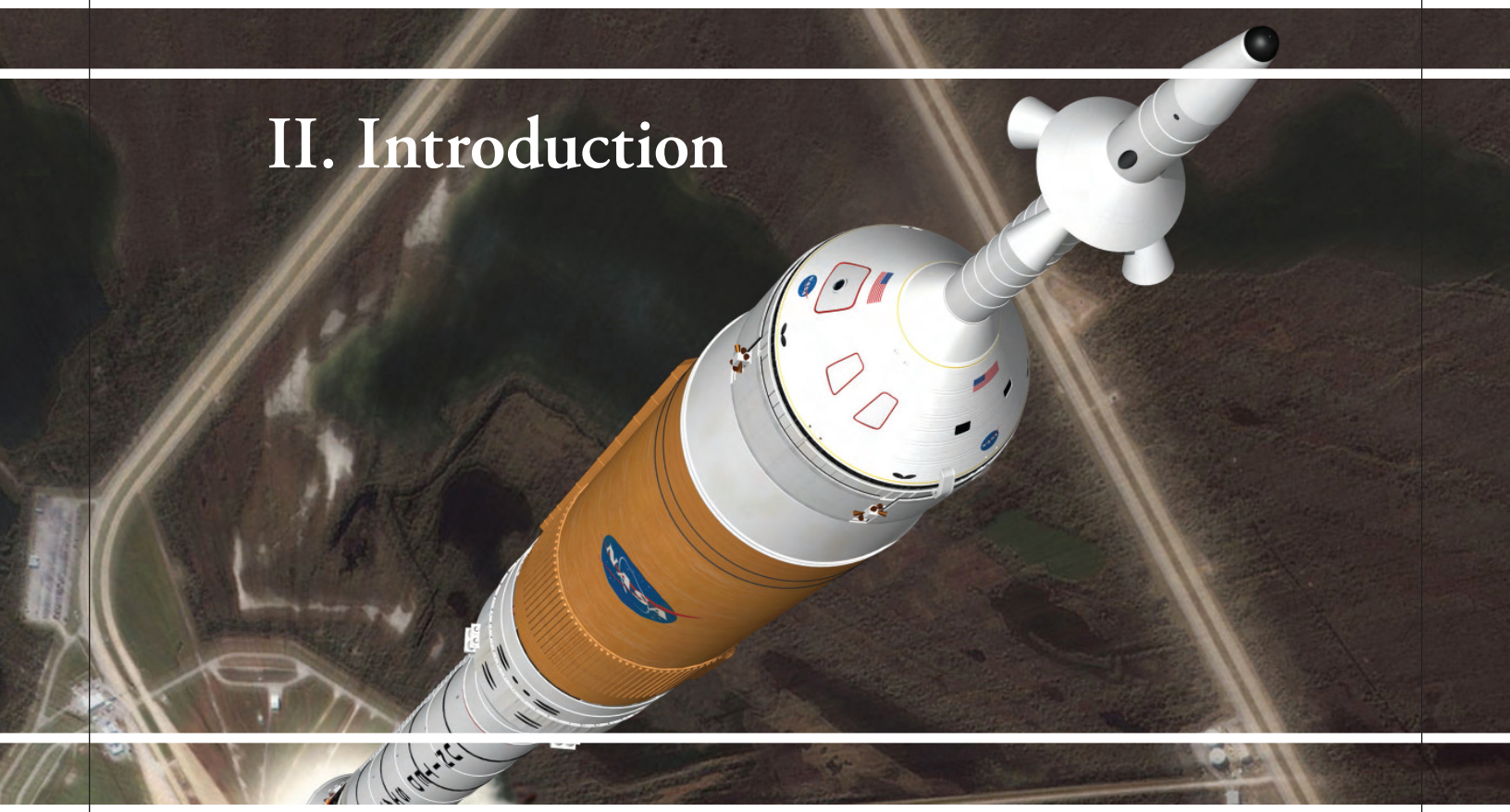
Prompted by these concerns, the ASAP requested further information on NASA's current and projected budget profiles, and OSMA responded with a document titled "Analysis of NASA Safety and Mission Assurance Resource Estimates." In reviewing that analysis (which is reprinted in this annual report), the ASAP noted the emphasis on decentralization in managing disciplines to support programs and projects and in budgeting for their implementation. The Panel pointed out the numerous organizational drawbacks in such an approach. For example, when dealing with one of the numerous large-scale projects that have principal portions distributed across the Agency, the ASAP asked how NASA management can shift resources from one portion of the work to another in order to efficiently execute the overall project.

Based on the OSMA document, the ASAP concluded that NASA Headquarters does not have a way to independently assess how its budget is being expended to promote safety. The Panel objected to the reliance on a steady 5 percent in the budget allocation for SMA. The idea that the amount of resources expended in this area should be constant throughout the life of a program gives the impression that "safety is just a part of overhead," not a core consideration in the program. And the ASAP objected to the lack of clear estimates in OSMA budget projections, even for years in the near term.

The ASAP urged the Administration and Congress to address the budget deficit created by requiring NASA to operate under the FY 2007 Continuing Resolution, and the Panel called for full Agency funding for FY 2008 and beyond. The Panel recommended that NASA standardize and centralize its SMA budget development and allocation and that NASA require explicit itemization of safety-related expenditures and shortfalls. Also, the ASAP recommended two requirements for OSMA: The Office should conduct quarterly reviews of programmatic safety requirements versus budget authority to ensure safety issues are being addressed, and it should validate to the Administrator, on a quarterly basis, that the proper level of budget authority has been provided for Centers and programs to fulfill their safety objectives.



II. Introduction



Introduction

Since its inception in 1968, stemming from the Apollo 1 (AS-204) fire the previous year, the Aerospace Safety Advisory Panel (ASAP) has been evaluating NASA's safety performance and advising the Agency on ways to improve that performance. This annual report describes the ASAP's efforts during calendar year 2006.

The ASAP develops its insights through direct observation of NASA operations and decision-making. Such observation could only be possible with the unstinting cooperation of senior NASA leadership. Thanks to the access provided by the Agency, the full Panel conducts site visits at NASA Centers. There were three such visits in 2006. Single Panel members or groups of members attend key NASA meetings and formal reviews, such as Flight Readiness Reviews (FRRs) and Safety and Mission Success Reviews (SMSRs). At the July 2006 FRR for STS-121, an ASAP member gave a formal briefing to all review participants. As the Space Shuttle Program fully returned to flight with three successful missions in 2006, the ASAP monitored not only these reviews, but also launches, on-orbit operations and post-mission analyses.

ASAP members examine facilities and attend conferences outside NASA as well, when those sites and discussions have bearing on NASA's safety mandate. For example, throughout 2006, Panel members monitored the functions of the NASA Intercenter Aircraft Operations Panel (IAOP). ASAP representatives attended one IAOP conference and participated in the group's safety audit of the aviation program at the University of North Dakota, which operates and maintains a NASA DC-8 research aircraft. An ASAP member also audited the Program Manager Training program at the Jet Propulsion Laboratory (JPL). And the ASAP provided a member to the Senior Advisory Group that met numerous times during the year to provide guidance and advice to NASA's Exploration Safety Study. This study examined ways to optimize NASA's Safety and Mission Assurance organization, policy and procedures.

The ASAP also conducts its own meetings, held quarterly, some at Centers, some at NASA Headquarters. (For a list of the ASAP's 2006 meetings, see Appendix C of this report.) These meetings are among the means through which the ASAP announces its conclusions, identifying what it sees as NASA's safety successes and shortcomings.

When the ASAP first met with Dr. Michael Griffin, NASA Administrator, in July 2005, he indicated that there were four main areas in which he particularly hoped to receive advice from the Panel: Technical Authority; Workforce; Safety Culture; and Risk Management. There is a section devoted to each of these topics, plus five more, in Part III of this annual report, titled "Pivotal Issues."

In the course of its 2006 evaluations, the ASAP issued 10 recommendations to NASA. These recommendations included: two concerning STS-121 risk assessment and launch decision-making; three concerning contractor safety and embedding contractor safety in the procurement process; two concerning the new Exploration Program; one on risk assessment and communication; one on leveraging Center safety expertise; and one on improving random drug and alcohol testing. In addition, there was one "special recommendation" concerning the STS-121 launch decision, which urged the Administrator to consider revising the mission to strictly a test flight with a minimum crew. (See Part IV of this report for a compilation of the Panel's 2005 and 2006 recommendations, including the current status of each recommendation.)

In general, 2006 was a year marked by significant achievements for NASA in the Space Shuttle and International Space Station programs and in the new Exploration Program. But in addition, specifically in the realm of safety, the ASAP recognizes the strides made by the Agency. Ten prominent examples are the following accomplishments identified by NASA's Chief Safety and Mission Assurance Officer:

1. Establishing the NASA Safety Center near the Glenn Research Center.
2. Improving the metrology program at KSC to provide an improved product at reduced cost for the Shuttle Program.
3. The performance of high-quality, risk-based trade studies for several major decisions, including: engine cutoff sensors for Shuttle; Hubble repair; micrometeoroid/orbiting debris (MMOD) late inspection; day vs. night launch; and composite overwrapped pressure vessels (COPV) reliability over time.
4. Development of autonomous air refueling flight-control software at the Dryden Flight Research Center using the F-18 aircraft probe and drogue.
5. Establishment of the "Operability Design Analysis" team at Marshall Space Flight Center (MSFC) for Crew Launch Vehicle (CLV) design. This effort ensures early integration of Safety and Mission Assurance analysis activities in the design.

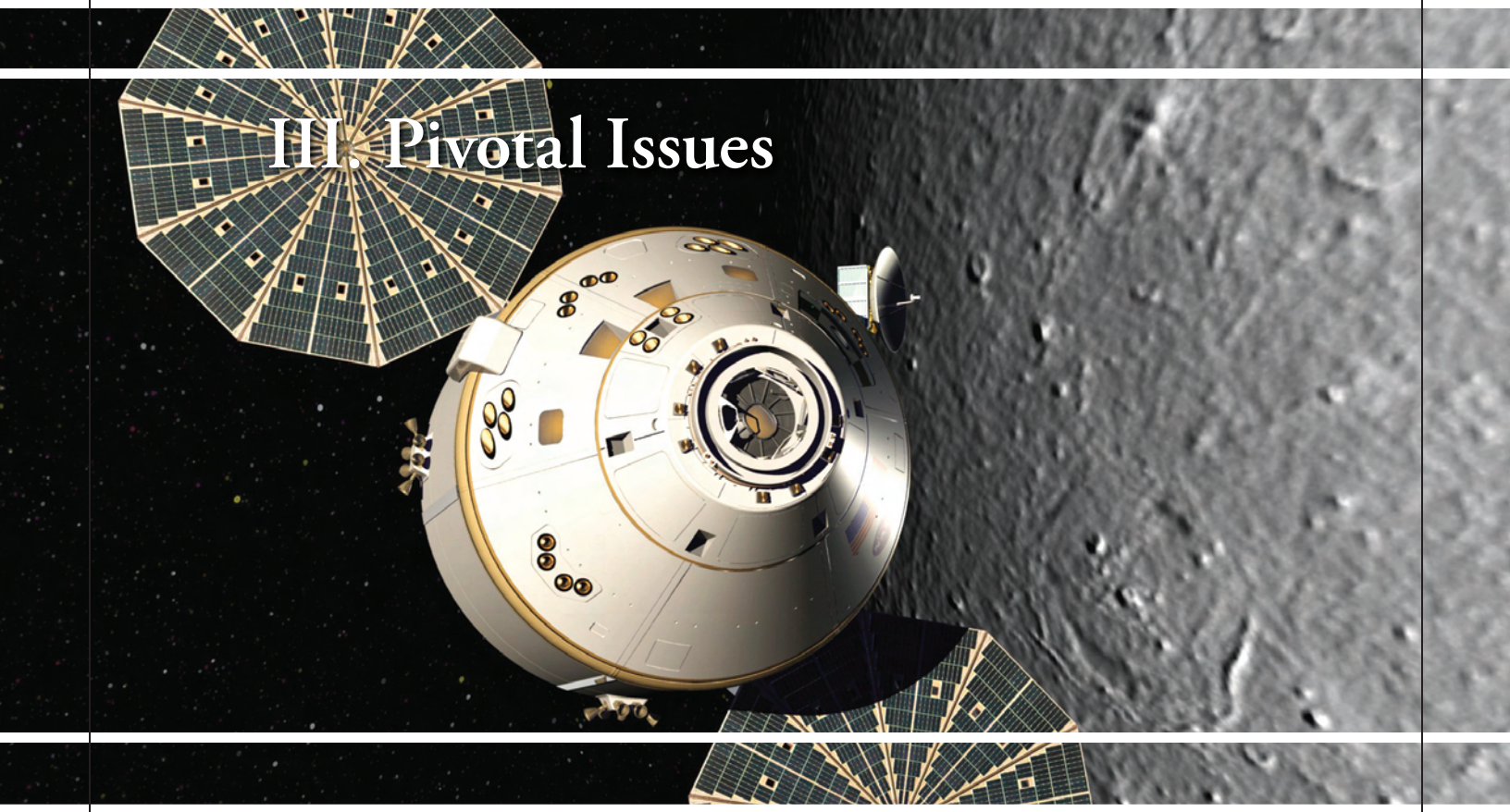
6. Addition of the Engineering organizations into Safety and Mission Success reviews.
7. New human-factor protocols for operations teams at JPL.
8. Ownership of the risk-management program by Shuttle Program management.
9. Unprecedented sharing of process escapes across Shuttle Program elements.
10. Addition of "late inspection" to Space Shuttle on-orbit operations.

The ASAP's Statutory Mandate and Panel Membership

Congress established the ASAP's statutory duties through the NASA Authorization Act of 1968. Once the Federal Advisory Committee Act of 1972 (FACA) was enacted, that legislation governed the operation of the Panel. But after the Shuttle *Columbia* accident, Congress—through the NASA Authorization Act of 2005—reinstated the ASAP's original statutory duties. Amendments to the original Act included a requirement that the ASAP evaluate "NASA's compliance with the return-to-flight and continue-to-fly recommendations of the Columbia Accident Investigation Board [CAIB]," as well as a requirement to submit an annual report to the NASA Administrator and to Congress. Among the report's contents, the 2005 Act stipulated that the ASAP address NASA's compliance with the CAIB recommendations, and the report is to "include an evaluation of NASA's management and culture related to safety." The NASA Administrator signed the current ASAP Charter on November 18, 2005.

From 2005 through early 2007, there was substantial turnover in ASAP membership. Three Panel members were reappointed for new terms beginning in 2006: the ASAP Chair, Vice Admiral Joseph Dyer, USN (Ret.); Ms. Deborah Grubbe; and Mr. John Marshall. Members with terms expiring in 2006 and late 2005 included: Dr. Dan Crippen; Mr. Steven Wallace; Mr. Rick Williams; Dr. Augustine Esogbue; and Major General Rusty Gideon, USAF (Ret.). Dr. Amy Donahue's term ended in early 2007. Newly appointed members include: Mr. John Frost; Ms. Joyce McDevitt; Major General Charles Bolden, USMC (Ret.); Dr. James Bagian; and Dr. Donald McErlean.

III. Pivotal Issues



A. Safety Management

In fulfilling its mandate to monitor safety performance throughout NASA, the Aerospace Safety Advisory Panel conducts ongoing oversight of the agency's Safety and Mission Assurance (SMA) activities. In 2006 this oversight included site visits to the Marshall Space Flight Center, the Kennedy Space Center, the Jet Propulsion Laboratory and the Johnson Space Center. In the course of these visits, as well as the review of SMA actions in general, the ASAP found much to commend. At MSFC, for example, lost-time accident rates are improving, and the Panel noted there is a direct line of authority between the facility's SMA Director and the Center Director. As program demands change, SMA recognizes the need to adjust available technical expertise accordingly. Center-wide workforce education is therefore a high priority. For example, a training deficiency in chemical handling was identified and corrected. At the same time, the ASAP noted areas where safety management could be improved. Among these observations, ASAP found that MSFC (and the Agency overall) could better gauge the likelihood of losses by developing leading indicators, rather than continuing to depend on lagging indicators.

Improvements in safety statistics are not limited to MSFC. The ASAP has noted with interest that in FY 2006, NASA's overall number and severity of on-the-job accidents was one of the lowest in the federal workforce. During the first three years of the President's Safety, Health and Return to Employment (SHARE) initiative, NASA reduced total accidents from 121 in 2003 to 90 in 2006, and the Agency's lost-time injuries declined from 42 to 36. During this same period, a new metric for lost-production days, which measures the amount of time away from work, was reduced in half—from 9.9 days per 100 employees to 4.7. Most importantly, this meant that during the past three years, 123 NASA employees have avoided injury, and of that number, 15 avoided serious injury. In addition, the lost-production-day injuries that did occur took less than half the number of days off work as did injuries in 2003. The ASAP views these reductions as a clear indication that NASA is committed to reducing the number and severity of employee injuries, and the Panel commends NASA for this effort. This impression is corroborated by the results for 2006 of NASA's Performance Evaluation Profile survey, used to assess the Agency's occupational safety and health programs. That PEP report is included as Appendix E of this annual report.

Since a large portion of the work at NASA Centers is performed by contractors, in many ways NASA's safety performance depends on its contractor safety programs. KSC personnel, for example, comprise approximately 13,000 contractors, compared with 2,000 NASA employees. Contractors at that one Center perform myriad functions, from roofing to Shuttle processing. The ASAP acknowledges the challenges in developing and instituting safety programs to cover such a large and diverse workforce. Still, uniformity should be a goal of contractor safety management policy. Other goals include transparency to all personnel involved and continuous benchmarking with the private sector. To achieve consistency across the Centers and to maximize the safety benefits of successful programs, while avoiding wasteful duplication of effort, the ASAP continues to advocate a system that involves "buy-in" from the top. Best practices—such as the fall-protection program developed at KSC—should be adopted at the Headquarters level and then be required agency-wide. For that fall-protection program, as well as other elements of NASA's Occupational Safety Program, one of the ASAP's 2006 recommendations spells out the need to leverage and align safety expertise among the Centers.

In the efforts to achieve such goals, the ASAP found there is room for improvement. The best practices cited above often fail to be communicated between Centers and even within Centers. Contractors need greater encouragement to embrace these practices and to incorporate them into their routine operations. One way of imposing contractor accountability is to embed safety requirements in contract language, with provisions to withhold fees in the event of major breaches, or to authorize awards for jobs well done. The ASAP issued recommendations addressing these elements of contractor safety. Among other measures, the Panel called for a semiannual community-based information session for contractors who work or wish to work at KSC.

In an enterprise the size of NASA, mishaps can be expected to occur. The mishaps in 2006 included one fatal accident. On March 17, a contract worker was killed in a fall on the roof of a warehouse at KSC. Following this mishap, an accident investigation board was convened. The ASAP has closely monitored the inquiry conducted by this board, just as the Panel reviews other investigations of mishaps and close calls at NASA involving serious injury, significant hardware damage and major financial loss to the agency. The Panel has been impressed with the meticulousness and rigor shown by the board investigating the March 17 accident and with the remedial measures it has developed, such as enhancements to the Center's fall protection program. However, it does appear to the ASAP that the investigation has taken longer

than expected: While the investigation and preliminary report only took 30 days, it took an additional eight months to release the final report. Timeliness is a factor in deriving maximum benefit from accident investigations. Closing out the process and releasing the report is just as important as conducting the investigation. It is extremely important for investigation findings to be released and disseminated by Headquarters to other Centers, where similar hazards are likely to be found, so that appropriate safeguards can be instituted. As the Panel monitors subsequent accident and incident inquiries, it will likely focus on Mishap Investigation Board adherence to investigation procedures established within NASA, as well as the efficiency in completing reports.

Among the ASAP's 2006 recommendations stemming from its review of NASA's incident investigation efforts is a recommendation dealing with the assignment of responsibility—both for conducting the investigation and for implementing corrective actions. The Panel said that responsibility should rest with the organization that had authority over the operation in which the incident occurred, rather than the Center where it took place. The ASAP also issued a recommendation concerning random alcohol and drug testing, calling for a consistent, Agency-wide requirement for such testing among contractors—where it now appears to be lacking—as well as among NASA civil servants. Drug and alcohol testing should also be a standard, uniform procedure followed in accident and incident investigations.

B. Risk Management

In complex systems, utilizing breakthrough technologies in unforgiving environments—which is the realm in which NASA routinely operates—risk can be minimized, but not eliminated. The 2003 *Columbia* accident revealed serious shortcomings in NASA's efforts to properly assess and understand risk, specifically the hazards associated with foam shedding from the External Tank. Throughout the duration of the Space Shuttle Program, but particularly since the loss of *Columbia* and its crew, the ASAP has scrutinized risk management, risk mitigation and risk acceptance in that program. The Panel has observed NASA come a long way in its understanding of failure modes in Shuttle operations. In the case of the foam, NASA has made great strides, adopting a host of design modifications and other safeguards, but also recognizing, given the design of the system, that a potential hazard will persist throughout the remainder of the program. For that reason,

and in consideration of other hazards attendant with such a complex vehicle that remains developmental in nature, NASA has shown awareness that it must continue to diligently identify, characterize and assess all risks in order to make appropriate risk-acceptance decisions through the last Shuttle flight.

The ASAP's safety oversight extends to the broad spectrum of NASA's initiatives, including not only the Shuttle Program, but also the International Space Station and the Constellation Program. From this vantage point, the ASAP seeks to ensure that best practices are fostered Agency-wide. The Panel is examining, for instance, whether the lessons from the Shuttle Program in risk assessment and mitigation are being conveyed to the Constellation staff and whether that staff is fully implementing those lessons. Despite initial difficulties, stemming from a lack of top-level requirements, the Constellation Program appears to be taking proactive steps to embed safety and risk analysis into the overall design process, particularly for the Crew Launch Vehicle (CLV).

As stipulated in the NASA Authorization Act of 2005, an ASAP member, John Marshall, serves on the International Space Station Independent Safety Task Force. Mr. Marshall has served in that role during 2006, and he has contributed to the annual report of the Task Force.

Since the resumption of Shuttle missions in 2005, the ASAP has devoted particular attention to the launch-decision process for those missions. Panel members observed all three flight-readiness reviews in 2006. Risk management for STS-121 was a major subject in briefings by Shuttle Program Office staff at the January ASAP quarterly meeting at the Marshall Space Flight Center and the April meeting at NASA Headquarters. With the expectation that External Tank (ET) modifications would be completed to eliminate the LH2 and LO2 protuberance air load (PAL) ramps as potential foam debris sources, but with NASA lacking sufficient time to complete modifications for the ET's ice/frost ramps, the ASAP prefaced its first recommendation of 2006 with the question: "How will the team determine the tank is 'good to go'"? The Panel sought further details about the risk-assessment process for clearing the ET and modifications for launch and for determining total mission risk in the go/no-go decision for STS-121 at the FRR. The Panel recommended that NASA obtain an independent evaluation, such as one from the NASA Engineering and Safety Center (NESC), to support the pre-launch decision-making. Such an evaluation would validate the risk-assessment results, and it would help ensure that the associated flight risk was accepted at the appropriate level and properly mitigated.

In response to the ASAP's request for additional information on the risk-assessment process for the STS-121 launch decision, Shuttle Program Office staff, including Shuttle Program Manager Wayne Hale, briefed the Panel at its second quarterly meeting. In the course of the ASAP's examination of these issues, prior to and during that meeting, the Panel became concerned that NASA's risk-management process did not provide senior leadership with a full picture of the total risk presented by a given mission.

To provide clarity and better understanding of the risks, both known and unknown, in preparation for the launch of STS-121, the ASAP issued a recommendation for the Shuttle Program to establish a clear list and tracked status of test and analytical results associated with the ET modifications. The Panel recommended that these results be separated into three categories: those for which firm pass/fail criteria could already be established; those for which such criteria would be available prior to the FRR; and those for which the criteria would not be available by the time they would be needed at the FRR. The ASAP felt strongly that the elements or decision points in the third category would serve as one reflection of the degree of risk in the upcoming launch decision, and without firm criteria, NASA managers would have to rely on good engineering judgment in assessing those points. As part of that recommendation, therefore, the ASAP asked what assumptions the managers would use in dealing with that third category. The Panel found that NASA's response did not constitute sufficient development of the proposed solution, since the specific details that would show the direct correlation of test and analytical results with either firm pass/fail criteria or "engineering judgment" at the various decision points were lacking. NASA subsequently responded with the details after the mission.

During the two months between the issuance of that recommendation and the launch of STS-121, the ASAP continued to assess risk management in the launch-decision process. At the FRR, Panel member John Frost observed as NASA's Chief Safety and Mission Assurance Officer, Bryan O'Connor, and the Agency's Chief Engineer, Christopher Scolese, dissented in the decision to proceed with the launch because of unresolved foam-shedding issues. Responding to the same concerns about the status of ET modifications, the ASAP issued a recommendation suggesting that the NASA Administrator consider reconstituting STS-121 as a test flight, with minimum crew, rather than the planned operational flight, and to forego program objectives if necessary. While Dr. Griffin ultimately made the decision to launch, the openness of the process and willingness to discuss concerns at all levels

indicates that the NASA safety culture is making great strides. Dr. Griffin indicated that he understood the recommendation and the thinking behind it, but he and his program principals felt that adding an additional flight would introduce far more risk. He said he also felt that breaking crew integrity was really not an option, in view of the complex duties and training that would be involved. Dr. Griffin therefore accepted the risk for the full flight objectives. He clearly articulated all of this during a press conference and associated interviews.

Through observations at each FRR, the ASAP has observed that launch decisions are regularly being elevated to the Administrator level. The Panel feels that this situation should be the exception rather than the norm, particularly in the future when a different Administrator might not have a deep technical background like Dr. Griffin's.

In discussions with the Administrator at the ASAP's third quarterly meeting of 2006, the Panel gained insight into his approach to risk management. At the same meeting, the Administrator requested and the ASAP offered to provide advice on the most current techniques for handling risk issues. On September 13, the Administrator sent a letter expressing once more his interest and formally requesting that advice. Through the remainder of the year, the ASAP examined the STS-115 and STS-116 risk-management processes, and the Panel undertook the work that will ultimately provide the requested advice to the Administrator in 2007.

Another risk-management problem identified by the ASAP in 2006 is the lack of an analytical risk-assessment process that is standardized, comprehensive and well understood throughout the Agency. The Panel found differences among programs, among Centers and even within Centers as to the risk-matrix definitions they have been using. In the deliberations leading up to the launch of STS-121, Panel members noted that there was detailed analysis for only two of 569 known potentially catastrophic hazards. NASA does not seem to have a good approach as to how all of these risks add up, the ASAP concluded, to indicate the overall likelihood of catastrophic failure. To remedy this situation, the Panel recommended that NASA replace these fragmented, inconsistent tools and methodologies with a comprehensive and standardized system for assessing, communicating and accepting risk.

C. Technical Governance

The Columbia Accident Investigation Board identified not only the physical failures in Space Shuttle design and operations that led to the accident, but also the organizational shortcomings within NASA that allowed those failures to develop and persist. The CAIB issued several recommendations aimed at correcting those problems in NASA's organization. Among other concerns, the CAIB identified the conflict of interest inherent in a system in which the Space Shuttle Program Manager was responsible for resources, schedule and safety, which was the case prior to the *Columbia* accident. To meet schedule demands or budget constraints, the Program Manager was frequently called upon to approve waivers of technical requirements, even if those waivers could compromise safety. The CAIB therefore called for an "independent Technical Engineering Authority that is responsible for technical requirements and all waivers to them, and will build a disciplined, systematic approach to identifying, analyzing, and controlling hazards throughout the life cycle of the Shuttle System."

Under Administrator Sean O'Keefe, NASA proceeded to reorganize along the lines specified by the CAIB, a process that the ASAP has monitored. Shortly after Michael Griffin became Administrator in 2005, he communicated to both NASA leadership and the ASAP his desire to shift the Agency's approach from a purely independent technical authority to one based on organic technical excellence.

The CAIB also issued this recommendation concerning OSMA: "NASA Headquarters Office of Safety and Mission Assurance should have direct line authority over the entire Space Shuttle Program safety organization and should be independently resourced." In response, NASA did increase Headquarters authority in this area, but each Center's SMA organization continued to report to the Center Director, rather than to the Chief Safety and Mission Assurance Officer at Headquarters.

As NASA Administrator, Dr. Griffin has indicated his intention to maintain the independent management paths for technical authority and safety. However, while keeping them separate, he is instituting changes in those paths. The Centers are to take on greater control. Lead engineers, replacing the ITA's discipline warrant holders, will still answer ultimately to the Chief Engineer, but the lines of authority will be channeled through the Centers' engineering directorates. A similar technical governance model will apply to Safety and Mission Assurance authority and to Health and Medical authority.

Early in 2006, Chief Engineer Christopher Scolese and Rex Geveden, NASA Associate Administrator, briefed the ASAP on the planned transition from ITA to the technical governance model, which included the Centers developing local implementation plans. This transition continued throughout 2006, and toward the end of the year, a similar implementation for safety management was under way.

The Panel noted evidence of the change at the flight readiness review before the launch of STS-121, when, as described above in the *Risk Management* section, Chief Engineer Scolese joined with NASA's Chief Safety and Mission Assurance Officer, Bryan O'Connor, in opposing the decision to proceed with the launch.

The ASAP sees merit in the new approach, but it is concerned about the amount of time needed for full implementation. The Panel has held off from extensive comment on the subject during 2006, to allow for completion of the transition, but it will look forward to seeing specific, successful results at the Center and program level in 2007. The Panel will also be looking for indicators of a standardized full implementation Agency-wide, with principles of technical governance and the current approach to Technical Authority well communicated throughout.

The ASAP began examining questions of technical governance well before the recent transition. In fact, Independent Technical Authority has been one of the Panel's most pivotal issues ever since the *Columbia* accident. In 2004 the ASAP issued three recommendations (2004-02-01, 2004-03-05, and 2004-04-02) related to ITA. Subsequently, while the ASAP recognized that there was significant Agency activity related to Technical Authority, the Panel felt that responses to these recommendations were not being provided in a timely manner. The ASAP raised these concerns at its third quarterly meeting of 2005, at which time the Panel reissued Recommendation 2004-02-01 as Recommendation 2005-03-04. In that recommendation, the ASAP requested that the NASA Chief Engineer assess ITA and answer the following questions:

a) Who is the technical authority (i.e., who shall have overall responsibility, accountability, and authority to administer ITA)?

b) What are the key functional areas making up the ITA?

c) Who are the representative subject-matter experts assigned to lead key areas?
    a. Where do they reside?
    b. To whom do they report?
    c. Who signs their performance evaluations?
    d. Who can override their direction?

d) What are the reporting, evaluating, and oversight relationships between the functional leaders/ITA and matrix personnel (e.g., between the head structural engineer holding ITA authority for structures and structural engineers assigned to program teams)? This is important because the individuals assigned to the program teams must feel the responsibility and accountability of "good technical conscience" (i.e. there must be a linkage between engineers assigned to the team and to the technical authority if necessary insight is to be achieved).

e) Is a lead functional/ITA person responsible for the long-term career development and continuing education of ALL the people within his/her functional area? Is this responsibility independent of geography; or, are there multiple people at multiple sites? If a single ITA functional lead does not have this responsibility, accountability, and authority all across NASA, how is it exercised at the Agency level? If distributed, how is it integrated?

f) Is there dual reporting? Is there a feedback loop? How are disagreements resolved?

NASA did answer these questions, and since then, the ASAP has closed all of the ITA-related recommendations it has issued up to this point.

See Appendix D for diagrams illustrating technical governance within NASA.

D. Safety Culture

In its August 2003 final report, the Columbia Accident Investigation Board identified systemic safety culture and organizational issues that contributed to the loss of Shuttle *Columbia* and its crew. The CAIB specifically noted failures of decision-making, risk management and communication. To its credit, NASA aggressively responded to these areas by embracing a comprehensive approach, including selection of an outside contractor, to lead the "transformation of its organization and safety culture" that the CAIB had called for. First, a cultural assessment was completed in early 2004 that identified the Agency's strengths to be technical excellence, teamwork and a can-do attitude. Weaknesses, however, were seen in a lack of upward and open communication within the organization, failure to communicate deficiencies, and unwillingness to accept bad news. With a baseline in place, NASA then set in motion a two-phased process to address these deficiencies. The pilot phase began in April 2004 with personnel at the Glenn, Stennis and Johnson Centers undertaking broad-based group activities to begin changing the culture.

Initial results were reported to be promising. Kennedy and Goddard also began limited training. Phase 2, which would continue to develop and further integrate this effort throughout the entire agency (except at JPL), began in January 2005. Areas of focus included: leadership coaching; multiple-rater feedback; skills training; cognizant-bias recognition; and behavioral observation and feedback.

In April 2005, Administrator Michael Griffin decided not to proceed further with this approach, even though 84 percent of survey participants said they found the training useful. Instead, he opted to decentralize the focus of measuring and changing safety culture. To do this, he required Center Directors to incorporate follow-ons into their individual management activities for addressing previous deficiencies. He told them it was important that they lead by example, paying particular attention to upward safety communications—one of the areas of most concern following the CAIB report. In addition, the Agency responded by: encouraging (but not requiring) the use of a Performance Evaluation Profile (PEP) survey tool, derived from an Occupational Safety and Health Administration (OSHA) source, for use in internal audits; benchmarking all three military service safety centers to see how they address culture measurement and to see if any of them has a better survey tool to help change culture; requiring that each Center include ongoing safety culture activities as part of every institutional safety audit; and adding two safety culture questions (similar to those used in the Behavior Science Technology [BST] survey) to the NASA-wide "17-year NASA culture survey."

In late 2005, NASA formalized the shift in its approach back to individual Centers being responsible for routinely monitoring and reporting on the status of safety culture within their organizations by codifying language and philosophy in the Agency's newly published Strategic Management and Governance Handbook. This document echoed the need for encouraging the importance of a positive safety culture. Today, NASA is continuing this approach, encouraging voluntary executive coaching and training, as well as the use of a PEP-style performance evaluation at the Centers.

In response to these changes, the ASAP noted in its First Quarterly Report of 2006 that it was concerned about NASA's shift away from its previous emphasis to positively modify safety culture to an approach that only monitors the status of culture. The Panel also noted that it was less confident than it had been that the issues identified by the CAIB were being addressed. In this regard, the ASAP noted that it felt that NASA's new approach: lacks the metrics necessary to positively measure safety culture; lacks standardization within the Agency, thereby preventing Agency-wide comparisons; and does not systematically provide visibility of cultural changes (positive or negative) to NASA's senior management.

Nonetheless, at this point the ASAP also finds healthy improvement across the Agency in safety communications. While conditions are still far from ideal, signs of a positive safety culture are visible. Of particular note are the frankness of internal debates (which are sometimes even being encouraged), during reviews preceding Shuttle launches, as well as the openness to outside experience and the acceptance of internal dissent. In addition, the ASAP notes that NASA today appears to be benchmarking other organizations more and using "gray beards" to help capitalize on previous lessons learned—both positive signs of a "learning" organization. Additionally, the NESC, along with the Constellation and Shuttle programs, all appear to be reaching out across Centers to obtain the best talent to solve problems, not just the best local engineers. This has helped cut down some of the old Center-to-Center jealousies and communication barriers prevalent in the days before the *Columbia* accident. Furthermore, technical checks and balance in place today have had the beneficial effect of including more people in the discussion.

The ASAP particularly noted a JPL-completed safety-culture assessment conducted February 14–March 21, 2006, which included the following major areas: Management Commitment; Employee Involvement; Worksite Analysis; Hazard Prevention and Control; Safety, Health and Training; Workers Compensation Cost Trend Analysis; and Safety Culture. The Safety Culture item was evaluated through interviews at all staff levels and using the Wyatt-Watson (2005) survey, whose results reflected a commendable safety standing. Safety Culture results indicated high customer satisfaction in safety management, safety programs and safety trending. Additionally, the positive reception given to the "Making Zero Incidents a Reality" Management Overview provided further evidence of a positive safety culture at this Center.

Despite these positive observations, the ASAP believes that NASA still has much to do in its efforts to develop and retain a positive safety culture. For instance, individual Center survey results still show concern in the Agency with upward communication and management support. Additionally, there are some areas where the Panel observes increasing mishap rates, particularly involving contractors supporting NASA, and so far, it appears that these increases have been ignored in the safety-culture discussion. Also, as time goes on and the Agency faces challenges from new and different issues, the ASAP is concerned that NASA may reverse its positive course. To prevent such an outcome, there should be more efforts to institutionalize individual Center programs into more quantifiable, NASA-wide programs to reinforce safety as a core value within the Agency. For this reason, the ASAP believes that NASA must:

- Continue to positively influence and measure safety culture at every level within the Agency;

- Include on-site contractors in measuring, reporting and enhancing employees' safety culture;
- Standardize its approach to measuring safety culture within the Centers; and
- Routinely brief NASA's most senior leaders on changes in the Agency's safety culture.

E. Workforce and Human Capital

Workforce composition is a growing concern throughout the federal service, and in the U.S. private sector as well. Among the widespread management issues are "brain drain," or retention challenges, and shifting demographics. The problem is not simply a matter of keeping a sufficient number of personnel on the employment rolls; it is maintaining a workforce with competencies well suited to the current and projected functions of the organization. At NASA, these problems are particularly acute, because of several factors: the technical and specialized nature of most of the Agency's work; and the large-scale program transition it is now undergoing. For that reason, when Administrator Griffin first met with the ASAP in 2005, he included workforce as one of the four areas to which he requested that the Panel devote particular attention.

During that year, the ASAP issued two recommendations on the subject of human capital. First, it urged NASA to "make it a priority to develop a Strategic Workforce Plan. Having the right people with the right qualifications in the right jobs is central to all NASA endeavors, including safety." The Panel also recommended that NASA consider obtaining outside verification and validation of a competency assessment that the Agency had completed. Such an external review, the ASAP said, would not only lend added credibility to the findings, but would also help pave the way for "more comprehensive analysis of human capital needs and development of strategies to meet those needs."

In 2006, the ASAP continued its examination of these issues, with particular focus on the workforce impact of the transition from the Space Shuttle Program to the Exploration Program. Through research and strong interaction with the Office of Human Capital Management and OSMA, the ASAP was able to examine the details of the problems facing NASA and the measures being taken in response. At each session there was evident consensus, among Panel members as well as those presenting the briefings, that the future of NASA truly depends on successful resolution of these problems. As Panel member Amy Donahue stressed, "There is no mission without workforce."

NASA has not shut down a major program since the end of Apollo. As it begins to do so now, with the upcoming conclusion of the Shuttle Program, the chief human capital objective is to retain all the core competencies needed to maintain high safety standards all the way through the last Shuttle flight. At the same time, NASA management has to anticipate the engineering talents, knowledge resources and other human capital needs in the development of the new Constellation vehicles. It needs to accomplish this transition seamlessly, without gaps in available talents, or overall mission success will suffer, possibly including safety performance. What makes the challenge still greater is that the NASA workforce, while generally stable, is also aging. In other words, employees tend to stick with the Agency through long careers; but many of those careers are drawing to a close, as increasing numbers of the most experienced employees approach or enter retirement. This is particularly true in the areas of science and engineering, which account for about 60 percent of NASA personnel.

Among the responses to this situation, as the ASAP has observed, NASA has been developing a Shuttle Human Capital Plan, which makes use of tools such as surveys of the Agency's Civil Service employees. At the same time, a new approach to strategic workforce planning is aiming for goals such as improved Agency guidance to Centers and planning beyond a one- or two-year horizon. Current and anticipated measures to maintain the appropriate skill base include recruitment efforts outside the Agency. For employees already on staff, NASA has an extensive professional development program in place, and the Agency has undertaken succession planning, focused in particular on Senior Executive Service positions. Some contract workers are likely to be offered retention incentives, administered through their companies.

As indicated in the ongoing ASAP review, NASA has not only an aging workforce, but also an entrenched one. Unlike military service, where movement among duty stations is the norm, NASA employees have tended to hire on at a given Center and then remain there. According to Toni Dawsey, Assistant Administrator for Human Capital Management, NASA now plans to offer increasing numbers of rotational assignments, even for employees at early points in their careers.

The ASAP is encouraged by the NASA human capital initiatives. The Panel's chief concern is one that it has heard echoed by human capital managers themselves—that the process may not be moving fast enough, that needed measures might not be in place soon enough to meet growing needs. The Panel will also continue to look for confirmation that Headquarters and the Centers are working together in the most effective way possible to ensure that NASA has a workforce it can rely on to meet today's missions and those that lie ahead.

F. The Constellation Program

NASA's Constellation Program has become a primary focus of ASAP review because the Panel recognizes this major new initiative as a significant opportunity to advance the state of safety culture Agency-wide. As new spacecraft to be developed, the Crew Exploration Vehicle (CEV), the Crew Launch Vehicle (CLV) and related equipment essentially serve as a clean slate, upon which the best techniques, concepts and processes in system safety can be applied and consequently embedded in the Agency. At the same time, this endeavor can utilize the safety lessons learned in more than 25 years of Shuttle operation, as well as those of Apollo before it.

One area of concern for the ASAP is the requirements process for the Constellation elements. Since the top-level requirements of the Constellation Program are still to be defined, even as some subsystem parameters and design options are being selected, it has proven difficult to follow the normal flow of safety requirements identification and allocation. In some cases, program planners have lacked a clear indication of what risk levels they were designing to. Risk assumptions had to be made on Level III requirements because of the incomplete top-level requirements. Requirements decisions were being made before the completion of trade studies—which is unfortunate, because that means requirements were being determined without the comparative data to be produced by those trade studies, and the outcome of the studies will indicate expected degrees of safety and facility readiness.

At least at one Center, KSC, the ASAP believes that management has been very resourceful in coping with these undesirable circumstances resulting from Constellation's aggressive development schedule. KSC has adopted a system in which all requirements assumptions are documented and tracked, along with proposed design solutions. As the ASAP noted in one of the recommendations it submitted to the NASA Administrator on September 26, 2006, "This system should allow reliable flowdown of changes in those requirements assumptions to avoid unintended consequences." The ASAP went on to recommend that a similar system be implemented Agency-wide to formally track requirements assumptions that could impact future safety performance.

With the Shuttle Program drawing to a close, coupled with the advent of the Constellation Program, NASA is facing a period of transition. That transition especially involves NASA facilities: how to transform the structures and processes to accommodate Exploration activities, while still conducting the remaining Shuttle flights. The transition applies similarly to the NASA workforce: how to maintain

the appropriate mix of critical skills for both the end of Shuttle and the beginning of Constellation. Finally, this program transition should serve as the occasion for a fresh evaluation of business practices, particularly their impact on safety. Just because a given policy or procedure was employed during the Shuttle era does not mean it should be carried over to Constellation.

The ASAP noted one example of such a re-evaluation during the Shuttle/Constellation transition, and that concerns the explosives policy at KSC's Vehicle Assembly Building (VAB). VAB operations often involve hazardous fuels and propellants, yet for years, some employees have been assigned to offices in the building, even though their jobs have not been directly related to the ongoing operations there. This has been an efficient arrangement, and it was permitted under a waiver of the explosives-siting guidelines customarily imposed at the Center. But now, as decisions are being made about explosives-related elements of the Constellation Program, such as which site will be used for hypergolic fuel loading, and the total quantity of solid propellants to be utilized in the VAB, the ASAP has recommended a re-examination of the hazards of placing personnel in close proximity to explosives.

Even while preparations are under way for the Constellation Program and the manned exploration activities it will support, the ASAP has also continued to focus on advancements in the robotics field. It is clear that the capabilities and effectiveness of unmanned-systems technology are progressing worldwide at an astonishing rate. Remotely operated ground and sea devices, as well as autonomous and semi-autonomous systems, are eliminating the need to expose humans to the risks of hazardous operations such as bomb disposal, reactor cleanup and mine-clearing. Unmanned aircraft are rapidly filling the skies and taking over numerous hazardous military missions that previously placed humans at grave risk. Similar technology is being developed to reduce costs and eliminate the potential for human error in less hazardous but repetitive tasks, such as piloting cargo aircraft. And in space, NASA has had tremendous success with highly effective use of unmanned spacecraft and rovers to accomplish numerous missions that would have been extremely risky, enormously expensive or even impossible with manned missions. Not only do unmanned approaches to space exploration eliminate all risk to human crew, they also can reduce mission costs and increase mission capabilities by eliminating the need for life support, man-rated systems and return-to-earth capabilities.

To examine the safety and other mission benefits of unmanned vehicles, in 2005 the ASAP conducted a facilities review at the Robotics Laboratory of the Jet Propulsion Laboratory. Following that review, the Panel issued a recommendation, urging the Exploration Program to establish a formal process aimed at ensuring the optimum mix of manned and unmanned missions. Such a process should examine and weigh the risks and benefits of the two approaches, particularly with regard to safety and mission success.

G. Status of CAIB Recommendations

The Columbia Accident Investigation Board was established within hours of the loss of Space Shuttle *Columbia* and its seven-member crew, on February 1, 2003. By the time the CAIB issued its final report on August 26, 2003, it had issued 29 recommendations, plus numerous additional findings and observations. On July 18, 2003, even before the CAIB's work was completed, another independent body, the Return to Flight Task Group, was chartered. The purpose of the RTF TG was to assess NASA's response to 15 out of the CAIB's 29 recommendations that were designated "return to flight." The CAIB had indicated that these 15 recommendations should be implemented before the Space Shuttle Program resumed flight operations.

The RTF TG determined that NASA had met the intent for 12 out of the 15 RTF recommendations. The remaining three dealt with External Tank Debris Shedding (CAIB Recommendation 3.2-1); Orbiter Hardening (CAIB Recommendation 3.3-2); and Thermal Protection System Inspection and Repair (CAIB Recommendation 6.4-1). The RTF TG found that these recommendations "were so challenging that NASA could not comply completely with the intent of the CAIB," but the Task Group also took note of the extensive work NASA had undertaken in each of these areas, including hardware modifications, which "resulted in substantive progress toward making the vehicle safer." The RTF TG emphasized that "the inability to fully comply with all of the CAIB recommendations does not imply that the Space Shuttle is unsafe." And the Task Group further stated that it could not and would not "make a determination of the safety or reliability of the next flight; that is NASA's responsibility." Exercising that responsibility, NASA did resume Shuttle flights on July 26, 2005 with STS-114. To date, there have been four Shuttle missions following the *Columbia* accident.

In the same month as the STS-114 launch, the RTF TG concluded its activities and issued its final report. The Task Group's responsibilities for monitoring NASA implementation of CAIB recommendations were transferred to the ASAP, under a formal agreement that had been signed two months earlier by Thomas P. Stafford and Richard O. Covey, the Task Group Co-Chairs, and Joseph W. Dyer, the ASAP Chair. As spelled out in the Task Group's final report, and at a July 2005 meeting between members of the two bodies, the ASAP would monitor not only responses to the three open RTF recommendations, but also to several of the other 12. Even though the Task Group had concluded that NASA had met the intent of recommendations such as the one for Ground-Based Imagery (CAIB Recommendation 3.4-1) and the one for Mission Management Team Improvements (CAIB Recommendation 6.3-1), the Task Group felt that these areas still warranted continued scrutiny by the ASAP. In addition, the NASA Authorization Act of 2005 directs the ASAP to monitor NASA compliance with the RTF recommendations, as well as the 14 non-RTF recommendations, known as the CAIB's continue-to-fly recommendations.

In the year and a half since that hand-off from the RTF TG, the ASAP has closely monitored NASA's efforts associated with the designated RTF recommendations and with the continue-to-fly recommendations. NASA has undertaken additional safety initiatives that were not called for by the CAIB, so-called "raising the bar" actions, and the ASAP has evaluated these as well. At three of the ASAP's 2006 quarterly meetings, the Panel met with staff of the Space Shuttle Program Office, and the ASAP continues to review the progress documented in *NASA's Implementation Plan for Space Shuttle Return to Flight and Beyond*, which is currently in its 12th edition. Overall, the ASAP has found NASA's various efforts to be commendable and the progress it has made satisfactory. The ASAP has offered guidance to maintain safety standards—for example, as NASA revises some of the new technologies it has instituted for the first few missions after the Shuttle Program resumed flights. And the ASAP has continuously observed the critical design review process for the External Tank modifications. However, contrary to what NASA has requested, the ASAP does not feel it is or will be in a position to make a final determination on the three currently open RTF recommendations, which would serve as the basis for closing those recommendations. Such a measure would require an extensive review and analysis that would be beyond the resources of the ASAP.

The ASAP commends NASA for all the work it has done to improve safety in the Shuttle Program, including the Agency's efforts associated with these three open recommendations. The ASAP also recognizes that there are limits to how much additional effort NASA can and should devote to these particular concerns. For the Space Shuttle, as with other programs, it is management's responsibility to set priorities and assess risk—and eliminating all risk is an unrealistic goal. The Agency and the Shuttle Program must guard against developing "tunnel vision" with respect to foam, which could distract them from potential problems developing in other areas.

H. Safety of NASA Aircraft

By all accounts, flight operations within NASA remain sound and well managed. Totals of mishaps involving NASA aircraft in CY 2006, like the figures for CY 2005, generally showed improvement over earlier years. There were no Class A mishaps in 2006, 2005 or 2004. There were no Class B mishaps in 2006 or 2005, but there were two in 2004. For Class C mishaps, the totals were five in 2006, three in 2005 and five in 2004. For Class D mishaps, the totals were five in 2006, six in 2005 and eight in 2004.

These totals, including both ground and in-flight reports, are from the NASA Incident Reporting Information System (IRIS) system as of November 29, 2006. Under a classification system widely used among federal agencies, a Class A mishap is defined as an accident resulting in a fatality, an aircraft hull loss, or a direct cost of $1 million or more; a Class B mishap is one resulting in a permanent partial disability or damages of at least $250,000 but less than $1,000,000; Class C involves a cost of at least $25,000 but less than $250,000; and a Class D mishap is one with damages of at least $1,000 but less than $25,000.

In an effort to further standardize aircraft operations and procedures across NASA, in CY 2006 the Agency's Aircraft Management Division added or rewrote eight chapters in NASA Procedural Requirements (NPR) Document 7900 dealing with aircraft operations management. Among these was a chapter on "Airworthiness." To make the content of that chapter more in line with Defense Department processes for certifying the airworthiness of an aircraft, and to ensure that a more robust program is in place, this new standard includes thresholds for conducting airworthiness reviews, data required for airworthiness certification and technical competencies required to review airworthiness certifications for approval. The Aviation Safety chapter requires

additional training for Aviation Safety Officers (ASOs) to ensure that each ASO is maintaining the highest level of knowledge of current industry practices in aviation safety. Two new chapters have been added standardizing operations for "Unmanned Aerial Vehicles (UAVs) Operations" and "Airfield Operations." The chapter on UAV Operations provides guidance for a Center Aircraft Office or for Project Managers in the safe conduct of UAV operations. The chapter on Airfield Operations provides standards for which all NASA Center airfields will now have to comply that are based on the FAA's 14 CFR 139.

In addition to these four chapters, major changes have been made to sections dealing with general flight operations, research and support operations and mission management operations. Additionally, NPR 7900 has incorporated important guidelines that standardize management practices as they relate to: aviation medical care; aircraft acquisition and disposition; flight operations measurements and reporting; and removals from flight status of certain aircrew members.

In CY 2006, the Intercenter Aircraft Operations Panel (IAOP) conducted audits of aviation programs at the University of North Dakota (UND), which is home to a NASA DC-8, as well as at the Kennedy Space Center (KSC), the Johnson Space Center (JSC) and the Wallops Flight Facility. The NASA IAOP review program provides an objective management evaluation of the procedures and practices that are being used at each facility to ensure the safe and efficient accomplishment of assigned missions and goals. In addition to providing Center directors and Headquarters management officials with an overview of the general health of all aspects of aircraft operations, the IAOP review teams also identify deficiencies in, or deviations from, NASA-wide policies, procedures and guidelines.

Although not all-inclusive, the following are some of the results from the 2006 IAOP reviews:

- The review of UND identified deficiencies in: aircraft basing arrangements; NASA on-site oversight of UND; and definition of roles and responsibilities between UND and NASA.
- The review of KSC identified deficiencies in airfield standardization and wildlife management. The review also revealed the need for better mishap reporting and the need to address staffing discrepancies.

- The review at JSC identified deficiencies in maintenance practices for aviation life-support equipment, and it pointed out deteriorating ramp conditions. The review also noted deficiencies in future USAF UAV operations at JSC's Ellington Aircraft Operations Division.
- The Wallops review identified deficiencies in management structure, pilot training records, crew duty day and tool control.

Furthermore, common challenges across the Agency that were observed during 2006 IAOP reviews, as well as proposed corrective actions, included:

a. *Observation:* The need for better management oversight of contractors.

   Recommendation: Standardize Center processes for conducting surveillance of contractors tasked to conduct flight operations for NASA, utilizing each Center's Aircraft Operations Office.

b. *Observation:* The lack of proficiency flying hours (i.e. training dollars) for research pilots.

   Recommendation: Establish a baseline of funding within program budgets or the Shared Capability Assets Program (SCAP), as appropriate, to provide proficiency flight training for pilots conducting research operations within the Agency.

c. *Observation:* Need for a better way to address the Aviation Cultural Survey process and its integration with the IAOP reviews.

   Recommendation: In collaboration with the Aircraft Management Division, the Office of Safety and Mission Assurance should develop a cultural survey/assessment tool for aircraft operations managers to identify concerns and issues associated with morale, personnel and management.

The ASAP agrees with these proposed corrective actions and recommends that the Agency move aggressively to resolve each issue.

A positive finding during each of the NASA installation audits was that all Center ASOs now have open and direct access to their respective Center Directors, along with improved communication regarding aviation safety.

In an effort to establish a standard aircraft incident reporting system to be used across the Agency and to share the lessons learned at all the Centers, NASA's Aircraft Management Division has funded the Aircraft Module to IRIS (the Agency's Incident Reporting Information System cited above) to allow for better aircraft mishap and close-call reporting and tracking. Also, working with NASA's Office of Safety and Mission Assurance, the JSC Aircraft Anomaly Reporting System was adopted as the Agency's alternate reporting system. This system has been used by JSC's Ellington Aircraft Operations Division for the past several years with great success. Not only does the system serve as a means for capturing aircraft-related safety anomalies, it also provides a forum for disseminating lessons learned to aircrew personnel.

In an ongoing effort to identify "best practices" that can be implemented in the NASA aviation program, the IAOP ASO Subpanel has continued to examine successful aircraft operations found elsewhere in government and in industry. The Subpanel held its 2006 NASA Aviation Safety Officers Conference at the NTSB Academy in Ashburn, Virginia, providing NASA ASOs with the opportunity to benchmark the latest in NTSB accident investigation procedures and advances in aircraft survivability. The ASAP supports NASA in this initiative and encourages the Agency to continue this practice.

Finally, as part of an Agency effort to reduce costs to support the Vision for Space Exploration, the Office of Infrastructure and Administration (I&A) and the Office of Program Assessment and Evaluation (PA&E) are considering opportunities to reduce infrastructure and consolidate aircraft operations throughout the Agency where appropriate. The ASAP believes that before any changes are implemented, it is imperative that the flight-safety implications be carefully and fully considered, especially the possible impact on the oversight of chartered and unmanned aircraft.

I. Safety and Mission Assurance Resource Concerns

The ASAP has observed the NASA budget process, and it is concerned that this process, used to identify requirements and priorities, appears to be insufficient to the task now facing the Agency. That task is to simultaneously: conduct the remaining Shuttle missions; complete the International Space Station; fulfill the commitments to aeronautics and deep space missions; and advance the new Constellation Program—and while doing all that, to maintain the highest safety standards throughout. In general, the ASAP is troubled by the budget constraints imposed on NASA by the Administration and Congress and by the attendant impact of those constraints on safety. With little prospect for an increase in funding or work force—in fact, with likely decreases—the ASAP questions whether the Agency will have sufficient resources to live up to all of its program commitments without compromising safety. Prompted by this concern, the ASAP requested data and analyses on NASA's current and projected budget profiles. In response, the Agency's Office of Safety and Mission Assurance (OSMA) provided the following document on pages 43-45.

OSMA Analysis of NASA Safety and Mission Assurance Resource Estimates

History of these numbers

After the Office of Safety and Mission Assurance (nee Office of Safety, Reliability, Maintainability and Quality Assurance) was formed in the late 1980's, the headquarters office attempted to maintain an accounting of resources that were applied by the various major programs for that work considered as part of the effort that the safety and mission assurances disciplines represent. This accounting was in no way an attempt to build an SMA budget for the Agency; on the contrary the Agency has steadfastly believed that not only the management of the disciplines in support of programs and projects as well as the budgeting for their implementation should be decentralized at Center and Program level. The resources data have always been collected as a data call to the Center SMA Directors on a periodic basis and not every year. These data calls have always sought totals including the salary costs of SMA civil service and support contractors for both direct and indirect costs as well as a "good faith" estimate of the costs of SMA content in the prime and sub tier contractor work force. While attempts were made to be all inclusive, each dollar was not checked and crossed check using any sort of strict accounting principles. This was not possible in the early days with the decentralized and non-integrated accounting tools and the minimal resources invested in collecting the data and without a well defined work break-down structure for NASA work, collecting the data remain an imprecise manual task. The numbers are estimates for internal assessment and have been provided as information to inquisitors over the years. In the early part of the two decades where data have been kept, the ratio of SMA dollars spent seemed to be roughly 5% (termed the "SMA fraction" for purposes of this paper) of the Agency budget. This has been judged historically to be reasonable. No budgets were ever challenged using these "rules of thumb" and no one has ever seriously discredited the 5% being a comfortable SMA fraction.

Today and Transition

There is much unknown about any definitization of Exploration Systems Mission Directorate (ESMD) cost in the 2011-12 time-frame. We also know there are some known unknown costs in both Shuttle and ESMD operations in the 2011 and 2012 time frames and these will only become more apparent as we enter this year's Planning, Programming, Budgeting, and Execution (PPBE) exercise later in the spring. These plans will become more precise as new acquisitions are formalized and contracts definitized. In the meantime, all operating costs for Shuttle in the 2011 and 2012 time frame have been moved from the budget for the Space Operations Mission Directorate to the Exploration Systems Mission Directorate. An attempt to mimic this wholesale move has been made in the line for projected ESMD SMA estimated outlays.

What we do know is that civil service work force is fairly well understood at the summary levels and is pretty much capped by Agency ceilings. To augment SMA work that needs to be accomplished, dollars are applied as support contractor work and investments by dollars from OSMA augment this work to some small degree. Each year, each SMA organization addresses in an annual operating agreement the work it needs and plans to perform. In no case have any shortfalls been identified for the OSMA to address with a mission director. By and large, OSMA, as well as SMA Directors have been comfortable with the work levels and the resources they have been afforded for performing the work of assurance and where there were shortages, OSMA has successfully approached responsible leaders directly with appeal for more resources. OSMA will continue to evaluate the content of the Agency's outlay for SMA as a ratio of overall NASA outlay and will seek to use the tools being brought into service by the Integrated Enterprise Management Process to better automate the insight and make these SMA fraction estimates more precise and the acceptability of resources in support of SMA more insightful.

Attached is a matrix of information that explains what is known and what might be expected about SMA outlays in the present and future budget years. To use these numbers the following assumptions and considerations must be heeded:

1) The costs of contract work for any NASA program not yet approved or conceived in the future years are undefinitized. There will be plenty of this in the ESMD budget line. As an illustration, the numbers of SMA committed work provided for ESMD are the best that we have today. Even at that, we're missing some, notably the Prime costs for Level 4 Ares project (contracts are in procurement stage and information embargoed). That could easily add another $10M per year. The near term numbers are within about $10M, which is still a significant percentage of the total. However, the story becomes much different in the later years. The out year totals for Cx have not been subdivided. For example, Cx carries a budget line item for the Lunar Lander and the run out for that number is about $7B. There's one for ARES 5, which also is very large. No one has attempted to subdivide that into Research Development Test & Evaluation (RDT&E) vs. SMA vs. anything else at this point, because the development hasn't even been turned on yet. So, for the out years, there are large pieces missing because of a lack of contract definitization. This lack of definitization is normal, applies to all disciplines, not just SMA, and should be expected for a program that will take a decade or more to develop.

2) Any SMA costs that might accrue as a result of SOMD Cx operations activity are not yet fully scoped and SMA costs associated with Shuttle operations are carried under an ESMD SMA projected line until characterized. This approach directly parallels and mimics the method of moving all Shuttle operations costs to the ESMD budget in FY 11 and FY12 for subsequent allocation to either RDT&E or operations.

3) There exist some SMA costs possibly as part of close-outs for Shuttle program in 2011 (according to the ESMD these are to be added in the next PPBE exercise but these should not be greatly significant).

4) The operations-related SMA costs for Cx operations might not be as large as the costs for Shuttle owing to the Cx objectives of lower cost for operations and quality insight for the "touch" labor in processing. On the other hand the money garnered from the savings in operations cost are likely to be spent on RDT&E which will require an additive SMA fraction.

5) There was little effort to capture other than costs associated with the large human spaceflight programs. Even with that there is little similarity between prime contractors' organization to assume that all SMA costs are captured equally or similarly. These costs are difficult to obtain because NASA contracts for deliverable items and does not account for the people costs for prime contractors. For example, some primes do most of their failure modes and effects (FMEA) work in their engineering organizations, while others perform such work from within their safety and mission assurance organizations. If we asked for estimates of prime contractor "SMA costs" we would not always get an "apples to apples" comparison from contractor to contractor.

PRESIDENT'S FY 2008 BUDGET REQUEST FOR NASA

$K	2006	2007	2008	2009	2010	2011	2012
ARMD	893,500	529,300	554,000	546,700	545,300	549,800	554,700
ESMD	3,050,000	4,152,500	3,923,800	4,312,800	4,758,000	8,725,200	9,076,800
SMD	5,245,000	5,466,800	5,516,100	5,555,300	5,601,000	5,656,900	5,802,700
SOMD	6,905,000	6,108,300	6,791,700	6,710,300	6,626,000	3,036,600	2,978,000
Cross Agency Support Programs		502,000	489,200	453,500	460,400	454,700	454,400
Inspector General		33,500	34,600	35,500	36,400	37,300	38,300
Total NASA FY08 Budget		**16,792,400**	**17,309,400**	**17,614,100**	**18,027,100**	**18,460,500**	**18,904,900**

The ASAP recognizes that this is a preliminary estimate, with more work needed in the coming year to develop this notional cost and allocation profile. While the ASAP appreciates NASA's efforts thus far, the Panel still has many remaining concerns that should be considered by NASA. In response to the above analysis, the ASAP observes:

1) The following comment sets the tone of NASA's current budget challenge, though it appears to have only a peripheral relationship to the SMA budget: ". . . the Agency has steadfastly believed that not only the management of the disciplines in support of programs and projects as well as the budgeting for their implementation should be decentralized at Center and Program level." If this is the prevailing view, it could block any attempt at instilling enterprise behavior, competency organization, standardized processes and even organizational alignment. Under such an arrangement, NASA begins to resemble a confederation of independent agencies, with little uniting them. Considering the complexities of the current massive projects, which have principal portions distributed across the NASA enterprise, the ASAP asks: Who is the systems engineer? What authority does this person have? How can management shift resources from one portion of the work to another in order to efficiently execute the overall project? Thus, the above statement serves to raise more questions than it answers.

2) Based on this document, the ASAP concludes that NASA Headquarters does not have a way to independently assess how its budget is being expended, since this information has to come from a "data call" to the Center SMA directors, to which they may or may not respond, "on a periodic basis and not every year."

3) While the comptroller may estimate "historical" SMA costs at 5 percent of the budget, it is unclear what this means in relation to the work that needs to be done. The above analysis states: "No budgets were ever challenged using these 'rules of thumb' and no one has ever seriously discredited the 5% being a comfortable SMA fraction." But that sounds like a safety assessment performed by budget analysts, who aggregate numbers that they are given, with no means to independently validate the data. Those analysts, therefore, are likely to focus more on consistency and ease of estimation than on the requirements of the work itself.

Assessing system safety, with its strong component of design awareness for scientists and engineers, particularly system safety engineers, can be expected to impose a much larger workload at the launch of a program than later, as the program matures. How, then, can the percentage remain constant? Planning based on such a constant percentage can result in a dangerous self-fulfilling prophecy: Define 5 per-

cent as the "right" level and 5 percent is likely to be what is spent, regardless of the work involved or needed. Furthermore, the implication is that SMA management should be content if they are getting "their" 5 percent. The idea that the amount of resources expended in this area should be constant throughout the life of a program gives the impression that "safety is just a part of overhead," not a core consideration in design and execution of the program.

4) The OSMA paper stresses repeatedly that the cost figures presented are "undefinitized," and it states at one point, "This lack of definitization is normal, applies to all disciplines, not just SMA, and should be expected for a program that will take a decade or more to develop." The ASAP does not agree that this situation is normal. The projections here are for the years 2007 to 2012. For a timeframe that close to the present, budget data should already contain clear estimates, not just "undefinitized" contract numbers.

Considering the above, the ASAP respectfully recommends that the Administration and Congress:

1. Immediately address the current budget deficit created by requiring NASA to operate under the FY 2007 Continuing Resolution.
2. Fully fund NASA consistent with its mission requirements for FY 2008 and beyond.

And that NASA:

1. Standardize and centralize its SMA budget development and allocation based on pre-defined mission requirements identified by Centers and programs, as validated by OSMA.
2. Require explicit itemization of safety-related expenditures and shortfalls, to be reported quarterly, by all organizations and programs within the Agency.
3. Require OSMA, in conjunction with the Comptroller and the Office of Program Analysis and Evaluation, to conduct quarterly reviews of programmatic safety requirements versus budget authority, for the purpose of ensuring that safety issues are being addressed and identifying critical risks.
4. Require OSMA to validate to the Administrator, on a quarterly basis, that the proper level of budget authority has been provided for Centers and programs to fulfill safety objectives and to minimize risks, consistent with other institutional needs.

IV. ASAP Recommendations and NASA Responses

A. 2006 ASAP Recommendations and NASA Responses

Observations, Recommendations, and Responses

Quarterly Meeting Recommendations

OBSERVATION	RECOMMENDATION #	TITLE	STATUS
1	2006-01-01	Risk assessment process for ET and total mission risk for the STS-121 Go/No-Go decision at the FRR.	Closed
2	2006-02-01	Recommend that the Space Shuttle Program approach the STS-121 go/no-go flight decision with pre-established criteria (3 Bins)	Closed
3	2006-03-01	Program Mishap Accountability and Policy relating to Tenant Contractors	Open
4	2006-03-02	Risk Assessment and Communication	Open
5	2006-03-03	Leveraging the Center's Safety Expertise	Open
6	2006-03-04	Random Drug and Alcohol Testing	Open
7	2006-03-05	KSC Contractor Safety	Closed
8	2006-03-06	Procurement–Contractor Safety	Open
9	2006-03-07	Constellation Requirements Management	Closed
10	2006-03-08	Vehicle Assembly Building	Open

Other Recommendations

RECOMMENDATION #	TITLE	STATUS
N/A	STS-121 Minimum Crew Recommendation	Closed

Observation #1

After our meetings at Marshall, we carried away concern regarding the External Tank. More specifically, we did not receive a crisp answer to the question—"How will the team determine the tank is 'good to go?'"

Recommendation #1 (2006-01-01)

The Panel would like to better understand the risk assessment process that will be used to: 1) clear the External Tank and modifications for launch; and 2) determine total mission risk for the STS-121 Go/No-Go decision at the FRR. Additionally, the Panel recommends that NASA use a second and independent set of eyes (e.g. NESC) to validate the risk assessment results and give management more confidence in the overall risk situation during the critical decision-making events leading to launch, operations, and recovery.

Status
Closed

Responses

- 04/06/2006—The Space Shuttle Program provided a briefing on this recommendation to the ASAP during their 2006 2nd Quarterly Meeting at the NASA Headquarters.
- 10/06/2006—The Associate Administrator for Space Operations sent a letter requesting closure with the April Briefing enclosed.

Observation #2
After our meetings at Headquarters, we carried away concern regarding the Space Shuttle Program having a clear list and tracked Status of test and analytical results for modifications to the External Tank as they proceed toward the launch of STS-121. More specifically, we recommend that the Space Shuttle Program approach the STS-121 go/no-go flight decision with pre-established criteria in the following manner:

Recommendation #2 (2006-02-01)
We recommend that the Space Shuttle Program approach the STS-121 go/no-go flight decision with pre-established criteria in the following manner:

1. Define a list of test and analytical results which have firm pass/fail criteria which are or can be established at this time.
2. Define a list of test and analytical results which will have firm pass/fail criteria based on planned work to be completed prior to the Flight Readiness Review.
3. Define a list of decision points and/or test and analytical results for which there will not be firm pass/fail criteria at the time the decision will be required, e.g., go/no-go for launch at the FRR. For these, also articulate what assumptions NASA managers would have to make to be able to interpret the test data and reach a decision.

Response(s)
5/23/2006—Associate Administrator for Space Operations:

At the April 6, 2006 2nd Quarterly Aerospace Safety Advisory Panel Meeting, the National Aeronautics and Space Administration Headquarters, Office of Space Operations, Space Shuttle Program gave a status presentation. During that presentation you recommended that we establish pass/fail criteria in support of critical STS-

121 decision milestones prior to the point where those decisions would be made. We are moving closer to completing all required tests and analyses required to support our certification and validation processes in preparation for flight. The enclosed white paper delineates the critical milestones associated with modifications made to the External Tank and references where our pass/fail criteria are defined.

We look forward to your continued guidance in this regard. We are prepared to answer any questions raised by this response. Please contact me at your convenience.

06-13-2006—Letter from Vice Admiral Dyer to Associate Administrator for Space Operations:

Dear Mr. Gerstenmaier:

Thank you for your recent response to our 2nd Quarter ASAP Recommendation. We accept your offer to discuss this recommendation and the associated NASA activities.

However, we reiterate our request for a formal response to the panel's recommendation; specifically, we requested:

1. Define a list of test and analytical results which have firm pass/fail criteria which are or can be established at this time.
2. Define a list of test and analytical results which will have firm pass/fail criteria based on planned work to be completed prior to the Flight Readiness Review.
3. Define a list of decision points and/or test and analytical results for which there will not be firm pass/fail criteria at the time the decision will be required, e.g., go/no-go for launch at the FRR. For these, also articulate what assumptions NASA managers would have to make to be able to interpret the test data and reach a decision.

We especially and strongly believe the "engineering judgment" being applied to 3., above, needs to be clearly articulated, shared with transparency, and understood by the Program, NASA's leadership, and the ASAP if we are to collectively carry out our responsibilities.

08/08/2006—Associate Administrator for Space Operations:
The Aerospace Safety Advisory Panel (ASAP) 2nd Quarter Recommendation was for NASA to establish pass/fail criteria in support of critical STS-121 decision milestones prior to the point decisions were required. Your June 13, 2006, letter specifically requested a list of test and analytical results, and decision points, which have

established pass/fail criteria. The enclosures provide the data requested. Although we received your letter after the STS-121 Flight Readiness Review (FRR), it has taken some time to pull together the requested information given the focus on completing the STS-121 mission. I trust you will find that the activities described were primarily completed before the FRR was conducted.

Relevant data from the Space Shuttle Program (SSP) External Tank wind tunnel testing, SSP integrated schedules of STS-121 flight preparation activities and milestones, and STS-121 FRR presentations were used to support our position that firm pass/fail criteria were established for all pre-launch tests, analyses, and program decisions.

We look forward to your continued guidance concerning our human space flight program activities. Please contact me if you have any further questions.

Enclosures:

1. SSP Test/Analysis Activity
2. Boeing Document NSO6HOU126, Pretest Information for Aero-Acoustic Test IS-21A
3. Boeing Document NSO6HOU127, Pretest Information for Aero-Acoustic Test 15-2 lB
4. Stress Analysis, Space Shuttle Model 47-OTS as used for Aero-Acoustic Test IS-2 1 A& B in the NASA Ames 9x7 & 11 ft Wind Tunnels, Revision A
5. Space Shuttle Program Requirements Review Board (PRCB) Presentation, PAL Ramp Removal, Feb. 16, 2006
6. United Space Alliance Space Flight Operations Contract Document NSO6HOU13OA, Pretest Information–Component Unsteady Airloads Wind Tunnel Test of the Space Shuffle External Tank Cable Tray
7. Shuttle Program Systems Integration Review Board Presentation, IS-23 GRC Subscale Component Wind Tunnel Test Plan, Feb. 7, 2006
8. Space Shuffle Program Requirements Review Board Presentation, Integrated Schedules, May 4, 2006
9. Shuttle Program Systems Integration Review Board Presentation, Proposed Near-Term ET Instrumentation, Feb. 14, 2006
10. STS-121 Flight Readiness Review Certificate of Flight Readiness Exception #019
11. Lockheed Martin External Tank Test Plan Binder

Observation #3

During our meeting at the Kennedy Space Center, it was noted that while actions of contractors reporting to other NASA organizations can have, and have had, a direct effect on mishap likelihood, all mishaps occurring at a Center are currently charged to that Center based on geographic responsibility assignment. The host Center may bear the cost of conducting the mishap investigation and implementing corrective actions without apparent reimbursement from the organization having programmatic responsibility. This and a perceived lack of Agency policy concerning host Center safety authority over contractors from other NASA organizations can lead to an obfuscation of safety responsibility in activities involving tenant contractors.

Recommendation #3 (2006-03-01)

The ASAP recommends that future mishap accountability should be shifted to the programmatic organization having decision authority over the operation. In addition, NASA should clarify agency policy on safety responsibility and authority when tenant contractors of other NASA organizations are involved.

Status

Open

Response(s)

12-22-2006—NASA Office of Safety and Mission Assurance:

This is an interim report to identify our initial response and summarize NASA activities initiated to respond to specific elements of the ASAP's recommendation concerning contractor safety from the 2006 Third Quarterly ASAP Report of September 26, 2006.

There are two primary concerns identified within this recommendation for mishap accountability and host/tenant safety authority:

Mishap Accountability

Mishap accountability relates to shifting mishap accountability to the programmatic organization having decision authority over the operation. NASA Procedural Requirements (NPR) 862 1.1B, NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Recordkeeping, provides Agency requirements that specify how to respond to any mishap or close call from discovery through corrective action and closure. It contains requirements for classifying mishaps, establishing investigation authorities, and performing investigations. It describes roles and responsibilities, including those pertaining to funding mishap investigations and implementing corrective actions.

Per NPR 8621.1B, Paragraph 1.4.8, the "Program and project managers shall provide funding and support for investigations within their program jurisdiction or involving their hardware and facilities (Requirement 31112)." Additionally, when tasked by the appointing official, the responsible organization (program manager) shall develop the corrective action plan (CAP), implement the CAP, and support the Center safety office personnel as they verify that the CAP has been completed (Requirement 31117).

Per existing Agency requirements, the organization having programmatic responsibility currently has the responsibility to fund both the mishap investigation and the implementation of the corrective actions as contained within your recommendation.

It should be noted that the Center Director has the responsibility to maintain a Center Mishap Preparedness and Contingency Plan and serve as the appointing official for mishaps at his/her Center. The Center Director has been given this authority and responsibility because he/she manages the emergency response resources that can be utilized by any program at the site, can provide quick and immediate safing and securing of facilities for an investigation, and can provide an independent safety organization to support andlor conduct the investigation. The Center Director should have a process in place to determine the cost of Center safety services provided to a program during a program mishap and should charge the program for these services. Recently, under full-cost accounting, the NASA Center Director has been provided with the ability to more easily track costs associated with mishap cleanup and a mishap investigation.

Although the Agency has an adequate policy in place to ensure that the program/project maintains responsibility for funding both the investigation and corrective actions for its own mishaps, it is possible that some Center Directors, while serving as appointing officials, are not consistently reporting their costs to the programs and requesting reimbursement, or that programs are not responding when a request is made.

The Office of Safety and Mission Assurance (OSMA) will charter the NASA Safety Center to conduct a survey of the NASA Centers to evaluate the consistency in which Center Directors are requesting mishap-related funding from programs and the percentage of programs that are adequately responding to the requests. This

action will be completed by May 1, 2007. OSMA will use the results of this survey to reinforce program compliance, as necessary. In the meantime, OSMA will remind all Center Directors and Program Associate Administrators of existing Agency and program policy.

Finally, for record purposes, OSMA will investigate means by which mishap statistics can be labeled as program, institution, or both.

Host/Tenant Safety Authority

As you know, the Agency has been working diligently to define a technical authority model for NASA programs and projects. NASA is currently in the process of drafting Agency policy regarding technical (including SMA) authority as it applies to hosted programs and projects. OSMA believes this new policy will clear up any existing ambiguity.

Observation #4

During our meeting at the Kennedy Space Center, the ASAP noted, with regards to risk assessments that are being made to support launch decisions, it appears that a series of fragmented, non-standardized tools and methodologies are in use. The result is that risk recommendations to senior management concerning individual hazards effecting launch are sometimes made in isolation without consideration of overall launch risk. For example, the most recent Shuttle launch focused heavily on two of the 569 potentially catastrophic hazards currently known to exist, without any assessment of the overall likelihood of such a catastrophic failure. A lack of confidence in the technical basis for the assessments also appears to sometimes exist, and variations in risk matrix definitions among programs have been observed. Lastly, only limited guidance is available concerning Agency policies on what risks should be accepted under what conditions.

Recommendation #4 (2006-03-02)

The ASAP recommends that a comprehensive risk assessment, communication and acceptance process be implemented to ensure that overall launch risk is considered in an integrated and consistent manner The process should be sound, mature, consistently implemented to yield high confidence and consistent results that are generally accepted by the majority of the community.

Status
Open

Response(s)
12-22-2006—NASA Office of Safety and Mission Assurance:

This is an interim report to identify our initial response and summarize NASA's activities initiated to respond to specific elements of the ASAP '5 recommendation on Risk.

Assessment and Communication from the 2006 Third Quarterly ASAP Report of September 26, 2006.

NASA agrees with the ASAP that the risk assessment and risk communication techniques used in the Agency to support flight decisions need improvement. Despite the fact that NASA has made significant progress in developing Probabilistic Risk Assessment (PRA) models for its missions, these models are underutilized to support risk management (RM) decisions. The current RM approach at NASA is driven by pervasive use of "N x N" (most commonly 5 x 5) risk matrix. This matrix, which is intended to be a risk communication tool, is often used for risk assessment, decision on actions, and risk tracking/monitoring. As correctly noted by ASAP, these matrices have shortcomings that include:

- ambiguity in the consequence and likelihood scales.
- interaction between risks are not considered.
- inability to deal with aggregate risks (i.e., total risk).
- inability to account for uncertainties.

NASA's development of PRA requirements and guidance documents, such as NPR 8705.5, Probabilistic Risk Assessment (PRA) Procedures for NASA Programs and Projects, formed part of NASA's initial effort to improve risk assessment and risk-informed decision making. NASA recognizes that there is still much to be done in this area, and the following synopsizes our approach.

The Office of Safety and Mission Assurance (OSMA) is developing a top-down and integrated risk management framework to support decision-making. In this framework, appropriate PRA risk metrics will be defined for human safety, assets safety, and mission performance. These risk metrics (e.g., probability of loss of crew, probability of loss of mission) will be assessed and used to support decisions on programmatic alternatives at various key decision points. The currently

envisioned framework promotes the formal process of analyzing various decision alternatives (e.g., launch with a known defective sensor or launch after fixing the sensor) with respect to:

- their impact on the defined risk metrics.
- the assessment of uncertainty associated with their degree of impact. proposals of optimal decision alternatives using formal decision theory and taking into consideration risk acceptance criteria, program constraints, and the magnitude of uncertainties.

The deliberation process is a crucial element of the proposed risk management framework since it evaluates risk results and makes explicit all the pros and cons associated with the decision alternatives. Additionally, as a part of this activity OSMA understands the need to improve risk communication techniques that visualize risks not as discrete points that do not reflect uncertainties, but as ranges or regions.

To support this implementation strategy, OSMA has significantly altered the system safety modeling requirements of NPR 8715.3, NASA General Safety Program Requirements, and we are actively working with the Office of the Chief Engineer to provide additional guidance within the NASA Systems Engineering Handbook that is currently in revision. The new system safety paradigm requires:

- analysis of hazards using scenario-based accident modeling techniques. *
- integration of various analytical safety models (e.g., physics-based failure models, fault trees, etc.) into a coherent and integrated risk model to support quantification of risk metrics.
- recognition and analysis of uncertainties.
- consideration of risk metrics within the trade space.

OSMA believes that this initiative is responsive to the ASAP recommendation. In addition to the guidance that will be contained in the NASA Systems Engineering Handbook, OSMA plans to further document the elements of the enhanced risk management framework within a NASA Standard tentatively titled "Risk Informed Management of Safety and Mission Success," which is planned for release before the end of fiscal year 2007. The information contained within these documents will also be included within the training provided at the Probabilistic Risk Assessment Methods (PRAM) Workshops sponsored by OSMA.

* Scenario-based analyses provide more of the information that risk-informed decisions need, while expected consequences (probability times consequences paradigm of risk matrix) alone arguably do not adequately inform decisions. For example, a rare but severe risk contributor may warrant a different response than a frequent, less severe contributor, even though both have the same expected consequences.

Observation #5

During our meeting at the Kennedy Space Center, the ASAP noted that KSC's new Fall Protection Program is very comprehensive and well-designed, and represents an exemplary safety effort.

Recommendation #5 (2006-03-03)

The ASAP recommends that this program be promulgated across all Centers, with local modifications as appropriate. The ASAP further recommends that other Centers be tasked to develop similar programs for other elements of the NASA Occupational Safety Program, such as trenching/shoring, lockout/tagout, confined space entry etc. Individual centers can be developed as centers of excellence for individual program areas and serve as a resource for all NASA activities. This would provide best of class programs for all of NASA without duplication of effort by the Centers.

Status

TBD

Response(s)

12-22-2006—NASA Office of Safety and Mission Assurance:

NASA has initiated activities that respond to specific elements of the Aerospace Safety Advisory Panel (ASAP) recommendation 2006-03-03, Leveraging the Center's Safety Expertise, from the 2006 Third Quarterly ASAP Report of September 26, 2006:

Annually the Office of Safety and Mission Assurance (OSMA) seeks Center proposals for addressing areas of improvements in technical safety policy, standards, and enhanced technologies. Kennedy Space Center (KSC) responded to one of these calls in the area of fall protection. OSMA funded the KSC proposal entitled "NASA KSC Fall Hazard Survey," and Gravitec Systems performed the associated work. Gravitec Systems provided the final report and an associated hazard database to KSC in October 2005. Since that time, OSMA has been collaborating with the Safety Program Managers of KSC and each of the other Centers to develop a comprehensive fall protection plan for the Agency. The KSC plan and associated backup information are part of that activity. By April 1, 2007, OSMA will submit changes to supplement policy associated with fall protection for the official Agency review process as a step towards requiring application at all Centers.

NASA will continue to promulgate exemplary practices for mishap prevention through Annual Safety Directors' and Occupational Health Managers' Conferences, Safety and Mission Assurance Directors' Meetings, and through other NASA and Federal agency meetings. OSMA will continue to recognize those Centers that exceed Occupational Safety and Health Administration requirements and afford them the opportunity to present their "exemplary practices" across NASA so other NASA operations can leverage these practices. As one size does not fit all, each Center will have the opportunity to implement programs that best meet their needs. Currently, exemplary practices are identified during Operations and Engineering Panel Reviews, Occupational Safety and Health Reviews, and Institutional/Facility/Operational Safety Audits managed by OSMA and conducted with both Headquarters and Center participation. OSMA will continue to assure that good ideas identified during these activities are appropriately distributed across the Agency

Further, where Agency-level directives should be changed to supplement or modify standard processes or practices, OSMA will enlist the resources of the Centers to assist with the development work. These resources, in the form of cross-Center working groups, may or may not involve funding for research and development (as in the case of the KSC fall protection effort). Where a Center is given a lead role in developing an Agency-level standard, they will perform the "Center of Excellence" function suggested by the ASAP. More often, cross-Center teams will oversee these efforts. If this is the case, rather than a "Center of Excellence" per se, OSMA will select a team lead from Headquarters who will work the issue with his/her Agency-wide team.

Observation #6

During our meeting at the Kennedy Space Center, the ASAP noted that recent mishap investigation revelations indicate that there does not seem to be an Agency-wide requirement for random drug and alcohol testing among contractors.

Recommendation #6 (2006-03-04)

ASAP recommends that expanding both random pre-incident and targeted post-incident testing would be well advised for contractors as well as NASA civil servants.

Status
Open

Response(s)
No response received to date.

Observation #7
During our meeting at the Kennedy Space Center, the ASAP noted that 13,000 of 15,000 KSC personnel are contractors.

Recommendation #7 (2006-03-05)
ASAP recommends that KSC hold a semi-annual community-based information session for all contractors who work at the Center, and who wish to work at the Center, to allow them to understand what will be required of them to work at the Center.

Status
Closed

Response(s)
12-22-2006—Kennedy Space Center:

KSC will hold two information sessions a year to assist contractors in understanding safety and quality requirements necessary to perform work at the Center. These will be held at an annual Expo trade show and an annual Contractor Safety and Health Town Hall Meeting. The Safety and Mission Assurance (SMA) Directorate has partnered with the KSC Procurement Office in planning and participating in these events. The annual Expo is sponsored by KSC, the Canaveral Port Authority, and the Air Force's 45th Space Wing. It features over 175 business exhibits and also Government exhibits. It is an event to inform potential contractors of business opportunities and procurement processes. The Contractor Safety and Health Town Hall Meeting's focus is on informing and reemphasizing safety requirements of KSC contractors, subcontractors, and potential subcontractors.

On October 17, 2006, at Port Canaveral Cruise Terminal 4, KSC SMA Directorate personnel participated with contracting officer representatives in Expo 2006 for the first time. KSC SMA provided information on contractor safety requirements and answered specific questions regarding contractors' safety responsibilities. In the future, we will expand our level of participation and our ability to educate current and potential contractors to KSC safety requirements by sponsoring a dedicated KSC SMA booth. Additionally, KSC plans to form a committee to expand and improve our annual Contractor Safety and Health Town Hall Meeting. Some

planned improvements include increasing the scope of safety information provided and involving more contractors, subcontractors, and potential contractors. The next meeting will be held at KSC this spring.

Observation #8
During our meeting at the Kennedy Space Center, the ASAP observed that with respect to contractor safety, the Center has areas of opportunity to naturally strengthen and enhance this aspect through the procurement process.

Recommendation #8 (2006-03-06)
ASAP recommends that contracting language regarding safety should be made stronger, making the contractors more accountable for safety.

Status
Open

Response(s)
12-22-2006—NASA Contract Management Division:

Concur.

We believe our processes, policies, and procedures (including specific contract language) to provide a safe work environment for both contractors and civil servants can be improved. We would like to outline here some of our current efforts to improve contractor safety and accountability through stronger enforcement of contract requirements and improved contractor selection and management techniques. Some of these efforts were initiated or enhanced as a result of previous ASAP recommendations, and we would welcome your identification of an individual or subgroup of the ASAP which could serve as a point of contact for discussion of these current safety improvement efforts. This would allow us to obtain feedback and new ideas to enhance this ongoing process. Some of NASA's current efforts that were initiated within the last 18 months include:

- initiation and completion of the Electrical Safety Review and Assessment.
- tasking of the Engineering and Construction Innovations Committee (ECIC) to develop strategies to enhance contractor safety.
- increased emphasis on enforcement of safety requirements in NASA contracts through Procurement Surveys and SMA-led Compliance Verification Audits of the NASA Centers.
- collection, refinement, and dissemination of safety best practices in contractor selection and management.

These initiatives have combined the efforts of Headquarters and Center procurement and safety professionals with program and project technical personnel to identify and develop training, practices, policies, and procedures that will increase contractor safety. Three of the four initiatives mentioned above are ongoing and have resulted in multiple Centers developing specific contract language and provisions now being implemented to improve contractor safety.

Some of the specific actions resulting from the above efforts include:

1. The ECIC has developed a training course, "Making Zero Construction Safety Incidents a Reality," which broadly targets all Government and contractor personnel involved in NASA construction. The course provides tools, methods, and insight for contract management and construction oversight personnel to utilize, based on safety performance data collected by the Construction Industry Institute. The course includes breakout workgroup sessions aimed at helping Center personnel understand and develop specific construction contract management techniques that can be tailored to their location and situation, including use of historical safety indicators in contractor selection.

2. Several Centers have made practical application of the use of historical safety indicators in the contractor selection process and developed specific solicitation/contract language to implement. Some solicitations utilized the Experience Modification Rate (EMR) as a sole indicator of a contractor's past safety performance (this selection mechanism has evolved to utilize two or more trailing indicators in the selection process, such as EMR, Total Recordable Injury Rate (TRIR), and Days Away Case Rates (DACR.) Centers have reported that evaluating more than one historical indicator in a qualitative manner along with other information, such as the contractor's Safety and Health Plan, gives them a higher confidence level in the contractor's safety performance.

3. Centers are including evaluation of safety performance in fee evaluations for contractors with specific language in performance evaluation plans addressing safety; OSHA reportable and other lagging and leading safety indicators are being reported and evaluated.

4. Other Center and industry best practices are being refined and disseminated to and utilized by the NASA Centers including: using a price/performance trade selection method for procurements which would have otherwise been selection of "low bidder" and that incorporates evaluation of safety perfor-

mance indicators; using a safety subfactor in award-term evaluations where subpar safety performance alone can prevent the contractor from earning additional performance periods; holding prime contractors responsible for subcontractor safety performance; and using positive and negative safety performance incentives and requirements for a contactor personnel to undergo site safety orientations.

5. NASA Headquarters Contract Management Division has included the review of Center contracts for appropriate Safety and Health (S&H) provisions through procurement surveys at the NASA Centers. The Headquarters SMA Office includes a review of appropriate S&H requirements flow down to contractors in its Institutional Programmatic Support (IPS) Audits. These surveys and audits check for inclusion in contracts and compliance with safety-related provisions and requirements, including NASA's general S&H clause, contract specific Safety and Health Plans, and various safety requirements such as NASA procedural requirements and directives such as the NASA Policy for Safety and Mission Success, NASA Safety and Health Program Policy, NASA Safety Policy for Pressure Vessels and Pressurized Systems, NASA Occupational Safety and Health Programs, and NASA General Safety Program Requirements. In addition, the procurement surveys review for contract inclusion of NASA's Major Breach of Safety and Security Clause, which provides for contractor penalties in the event of a major breach of safety or security.

NASA believes the serious contractor mishaps that have occurred over the last several years can be prevented in the future through a combination of training, improved contractor selection and management techniques, targeted compliance and oversight reviews, and positive and negative contractor incentives on safety. NASA continues to obtain best practices and examples of solicitation, evaluation, and contract performance language from both within and outside the Agency. We review and refine such language and practices for targeted use to specific contracting situations; e.g., use of contract safety performance indicators for determination of the award for additional terms in award-term contracts and the use of EMR and OSHA recordable rates in price/performance trade evaluations for small and medium-sized construction projects. NASA continues to discover, review, and refine best practices for contractor safety and will continue to disseminate and implement these policies, practices, and procedures at NASA Centers and throughout the contractor community.

We believe our efforts to improve contractor safety should be a continuous improvement process. As mentioned above, further discussions with the ASAP might help us gather additional information to assist in these efforts. We look forward to that opportunity.

Observation #9

During our meeting at the Kennedy Space Center, the ASAP noted that KSC has shown great forethought in the initial preparation for implementation of Constellation program requirements. As many of the critical safety requirements have not yet been established and their potential future changes could have significant safety impact, KSC described a system where all requirements assumptions are documented and tracked along with proposed design solutions. This system should allow reliable flow-down of changes in those requirements assumptions to avoid unintended consequences.

Recommendation #9 (2006-03-07)

In view of the aggressive Constellation development schedule, the ASAP recommends that a system be implemented Agency-wide for formally tracking requirements assumptions that could impact future safety performance.

Status

Closed

Response(s)

12-22-2006–Exploration Systems Mission Directorate:

The referenced ASAP recommendation recognized "great forethought" in the way KSC documents and tracks requirements assumptions with proposed design solutions. The Constellation Program requirements are not yet established, but system design has been initiated in an effort to meet an aggressive development schedule. Experienced designers at KSC recognized the need to clearly document the assumptions that form the basis of these initial designs and to establish some formality in controlling changes in these assumptions as the Constellation Program requirements mature. This creates a clear flow-down of requirements changes to design solutions early in the Program formulation phase.

NASA agrees that tracking requirements assumption is a "best practice" and should be implemented throughout the Agency. NASA accepts the ASAP recommendation and will implement it via program, project and engineering processes and will include this "best practice" in our training activities so as to most effectively promulgate the practice throughout the various NASA programs and projects.

Implementation in three key areas are described below: (1) program/project documentation, (2) NASA procedural documentation, and (3) ongoing knowledge management and training.

(1) Program Documentation:

The Constellation Program at JSC has documented program-level requirements assumptions in "rationale" statements within the program requirements database for each requirement and is propagating this philosophy down to the individual systems and elements. The J2X element at the Marshall Space Flight Center is decomposing the Constellation Program requirements as they are developed and has implemented a formal requirements assumption management process.

The J2X upper stage engine element of the Crew Launch Vehicle (CLV) Project, like the long-lead ground systems at KSC, is on the critical path of an aggressive Constellation schedule. The J2X office has established an element requirements document and change control board prior to the Program requirements baseline. Design issues are coordinated with engineering, safety, and the CLV Project Integration Group to ensure that impacts to the developing launch requirements are assessed. In the same way, changes in Constellation Program launch requirements flow down through the Project Integration Group to the element where the upper stage engine design is assessed by engineering and safety. The J2X office conducted a preliminary system requirements review to baseline this requirements management process.

(2) Systems Engineering Procedural Documentation:

The examples above are best practices for meeting the Systems Engineering Processes defined in NASA Procedural Requirements (NPR) 7123.1, effective March 13, 2006. These processes include Stakeholder Expectation Definition, Technical Requirements Definition, Decomposition, and Design Solution Definition performed recursively during Program formulation. NPR 7123.1 requires the Center Director to "establish and maintain processes to include activities, requirements, guidelines, and documentation" for the 17 processes defined. Appendix C of NPR 7123.1 defines typical practices that support this requirement. Appendix C states that "the resulting technical requirement statements (1) have bidirectional traceability to the baselined stakeholder expectations; (2) were founded using valid assumptions; and (3) are essential to and consistent with designing and realizing the appropriate product solution form that will satisfy the applicable product-line life-cycle phase exit criteria." NPR 7123.1 also requires that the technical team address these entrance and exit criteria for each life-cycle phase (for example Systems Requirements Review).

To add further definition of systems engineering best practices, the Office of the Chief Engineer (OCE) is revising the existing NASA Systems Engineering Handbook, SP6 105 (dated June 1995) to reflect lessons learned since 1995, to reflect updated terminology, and to reflect the existence of the newly issued NPR 7123.1. NASA will include the formal documentation of requirements assumptions during the requirements decomposition and design solution definition process as a "best practice" within the new version of SP6 105.

(3) Ongoing Knowledge Management and Training:

The OCE is also working directly with the Constellation Program through a Technical Requirements Team to formalize an inter-Center engineering forum to support the Constellation Program and to integrate the Centers' best design and development practices in order to continually improve the overall NASA engineering support to programs and projects. Through this forum, best practices like the KSC requirements assumptions management process will be incorporated into the Constellation elements quickly. The Engineering Management Board chaired by the NASA Chief Engineer with the Director of Safety and Mission Assurance provides the Agency oversight for this requirements management process and will ensure that best practices from all NASA Centers are considered and incorporated where applicable.

Experienced design and development engineers find solutions to complex, often ambiguous problems and create best practices that should be disseminated throughout NASA to enhance the NASA engineering and safety culture. In addition to the processes described above, knowledge is being captured and shared through engineering training programs such as the Masters' Forum that is available to everyone. Specifically, the OCE is working directly with the Constellation Program Office to establish a sound requirements management process, to facilitate an inter-Center engineering forum, and to provide real-time training for the Constellation management and technical teams as they conduct their design and development activities. The practice of formally documenting requirements assumptions will be incorporated into this training forum.

Questions may be directed to Garry Lyles, Exploration Systems Mission Directorate Chief Engineer.

Observation #10

During our meeting at the Kennedy Space Center, the ASAP noted that for a number of years, workers not directly related to potentially hazardous VAB operations have been assigned office space in the VAB for efficiency purposes. This has been done under a waiver of normal explosive siting guidance. Additionally, structures surrounding the VAB have been sited based on propellant loadings associated with the Shuttle SRBs. The hazards of VAB operations may change significantly depending on pending Constellation program decisions concerning hypergolic fuel loading location and total quantity of solid propellants utilized.

Recommendation #10 (2006-03-08)

The ASAP recommends that the VAB explosive siting and occupancy issues be considered as part of Constellation design and operation tradeoffs.

Status

Open

Response(s)

12-22-2006—Kennedy Space Center:

Concur.

The Kennedy Space Center (KSC) has assessed and will continue assessing Constellation design and operation tradeoffs and their impact on the VAB siting and occupancy. Several assessments on proposed Constellation design and operations have been performed addressing potential hazards and recommending risk mitigation actions. The KSC SMA Directorate continues to participate with other KSC directorates in a coordinated program review, study, and tradeoff process. For example, studies and discussions are ongoing regarding solid rocket segments and hypergolic fuel loading, storage, and transportation. In order to better define and understand the safe separation distances for the VAB and other facilities under various operational considerations, assessment modeling is needed. For solid rocket propellant storage and handling in the VAB, KSC SMA has requested funding to conduct testing and associated reusable solid rocket motor burn modeling. A Center Technical Program Plan proposal was sent to the Office of Safety and Mission Assurance, as well as a request for support from the NASA Engineering Safety Center to perform a VAB quantity-distance study. Final risk management decisions associated

with Constellation operations will be dependent upon the results of the various ongoing trade studies, as well as any modeling that may be needed to characterize the associated hazards.

The studies and assessments conducted by KSC have been considered in the new Constellation ground processing designs and operations, addressing potential hazards and recommending risk mitigation actions. The Constellation Program has been actively involved with the assessment activities and will continue to be actively engaged with the Constellation design and operation tradeoffs and the future impacts of these decisions. As KSC continues to participate in the various trade studies, as mentioned in the KSC concur statement, the Constellation Program will continue to be engaged, recognizing that the start of a new program brings an opportunity to reevaluate and utilize best practices. The assessments currently under way are intended to produce recommendations to this effect. This is and will continue to be an area of emphasis for the program.

STS-121 Flight Readiness Review (FRR) Observation/Concern
While a detailed, integrated risk assessment has not been completed, it is clear that one or more "probable/catastrophic" risks still may exist with the current External Tank (ET) design. Such risk levels have not historically been considered acceptable for human spaceflight. The risk is deemed so serious that the Chief Safety and Mission Assurance Officer, the Chief Engineer, and the NASA Engineering Safety Center (NESC) have recommended against launching with the current ET configuration.

STS-121 Minimum Crew Recommendation—June 14, 2006 Letter from ASAP to the NASA Administrator:

Dear Dr. Griffin:

During our recent quarterly meetings at the Marshall Space Flight Center and Headquarters, we looked closely at the work being done to minimize the risk of External Tank insulation foam causing catastrophic damage to the Orbiter during ascent. After both of these reviews, we expressed our concerns with the lack of understanding of the failure mechanisms involved and the degree of risk that appears to remain with the current design. We have continued to follow NASA's efforts to control these risks as it relates to the launch of STS-121.

We feel an obligation to provide our recommendation for your consideration at the upcoming STS-121 Flight Readiness Review. While a detailed, integrated risk assessment has not been completed, it is clear that one or more "probable/catastrophic" risks

still may exist with the current ET design. Such risk levels have not historically been considered acceptable for human spaceflight. The risk is deemed so serious that the Chief Safety and Mission Assurance Officer, the Chief Engineer, and the NESC have recommended against launching with the current ET configuration.

We recognize an actual test flight may be the only method available to fully validate the modifications accomplished to date and to better understand remaining potential failure modes. If mission needs dictate a test flight at this time, the ASAP recommends you give strongest possible consideration to limiting the crew size to the absolute minimum required for the test flight. The Panel recognizes that such an approach may entail an additional flight to complete the International Space Station, but it is our counsel that overall risk to the astronauts and the Program would be minimized by such an approach.

Sincerely,
Joseph W. Dyer, VADM, USN (Ret)
Chairman
Aerospace Safety Advisory Panel

06/19/06—NASA Administrator Letter in Response to the ASAP

Dear Admiral Dyer:

The risk of Ice/Frost Ramp and adjacent acreage foam loss is currently considered the highest ascent debris risk in the Space Shuttle Program. As such, it is being accepted only for a limited number of flights.

The PAL Ramp removal on ET-119/STS-121 is a significant outer mold line (OML) change, which by itself greatly reduces our ascent debris risk. The PAL Ramp removal was considered a priority following STS-114, as it had the potential for foam loss of approximately 1 lbm. The Ice/Frost Ramps have the potential to liberate a maximum of 0.25 lbm; the worst case actually seen in flight has been 0.084 lbm. We analyzed for a mass loss protecting our flight history. Because the Ice/Frost ramp poses the highest known ascent debris risk in the program at this time, it will be mitigated through redesign as soon as possible. Such a redesign is in progress and will be implemented on a subsequent flight after design certification. There is no single ground test or analytical capability through which we can certify a new design. The flight of STS-121 will aid in the redesign effort.

Every flight subjects the crew to some level of risk that cannot be ignored in a risk trade. After taking this risk and safely launching a Space Shuttle to orbit, it is prudent to make the best use of this resource to accomplish mission objectives. Minimizing the crew size, as you suggest, would minimize our ability to accomplish a mission and would require an additional mission with its own level of risk exposure. Reducing crew size would also reduce our capability to inspect and, if necessary, perform repairs to our thermal protection system if damage is detected.

As you know, if there is damage due to foam debris that is shed during ascent, it is not immediately catastrophic, but is instead a cause for concern during re-entry. We have several means to mitigate this concern.

We have a broad capability to image the vehicle during ascent and on orbit to determine the condition of the Orbiter thermal protection system and to identify any need for repairs. In the event that, after our best effort to repair identified damage, the Orbiter is believed to be compromised to a level that safe entry is a concern, we have several options.

One option includes securing the Shuttle crew on the International Space Station until a rescue mission can be accomplished. The STS-121 Flight Readiness Review confirms that we can support all crew members onboard the ISS for up to 82 days, which is more than sufficient to implement a backup Shuttle rescue mission.

The second option is to secure some of the Shuffle crew on the ISS and return a partial crew on the Orbiter. We believe this, rather than ascent, is where we would meet the definition of an experimental test flight in terms that would cause us to minimize the crew size.

Finally, in the event that we can determine that the repairs made will survive entry and safely return the crew and Orbiter, we will choose to return the full six-member crew.

I appreciate that you have voiced your concerns and look forward to your continued guidance in this regard. We are prepared to answer any questions raised by this response.

Please contact me at your convenience.

Sincerely,
Michael D. Griffin
Administrator

B. 2005 ASAP Recommendations and NASA Responses

Observations, Recommendations, and Responses

Quarterly Meeting Recommendations

OBSERVATION	RECOMMENDATION #	TITLE	STATUS
1	2005-01-01	Standardization of Safety Reporting Processes and Management Focus on Close Calls and Minor Injuries	Closed
2	2005-01-02	KSC Safety for Prime Contractors and Subcontractors	Closed
3	2005-01-03	KSC Safety for NASA Employees	Closed
4	2005-02-01	Exploration Formal Process to Evaluate Human vs. Robot	Open
5	2005-02-02	Human Capital Develop a Strategic Workforce Plan	Closed
6	2005-03-01.a	GSFC Contractor Safety	Closed
7	2005-03-01.b	GSFC Close-Calls	Closed
	2005-03-02	Recommendation # Not Used	N/A
8	2005-03-03	Competency Management	Open
9	2005-03-04	Independent Technical Authority (ITA)	Closed

Observation #1

NASA has done a good job using employee awareness of lost workday cases to improve their overall safety record. Today, lost workday cases are "reasonably rare."

Recommendation #1 (2005-01-01)

To continue this improvement trend, NASA should increase standardization of reporting processes and communication mechanisms at each Center and across the Agency, especially in the area of employee awareness of first aid cases, recordable injuries, and close calls. Management focus, when turned on close calls and minor injuries, will support safer individual workplaces and facilities.

Status

Closed

Response(s)

6-28-2005—NASA Office of Safety and Mission Assurance:

I am pleased to respond to the first recommendation from the ASAP March 18,2005, letter that provides the recommendations from the ASAP'S 2005 First Quarterly Report. The recommendation concerned standardization of mishap reporting including a focus on close calls and minor injuries.

We believe that employee awareness of lost workday cases is key to improving our overall safety record. Center managers pay close attention to all injuries and illnesses that occur on their Center. In addition, the NASA Center Directors report all significant mishaps directly to the Administrator within 24 hours. This attention to detail at the senior level helps generate a special awareness for safety throughout the Agency, which in turn has helped NASA achieve one of the lowest injury/illness rates in the Federal government. NASA was recently recognized with an award by the Department of Labor's Safety Health and Return to Employment (SHARE) program for reducing reportable injury/illness mishaps by 10 percent in Fiscal Year 2004.

One of the tools that senior management uses to monitor progress of NASA programs, projects, and safety is ERASMUS. ERASMUS is an on-line performance dashboard that supports the measurement and accountability process within NASA. Based upon the data collected in the NASA Incident Reporting Information System (IRIS), safety statistics, including close calls, are reported in ERASMUS and discussed in management meetings. The NASA civil service workforce can also access this data using ERASMUS.

To ensure that the information presented to NASA management and the workforce is accurate, complete, and consistent, we have focused on assuring that we have robust mishap reporting requirements, a strong mishap reporting/analysis tool, and effective compliance verification to our requirements.

NASA Procedural Requirements (NPR) 862 1.1 A, NASA Procedural Requirements for Mishap Reporting, Investigating, and Recordkeeping, establishes the robust mishap reporting requirements. Senior management's endorsement of these reporting criteria in conjunction with the recording and corrective action requirements work to eliminate mishaps and equipment damage, not only with our Federal employees but also with our contractor workforce. These requirements were last updated in February 2004, and we believe they provide a solid foundation for continued improvement in our mishap rates.

The NASA IRIS provides NASA with a state-of-the art capability to document, track, and analyze all of our mishap data, including close calls. The implementation of the current version of this system is relatively new within NASA; however, we have expended significant resources to ensure that all of the NASA activities use this to effectively document and track mishap data. We are now working to utilize the capabilities of this system to perform the data analysis that will allow us to further prevent mishaps from occurring. Linking the data from this system to ERASMUS is one initial step in this process.

The final element for effectively standardizing our approach to mishap reporting is ongoing compliance verification that identifies not only lapses in compliance with our requirements but also provides a feedback mechanism to identify improvements in our requirements and tools. We have instituted a program of periodic Institutional Facility/ Operational (IFO) Safety Audits within NASA starting in February 2005 at the Dryden Flight Research Center. These IF0 Safety Audits will review all Centers for compliance with selected Federal and NASA operational safety criteria within an 18-month cycle. In this initial cycle, mishap reporting is included as one of the selected criteria to be evaluated. As we identify either concerns or areas for improvement during the course of these IF0 Safety Audits, we will make appropriate changes to our requirements, tools, or implementation. Upon completion of this cycle of audits in the July 2006 timeframe we anticipate that we will witness another significant reduction in our mishap rates.

We continue to aggressively pursue mishap prevention throughout the Agency. Standardizing mishap reporting, including a focus on close calls and minor injuries, is key to our efforts.

Observation #2
KSC identified issues with subcontractor safety by reviewing their safety metrics.

Recommendation #2 (2005-01-02)
KSC should develop and execute a plan to improve prime contractor and subcontractor safety performance on site. This plan could include the following: an outline of the role of the NASA employee in ensuring strong prime contractor and subcontractor safety performance, the specific safety criteria required before a contractor is allowed on site, and a review of the contractor's past injury and incident rates. The plan should include an outline of repercussions if safe behavior is not demonstrated, as well as recognition for strong safety behaviors. The plan needs to outline potential ramifications to employees and contractors for deliberately failing to report close calls, other safety incidents, and potential injuries.

Status
Closed

Response(s)
6/21/05—Associate Administrator for Space Operations

KSC has had a comprehensive program and strategy for assuring contractor safety performance onsite. New approaches have been implemented since the recent ASAP visit to KSC. They include the following:

1. Initiation of a new incentive-based award that may be paid to construction contractors based on their safety performance on fixed-price contracts.
2. Incorporation into construction projects of the requirement for a "Nuts and Bolts" meeting with the awarded contractor, prior to starting work. These meetings will focus on higher hazard operations, such as working at heights, scaffolding, trenching and excavating, electrical work, lockout/tagout, and confined space entry, etc.
3. Creation of three new committees to improve onsite safety, including prime contractor and subcontractor safety.

Observation #3
The ASAP sees opportunities for KSC to improve Civil Servant safety awareness and site specific knowledge particularly with the present need to support more frequent launch operations.

Recommendation #3 (2005-01-03)
KSC should emphasize adherence to existing safety rules on the Center, address education and training needs as staffing and pace increase to support more frequent launch operations, and increase employee awareness of safety in the facility in which they work. Increased employee awareness would include knowledge of unique safety rules and awareness of prior accidents or injuries in that facility.

Status
Closed

Response(s)
6/21/05—Associate Administrator for Space Operations

KSC has a multi-element approach to emphasizing safety rules on the Center. New approaches implemented based on the ASAP visit include the following:

1. Plans to increase the staffing of the institutional safety organization by over 40 percent. This will enable more inspections, audits, job surveillance, and assistance to supervisors in addressing any lapse in safety performance. In addition, the KSC Shuttle Operational Safety Group has recently implemented a safety surveillance program relative to USA operations.
2. Changing its Super Safety and Health Day from a generic, Center-wide safety approach to an organizational element safety stand-down. This approach will allow for increased awareness of safety and health as it pertains to employees' actual work setting and the hazards they face.
3. Preparation of a detailed training plan by the KSC S&MA Directorate to address education and training needs. The plan establishes a comprehensive safety and quality training curriculum. The S&MA Directorate is presently developing an implementation schedule for its training plan.

Observation #4
Looking forward to the Exploration Program and establishing the Exploration architecture, the ASAP thinks that it is vitally important to have a standardized process used to yield a risk-informed decision for using robots vs. humans to accomplish difficult tasks in space.

Recommendation #4 (2006-02-01)
Recommend the Exploration Program establish a formal process to compare the safety and mission success risk of performing logistics, maintenance, and other tasks with a human or a robot. Using robots can enhance safety and reduce the risk to astronauts.

Status
Open

Response(s)
10-16-06—Exploration Systems Mission Directorate

The NASA Systems Engineering Processes and Requirements document, NPR-7 123.1 (Mar 06), establishes NASA's formal process, the core set of common technical processes and requirements in this document are being used by NASA to develop the products that will satisfy the mission or operational functions as well as the life-cycle support functions of the system.

The Lunar Architecture Team (LAT) is currently making human v. robotic trades as part of its architecture formulation which is an integral part of the formal process governed by NPR-7 123.1. The LAT plans to have the first draft of the architecture available in the November time frame. We would be happy to brief you at that time.

Late 2005—Exploration Systems Mission Directorate
In the ASAP's 2005 Second Quarterly Report, your Panel recommended that "the Exploration Program establish a formal process to compare the safety and mission success risk of performing logistics, maintenance, and other tasks with a human or robot. Using robots can enhance safety and reduce the risk to astronauts."

We concur with this recommendation and offer the following status to the Panel:

- ESMD is in the process of reviewing and modifying, as required, the Exploration architecture defined by the Exploration Systems Architecture Study (ESAS) given ESMD budget limitations.
- ESMD is in the process of establishing requirements for both the robotic and human mission elements required to support this updated architecture beginning with a thorough needs, goals, and objectives analysis.
- As part of this requirements update process, ESMD is also formulating design policy objectives that will be used to ensure that Exploration element designers take into consideration specific design factors that NASA has established as key to overall Program success. The goal is to formalize this set of design policy objectives in a way that NASA can use them to evaluate the rationale behind design decisions. As work continues to mature this design policy document, a statement addressing this ASAP recommendation will be included.

We would like to brief the ASAP in more detail when the resolution of these issues are more mature--perhaps in the July 2006 timeframe.

Observation #5

NASA has a robust leadership development program and has started succession planning, particularly for the Senior Executive Service positions. NASA has begun a process to define core competencies at each Center, is identifying their current capability, and is identifying the needs necessary to fill future gaps.

Most importantly, NASA sees a real need for an Agency-wide strategic human capital plan that is integrated across the Agency and can allow the Agency to think about its needs now and in the future. The ASAP believes a comprehensive workforce plan is very important and is certainly interested to hear about how that planning process progresses.

Recommendation #5 (2006-02-02)

Recommend that NASA make it a priority to develop a Strategic Workforce Plan. Having the right people with the right qualifications in the right jobs is central to all NASA endeavors, including safety.

Status

Closed

Response(s)

10/12/06—Office of Human Capital Management

NASA submitted its Workforce Strategy to Congress on April 14, 2006, in response to a requirement of the NASA Authorization Act of 2005. The Strategy describes the critical issues the Agency now faces, identifies key principles underlying the strategy's development, and describes the planning process that will be used to support the strategy on an ongoing basis. In addition to describing the mission and budget changes driving changes in NASA's workforce, it also identifies the specific competency gaps and surpluses anticipated within the civil service workforce between now and 2011. It describes the actions NASA will take to respond to its most critical workforce challenges, with a particular focus on recruitment and retention.

Key actions and initiatives associated with the Strategy include: implementing a new workforce planning process; assessing competency gaps with greater detail and accuracy; and making effective use of a broad array of human capital tools and options to address workforce issues.

A Workforce Implementation Plan has been finalized to develop and institutionalize the appropriate human capital programs, processes, activities, and tools to implement the Workforce Strategy. An outline of the Workforce Implementation Plan was provided to the ASAP Executive Director on July 11, 2006. Work under this Plan is progressing.

NASA has addressed its uncovered capacity through a number of actions, including the movement of people and the movement of work. Throughout the past year, uncovered capacity has been further reduced as Mission Directorates have defined technical requirements for programs and projects and work has been assigned to Centers. The Agency continues to focus on existing uncovered capacity through identification of opportunities for assignment of meaningful work and retraining. In addition, we are pursuing a proactive workforce planning approach, integrated with budget, business, and acquisition planning, to assist in identifying potential serious workforce misalignments in the future and developing mitigation strategies.

To enhance competency management within the Agency, all employees were recently asked to enter in NASA's Competency Management System a list of competencies they have acquired during the course of their career, as well as their depth of expertise in each competency. Supervisors have been asked to review this information and provide validation on the level of expertise the employee has identified. Completion of this activity is scheduled for late October 2006.

NASA is also taking steps to strengthen the Agency's leadership development programs. Existing programs have been evaluated and benchmarking with other federal agencies has been conducted. Results are being reviewed and recommendations are being developed for approval and subsequent implementation beginning January 2007. In addition, while there are a number of mentoring programs in existence across the Agency, NASA is taking steps to strengthen and standardize them by building on Center best practices. The Agency has also just embarked on the first offering of a new leadership development course called "NASA Foundations of Influence, Relationships, Success and Teamwork" (NASA FIRST), which is designed to begin leadership training earlier than previous programs—with those at the journeyman level.

In addition to the work described above, NASA also submitted to Congress on April 14, 2006, a NASA Human Capital Plan for Mission Execution, Transition, and Retirement of the Space Shuttle Program. This document, also known as the Shuttle Human Capital Plan, focuses specifically on the strategy NASA will implement to ensure retention of critical workforce skills (both contractor and civil servant) needed for safe and successful mission execution and the smooth transition of Shuttle workforce skills, as appropriate, to the International Space Station, exploration systems, and other future programs. The Shuttle Human Capital Plan also lays out a plan for communicating and collaborating with key Space Shuttle Program stakeholders—especially the workforce. The Shuttle Human Capital Plan has subsequently been incorporated into the larger Human Space Flight Transition Plan submitted to Congress in July 2006. We have made a copy of the Shuttle Human Capital Plan available to the ASAP as part of this submittal.

Finally, NASA's Academy of Program/Project and Engineering Leadership (APPEL) is being enhanced to strengthen the Agency's program/project management and engineering expertise. Among the changes, NASA APPEL has integrated a systems engineering curriculum with the Massachusetts Institute of Technology and the International Council of Systems Engineering to emphasize the importance of systems engineering within the program/project management community. The curriculum addresses the implementation of the NASA Exploration Vision into all levels of career development: new hires and fresh-outs, the professional development of mid-career project managers and engineers, and executive development of senior NASA personnel. In addition, since February, NASA APPEL has fostered and integrated knowledge sharing in terms of engineering case studies and mobilizing expert practitioners across the Agency to drive the development of technical communities of practice, and improved communication of knowledge through the ASK OCE newsletter, an improved ASK Magazine, the Masters Forums, and Project Management Challenge.

Observation #6

Their largest personal safety issue is "Slips, Trips, and Falls," which is not uncommon in the industry. It has caused a few lost-time incidents in the past year and for a laboratory site there could be improvements there.

Recommendation #6 (2006-03-01.a)
Flowing from our August 2005 visit to Goddard Space Flight Center (GSFC)

The GSFC management team should continue to build on its strong safety culture and become more aggressive in the area of contractor safety. GSFC should develop and execute a plan to improve prime contractor and subcontractor safety performance on site. This plan could include the following: an outline of the role of the NASA employee to ensure strong prime contractor and subcontractor safety performance, the specific safety criteria required before a contractor is allowed on site, and a review of the contractor's past injury and incident rates. The plan should include an outline of repercussions if safe behavior is not demonstrated, as well as recognition for strong safety behaviors. The plan needs to communicate potential ramifications to employees and contractors for deliberately failing to report close calls, other safety incidents, and potential injuries.

Status

Closed

Response(s)
09-18-06—Goddard Space Flight Center

GSFC's safety program is inclusive and recognizes that contractors are a major part of the work force and engage in numerous high-hazard activities and operations. Mishap prevention efforts are applied equally to contractor employees as well as our civil service employees. The Center works hard to ensure a continuously improving contractor safety process for all prime contractors and their subcontractors. While these activities are dynamic and moving forward, this report is a snapshot in time of the actions and systems that were either in place, or have been improved since the ASAP visit to Goddard in August 2005. The information below is organized by contract phase (acquisition, performance and termination).

Contract Acquisition Phase: Improvement of contractor safety programs begins in the contract acquisition phase. In this regard GSFC has implemented several performance-based criteria elements that have proven successful at other NASA Centers. GSFC has established the use of a prospective contractor's two-year Experience Modification Rate (EMR) as a major eligibility factor during the Request for Proposal

solicitation phase of awarding a contract. This process requires prospective contractors have an EMR lower than 0.99. A recent acquisition effort for a major building project resulted in the elimination of several companies from the eligible candidate pool of 27 offerers based on the EMR criteria. The companies removed from this competition had EMR values greater than 0.99.

GSFC has also added a contractual requirement for Prime Contractors to demonstrate their system of communicating/ "flowing-down" safety requirements to their subcontractors before operations can begin. This is verified by conducting field interviews with subcontractor employees to assess the effectiveness of their system.

Finally, the Center Safety Office has worked with the Procurement organization to update the GSFC Premises Clauses which require contractors be held accountable for applicable GSFC Safety and Health Procedures and Requirements that affect their operations. These clauses are now part of all new contracts, not just field/construction related work.

Contract Performance Phase: The second phase of the efforts in increasing contractor safety is the oversight of contractors on current contracts. This oversight of on-site contractors continues to be a priority with several success stories. One of the most significant activities is the Annual Contractor Safety Performance Audit. These audits assess the health of a contractor's documented safety program, as well as its implementation. The scoring system is based on a possible 100 points, and the criteria include auditing a contractors' safety program against comprehensive OSHA compliance checklists. The checklists are distributed to the contractor prior to the audit to assist them in conducting a successful self-audit before the survey by NASA. GSFC scores the contents of their safety plan, number of mishaps experienced, previous findings that have gone uncorrected, and the timely submission of quarterly safety metrics. Thus far in FY06, 14 contractors utilizing the updated tools and protocols have been audited. The audit scores are provided to Contract Performance Evaluation Boards and affect the amount of Award Fee a contractor may receive for the year.

Another initiative is the Contractor Safety Working Group. This group consists of contractor safety professionals and collateral duty representatives who meet on a bimonthly basis. The Working Group is chaired by a Government Representative, and the group's objective is to provide a forum where companies can discuss relevant safety compliance issues, trends, and lessons learned, and hear briefings from participants on a variety of topics. A recent noteworthy example was the briefing by the Safety Manager from Swales Aerospace regarding Task Safety Analysis to help other contractors on Center develop/strengthen their hazard assessment program.

The Center Safety Office has also increased construction site visits/audits and attendance at all pre-construction meetings to ensure safety requirements are being communicated to all construction contractors/coordinators. The increased surveillance has resulted in major improvements with safety compliance by subcontractors.

A final example of the Center's commitment to instituting an excellent contractor safety program is the recently conducted independent third-party audit of a major on-site construction contractor. The audit showed that their overall safety program was sound, but some findings and recommendations were made to further improve their program. GSFC organizations are aggressively addressing those concerns.

The above examples highlight activities that the Center uses to proactively work with contractors to continually monitor their safety performance and identify and correct problems early. For those situations where a GSFC contractor is found to be non-compliant or in gross violation of safety standards/requirements, the Center takes progressively escalating actions consistent with the contract to bring the contractor into compliance. Notifications to the contractor, withholding award fee, stop work and ultimately removal of contractor (for non-compliance with contract safety provisions) are all actions utilized to ensure our contractors operate in a safe manner. For major compliance deficiencies and/or an immediate danger to life or health situation, a cease and desist order is immediately issued and the appropriate contractual options are pursued.

Contract Completion Phase: The last phase of improving contractor safety addresses those activities accomplished at the successful completion of a contract. This program is strengthening post contract oversight by ensuring that Contract Officers and Technical Representatives (COTRs) conduct an out brief with the Safety Office to ensure that all records that pertain to safety training and operations stay within Government control when a contract terminates. GSFC also conducts safety and health audits of previous contractor's workspaces before new tenants are permitted to occupy those areas.

Center Director's Summary: As you can see, I am committed to ensuring GSFC provides all employees a safe and healthy place to conduct world-class research and development. I am very proud of the GSFC workforce and their dedication to safety and mission success. I realize that one tragic mishap can set back our mission and adversely affect our GSFC family, and in that regard I make no distinction between contractor or civil service operations. That is why we are very proactive in ensuring successful contractor and civil service safety programs are in place and functional. GSFC Program Managers and Supervisors understand without a doubt my expecta-

tion regarding our safety program requirements and existing systems and tools will be reviewed and strengthened on a continual basis. I appreciate the opportunity to respond to the ASAP recommendations and look forward to their next visit. If I can be of any further assistance please contact me or Ms. Judy Bruner.

02-21-06—Goddard Space Flight Center

We consider these actions a high priority and have already taken steps to address each of these areas. We plan to initiate additional actions to improve the overall safety performance of all employees (civil servant and contractor) at Goddard Space Flight Center (GSFC).

Improvement of our contractor safety performance requires that we focus on three areas of the NASA contract cycle. The three areas: contract acquisition, contract performance, and contract termination, do need improvement from a safety perspective. First, we will look at the contract acquisition process to evaluate the criteria used in the selection of contractors, specifically, looking at the use of past safety performance and prime contractors' proposed flow-down of requirements to subcontractors. Secondly, we will finalize and document the oversight process for prime contractors and subcontractors during the performance period. While this process will evaluate the contractors' safety performance and award/penalize appropriately, the goal is to establish a partnership with GSFC contractors so that high safety performance is achieved as a normal course of action. The last life-cycle phase is contract termination upon successful completion of the contracted work. One real concern in this area is the retention (by NASA) of required "safety records" generated by a contractor during their normal course of work. This includes, but is not limited to, objective quality evidence of safety training, certifications, audits, and mishap investigations. Our corrective action plan will address the actions necessary to improve each of these areas.

Observation #7
Their largest personal safety issue is "Slips, Trips, and Falls," which is not uncommon in the industry. It has caused a few lost-time incidents in the past year and for a laboratory site there could be improvements there.

Recommendation #6 (2006-03-01.B)
Flowing from our August 2005 visit to Goddard Space Flight Center (GSFC)
The GSFC should address, in a more formal way, the monitoring, tracking, and analysis of close-calls.

Status
Closed

Response(s)
09-18-06—Goddard Space Flight Center

GSFC has formally documented its mishap/close-call process in a series of GSFC Procedural Requirements (GPR) documents, including GPR 8621.1A (Reporting Mishaps and Close Calls), GPR 8621.2A (Processing Mishap and Close Call Reports) and GPR 8621.3B (Mishap and Close Call Investigation). These documents have been in place for years and lay out the requirements that are levied on supervisors. Supervisors are expected to ensure that the necessary notifications are made, that the incident is thoroughly investigated and that follow-up corrective actions are taken. These activities are monitored by the individual responsible organization until corrective actions have been completed and depending on the criticality of the incident, timely status reports are given to senior management throughout the investigation. Additionally, overall Center mishap/close-call data is discussed each month during the Centers' Monthly Status Review.

From a contractor standpoint, all contracts contain the requirement to report mishaps/close calls and provide quarterly incident metrics to the Safety Office, which continually monitors and assesses contractor mishap/close call metrics to analyze trends and identify root-causes in order to assist them in developing proactive solutions. These metrics are cross-checked during the Annual Contractor Safety Program Audits and, as previously stated above, affect a contractor's award fee.

As part of the Centers' on-going effort to educate employees and reinforce the requirement to report mishaps/close calls, GSFC has distributed several bulletins to all Center employees and conducted numerous all-hands briefings and workshops for civil servants and contractors regarding the need to be on the look-out for mis-

haps/close calls and the requirement to report them through the Incident Reporting and Information System (IRIS). Specifically, an IRIS workshop was conducted for each GSFC Directorate during the first annual GSFC Safety Awareness Campaign (SAC) which was conducted in the fall of 2005. These presentations will continue to be a core agenda item in future SACs. Also, the IRIS Program Manager recently provided a briefing on the IRIS system to the Center Contractor Safety Forum, and a Center-wide workshop to discuss several recent mishaps is scheduled for October 2006. (This workshop will be conducted on a quarterly basis in the future, highlighting recent mishaps/close calls.) Additionally, the GSFC Employee Safety Pocket Guide contains information about identifying and reporting mishaps/close calls, including how to use IRIS and pointers to the appropriate GPRs, safety websites and Points of Contact.

Finally, the Safety Office plans to continue to benchmark with other NASA Centers to look for enhancements which will improve the GSFC process in the future.

02-21-06—Goddard Space Flight Center

We consider these actions a high priority and have already taken steps to address each of these areas. We plan to initiate additional actions to improve the overall safety performance of all employees (civil servant and contractor) at Goddard Space Flight Center (GSFC).

The second part of the recommendation dealt with formalizing the process of monitoring, tracking, and analyzing close calls. Again, we have taken several actions to improve this part of the safety program and plan additional actions. Close calls are captured in the Incident Reporting and Information System (IRIS). Improvement in this area starts with the "reporting" of close calls. The Center's safety organization has undertaken an action to increase awareness of the IRIS close-call reporting system through a series of workshops and issuance of bulletins. The workshops, part of the recent Center-wide Safety Awareness Campaign involving all directorates at GSFC, were designed to increase understanding and awareness of our close-call reporting process, as well as to encourage more complete reporting of all mishaps and close calls. In addition, we will continue to monitor close call metrics, provide wider distribution of the data/assessment results, and will schedule additional workshops over the coming months as needed. Again, all actions to strengthen this safety program aspect will be identified in greater detail in our corrective action plan.

Development of the corrective action plan will require strong coordination with a variety of groups within GSFC, and we have already initiated actions to benchmark with other NASA Centers (specifically JPL) in looking for solutions to our problem areas. We look forward to discussing our plan with your representatives following our finalization of that document.

Observation #8

ASAP knows that one of the difficult challenges with regards to culture is that you are often asked "if you are making progress rightly, properly, and quickly," the question that often follows is: well how do you know? To ensure that the product does not wear the filters and biases that exist inside the organization, an external perspective would be of value.

Recommendation #8 (2006-03-03)

NASA should consider outside verification/validation (via the NASA Advisory Council, National Academy of Public Administration, ASAP, etc.) of the Competency Assessment that Agency has recently completed to increase credibility and confidence in the findings. It is our expectation that this effort will support more comprehensive analysis of human capital needs and development of strategies to meet those needs.

Status

Open

Response(s)

02/21/06—Office of Human Capital Management

NASA agrees with the ASAP recommendation to involve outside experts in reviewing the Agency's internal workforce requirements assessment. In response to the ASAP recommendation, we intend to engage the National Academy of Public Administration in validating our human capital strategy, including the assessment of future workforce requirements and the plan to address these requirements.

Observation #9

In our 2004 Second Quarter Recommendations, we offered the following questions for consideration with regard to the shaping of the ITA construct. To date, the ASAP has not received a full complete answer to the series questions regarding Independent Technical Authority (ITA).

Recommendation #9 (2006-03-04)

We believe the questions remain germane; and, we again recommend consideration be given to the following:

Independent Technical Authority (ITA)–

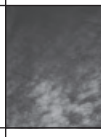
a) Who is the technical authority (i.e., who shall have overall responsibility, accountability, and authority to administrator ITA)?

b) What are the key functional areas making up the ITA?
   - Where do they reside?
   - To whom do they report?
   - Who signs their performance evaluations?
   - Who can override their direction?

d) What are the reporting, evaluating, and oversight relationships between the functional leaders/ITA and matrix personnel (e.g., between the head structural engineer holding ITA authority for structures and structural engineers assigned to program teams)? This is important because the individuals assigned to the program teams must feel the responsibility and accountability of "good technical conscience" (i.e., there must be a linkage between engineers assigned to the team and to the technical authority if necessary insight is to be achieved).

e) Is a lead functional/ITA person responsible for the long-term career development and continuing education of ALL the people within his/her functional area? Is this responsibility independent of geography; or, are there multiple people at multiple sites? If a single ITA functional lead does not have this responsibility, accountability, and authority all across NASA, how is it exercised at the Agency level? If distributed, how is it integrated?

f) If there is dual reporting? Is there a feedback loop? How are disagreements resolved?



Status
Closed

Response(s)
10/16/06 – Office of the Chief Engineer

a) *Who is the technical authority (i.e., who shall have overall responsibility, accountability, and authority to administer ITA)?*

By statute, the Administrator has ultimate responsibility and authority for all technical matters within the Agency. In NPD 1000.0, the Administrator's technical engineering authority has been delegated through the Associate Administrator (AA), to the Office of the Chief Engineer (OCE), to Centers to Engineering organizations. The OCE is the technical engineering authority, and in certain cases the OCE may delegate technical authority for a Program to a Center. Center Directors will administer technical authority for their institutions and for Projects hosted at their Center through their Engineering organizations with chief engineers who will be designated as the technical authority for each project and for delegated program activities at their Center and Center discipline leads who will be designated as the Center authority for their technical disciplines. Basically, technical authority flows from the Administrator to the AA to OSMA (safety and mission assurance) or OCE (engineering), to the Center Directors to the Directors of Center Engineering organizations and then to the program/project chief engineers and a limited number of lead engineers (subject matter experts) for execution. technical authority at Centers will be budgeted and funded directly from NASA Headquarters (Office of the Chief Engineer) and will be funded separate from the Programs/Projects. The Agency's Chief Engineer will be the AA's principle advisor for all matters regarding technical authority, including policy, and oversight and assessment of Agency-wide policies, implementation and technical readiness assessments. The integration of technical authority within Center Engineering organizations and the revitalization of engineering in the Agency to a peer relationship with programmatics is referred to as Technical Excellence.

b) *What are the key functional areas making up the ITA?*

Technical requirements will be maintained and approved by the technical authority (programmatic, top-level requirements are owned by the Mission Directorates). Center Directors are responsible and accountable for technical

engineering decisions made at their Center. Engineers who serve as a technical authority for a program or project or in a technical discipline area will be financially and organizationally independent of programmatic authority. The full technical capabilities of NASA resident in the institutional engineering enterprise of each Center will be made available to technical authorities.

c) *Who are the representative subject-matter experts assigned to lead key areas?*
   a. Where do they reside?
   b. To whom do they report?
   c. Who signs their performance evaluations?
   d. Who can override their direction?

   This is shown in Chart 5 of Chris Scolese's presentation to the ASAP on February 1, 2006. Center Directors are responsible for technical engineering decisions made at their center. Engineers who serve as a technical authority for a program or project effort or in a technical discipline area will be financially and organizationally independent of programmatic authority. Technical authorities are typically branch-chief or higher in the organization, reporting up through the chain of command in the Engineering organization at that center. A path for "engineering appeal/recourse" on critical technical issues is shown in the flow chart. The program/project cannot overrule a technical authority and therefore will not proceed without a resolution from the Engineering organization or the Center Director. If a technical disagreement cannot be resolved at the Center level, then the issue goes to the Chief Engineer, AA, and ultimately to the Administrator if unresolved at lower levels.

d) *What are the reporting, evaluating, and oversight relationships between the functional leaders/ITA and matrix personnel (e.g., between the head structural engineer holding ITA authority for structures and structural engineers assigned to program teams)? This is important because the individuals assigned to the program teams must feel the responsibility and accountability of "good technical conscience" (i.e. there must be a linkage between engineers assigned to the team and to the technical authority if necessary insight is to be achieved).*

   This is shown in Chart 5 of Chris Scolese's presentation to the ASAP on February 1, 2006. Center Directors are responsible for technical engineering decisions made at their center. Engineers who serve as a technical authority for a program or project effort or in a technical discipline area will be

financially and organizationally independent of programmatic authority. The individuals selected and designated as discipline leads will be recognized as the Center's leading subject matter experts, and would typically occupy a position at the level of branch chief or higher. These individuals will be personally responsible and accountable for establishing technical requirements, standards and criteria, and for maintaining the integrity of those requirements. Program/project engineering teams comprised of discipline engineers assigned or matrixed to programs/projects will interface with the program/project through the chief engineer, who will be the technical authority for that program/project. The discipline technical authorities will be expected to establish strong working relationships and clear protocols between engineers working at all levels within their respective Center, so that communication will be based on chain-of-command relationships as well as technical conscience.

e) *Is a lead functional/ITA person responsible for the long-term career development and continuing education of ALL the people within his/her functional area? Is this responsibility independent of geography; or, are there multiple people at multiple sites? If a single ITA functional lead does not have this responsibility, accountability, and authority all across NASA, how is it exercised at the Agency level? If distributed, how is it integrated?*

This is shown in Chart 5 of the February ASAP presentation. The supervisory chain of command is responsible for long-term career development and education of his/her direct-reports at his/her Center. The Office of the Chief Engineer is also developing a new Agency program, Technical Fellows, where subject-matter, discipline experts throughout the Agency will be named and will serve as a resource to the Agency. These Technical Fellows will be responsible for stewardship, outreach and engagement of their discipline within NASA. In addition, the NASA OCE offers career development and training programs offered through the Academy of Program, Project and Engineering Leadership (APPEL) which are executed at the Center Engineering organizations as a key element in achieving engineering excellence at NASA. The APPEL program will work with Center Directors and Center Engineering organizations to establish and fulfill training needs that will maintain individuals' potential for career progression. Center Directors, through the Directors of their Engineering organizations, are responsible for

implementation and execution of career development and resource planning for all Center Engineering personnel as a key to achieving engineering excellence at their Center.

f) *Is there dual reporting? Is there a feedback loop? How are disagreements resolved?*

As shown in Chart #5 of the February ASAP presentation, Technical Authorities will have only a single reporting line that includes supervisory control and problem resolution. The association between the program/project and the chief engineer will be primarily engineering work assignment and integration of engineering requirements, engineering processes and results of engineering effort into the program/project effort. A line engineer's supervisory path will be within the Center's Engineering organization and all engineering personnel, even those assigned or matrixed to a program/project, will be employees of the Center's engineering organization. If there is a technical issue that requires a deviation from the established technical requirements, the line engineer engages the discipline lead (the technical authority). If there is a disagreement between the discipline lead or the chief engineer and the program/project management, the flow for resolution is up to the Director of the Center's Engineering organization, to the Center Director, and ultimately to the Associate Administrator if necessary.

Status Update—September 12, 2006

Since OCE's report to the ASAP in February, 2006, very significant progress has been made with regard to implementation the new Technical Authority model at NASA. The OCE is pleased to provide the following status update to the ASAP.

Engineering Organization

Each NASA Center was required to develop a Technical Authority Implementation Plan reflecting organizational separation of engineering from programs and projects and who should be independently funded. The 9 of 10 Plans were submitted to the Office of the Chief Engineer during the spring 2006, and were preliminarily approved by the Chief Engineer in July.

This required the reorganization of Centers like KSC and GRC, since their engineering personnel generally worked directly for programs and projects. KSC is re-organizing and creating a unified Engineering Directorate to better adhere to the governance model, and is in the process of developing their plan. GRC completed their reorganizing during the early summer. The major changes at these Centers includes establishment of Engineering Directorates with direct reporting of engineering personnel, with engineers matrixed to the programs and projects. This change creates organizational independence. The other Centers were already appropriately organized.

At all Centers, program and project Lead Systems Engineers or Chief Engineers and Lead Discipline Engineers are organizationally in the Engineering Directorates and separately funded from the programs and projects.

To ensure consistency at all levels within the Agency, Headquarters' Mission Directorate Chief Engineers were reassigned to OCE and matrixed back to the Mission Directorates to provide independence of the technical chain.

Academy of Program/Project and Engineering Leadership (APPEL)

NASA APPEL has integrated a systems engineering curriculum, with the Massachusetts Institute of Technology (MIT) and the International Council of Systems Engineering (INCOSE), to emphasize the importance of systems engineering within the program/project management community. This new curriculum emphasizes the NASA mission, governance model, lexicon, and documents (i.e. NPR 7120.5D NASA Program and Project Management Processes and Requirements, NPR 7150.2 NASA's Software Engineering Requirements, and NPR 7123.1 NASA Systems Engineering Processes and Requirements) to accomplish the NASA vision. The curriculum addresses the implementation of the NASA Exploration Vision into all levels of career development over a 30-year span: new hires and fresh-outs, the professional development of mid-career project managers and engineers, and executive development of senior NASA personnel.

In terms of performance enhancement, APPEL has shifted from the individual to teams. The performance enhancement resources, in terms of expert practitioners, are now supporting Exploration project teams along with other project activities. The Constellation Program at JSC has embraced NASA APPEL's approach in developing individuals and teams to meet their mission responsibilities.

Since February, NASA APPEL has integrated knowledge sharing in terms of engineering case studies and mobilizing expert practitioners across the Agency to drive the development of technical communities of practice. APPEL has also focused on facili-

tating various agency knowledge management initiatives and systems towards a focus on improving systems engineering and project management. APPEL greatly improved the communication of knowledge through the ASK OCE newsletter, a revamped and improved ASK Magazine, the Master's Forums, and Project Management Challenge. APPEL is reaching out to functional offices and mission directorates to include and consolidate common themes and issues in these activities.

NPR 7120.5D

NPR 7120.5C, *NASA Program and Project Management Processes and Requirements*, is being revised to reflect the NASA governance model, to focus on space systems development, to address the recommendations from a GAO audit performed in August 2005, to establish a uniform process for conducting space systems development, and to also focus not only on program/project management processes and requirements, but on the broader scope of how NASA does programs and projects. The new document is called NPR 7120.5D and will focus on spaceflight and ground support systems only. Separate NPRs for the other product lines covered in NPR 7120.5C (Basic and Applied Research, Advanced Technology Development, and Infrastructure) are being developed in parallel with NPR 7120.5D. Because NPR 7120.5D impacts many other Agency documents, OCE has been coordinating with the "owners" of those documents (i.e. NPR 7120.4, NPR 7123.1, NPR 8000.4, etc) to ensure they stay in lock-step with the requirements in NPR 7120.5D.

The revision to NPR 7120.5 is being performed by a team composed of over forty senior representatives from all the Centers, Mission Directorates, and Mission Support Offices and is being led by Tom Gavin of JPL. Three drafts have been generated and reviewed by representatives from all of the Mission Directorates, Centers, and Mission Support Offices including members from the Program/Project Management Board. The final draft is being generated now and is scheduled to go into the official NASA approval process 25 September, 2006.

Acquisition Process

NASA is updating its acquisition process to require additional decision meetings earlier in the planning stages of Agency strategy and earlier in the program/project lifecycle to help senior Agency leaders make informed strategic decisions in a disciplined, systematic way. Currently there is a Procurement Strategy Meeting (old Acquisition Strategy Meeting) that looks at the procurement approach for each acquisition. However, this meeting is tactical in that it looks at contracts and does not address the Agency acquisition process from a strategic point of view.

Two new decision points are being added to the acquisition process. The Acquisition Strategy Planning (ASP) meeting is integral to the annual budget development process. The ASP meeting is structured to allow Agency senior management to review potential major acquisitions that evolve from requirements introduced to the Agency from external sources (e.g., The President's Vision for Space Exploration) and internal sources (e.g., major acquisitions initiated by the Mission Directorates/ Mission Support Offices). The purpose of the ASP meeting is to identify and define roles and responsibilities of Mission Directorate(s), host Center, other participating Centers, major partnerships, and associated infrastructure (workforce and facilities), with a focus on mission success and to maintain ten healthy Centers. The ASP meeting will also delineate if an Acquisition Strategy Meeting (ASM) is required for each acquisition under consideration.

The Acquisition Strategy Meeting (ASM) applies to both programs and projects. ASMs are to be convened as early as practicable and prior to partnership commitments. The purpose of the ASM is to obtain senior management approval of acquisition strategy (e.g., make/buy, Center assignments, and targeted partners) for programs and projects. The supporting materials for the ASM will include appropriate program/project documentation that cover budget, schedule, requirements and risk.

Review Process/Systems Engineering

NASA has updated its review process for all of its spaceflight projects to have standard reviews with defined entry and success criteria as well as defined Key Decision Points (KDPs) where a decision authority (AA for programs and category 1 projects, MDAA for category 2 and 3 projects) determines if the program/project is ready to enter its next phase in the lifecycle. In addition, an independent Standing Review Board (SRB) composed of members outside the advocacy chain of the program/project, is required to assess the project from formulation through launch. The members of the SRB are approved by the decision authority and the technical authority so as to preserve the NASA governance model (programmatic chain and the technical chain). This process is being institutionalized in NPR 7120.5D, *NASA Spaceflight Program and Project Management Requirements*, and the newly released NPR 7123.1, NASA *Systems Engineering Processes and Requirements*. NPR 7123.1 was released earlier in the year and is now being updated to line up with NPR 7120.5D. NPR 7123.1 requires common systems engineering processes to be used across the Agency. NASA is also updating SP 6105, *Systems Engineering Handbook*, which was released in the early 90's to reflect current NASA system engineering policy.

Budget

NASA's FY08 Budget preparation is completed. NASA has created a new budget process for the FY08 budget that will simplify full cost. This process established a new budget structure and baseline for Technical Authority. The ITA Agency Service Pool has been eliminated consistent with the retirement of the Warrant System, and the new funding mechanism will be in place for the start of FY07.

In addition to simplifying full cost for the FY08 budget process, NASA has streamlined budget execution activities with this new structure. Consistent with the CAIB, Technical Authority funding will continue to be funded independently from programs/projects and distributed from Headquarters. TA funding is totally aligned with the new governance model. Separate funding for Technical Authority includes funding for all Center Chief Engineers (e.g. Lead System Engineers) and Engineering Branch Chiefs in all Center engineering organizations.

Collaboration with Office of Safety and Mission Assurance

The Office of the Chief Engineer and the Office of Safety and Mission Assurance have significantly increased communications and collaboration in four major areas: (1) key policy and process issues affecting Engineering, SMA and project management communities; (2) striving for consensus decisions when possible on key joint issues; (3) Establishing common framework for Technical Authority Implementation, policy, and definitions; and (4) Assigning OCE and OSMA subgroups to integrate individual policy and processes.

The OCE and OSMA are jointly standardizing terminology, starting with basic terms such as safety, waiver, deviation, non-conformance, tailoring, dissenting opinions, etc. The two offices play integral roles in developing and revising NPR 8000.4, Risk Management; Systems Engineering Handbook; NPR 7120.5D, Program and Project Management; and NPR 8715.3 Integrated Safety Manual.

OCE and OSMA are also collaborating on integrating OSMA training with the OCE led APPEL training program, where appropriate. This will increase consistency, enhance cross training, and maximize resources.

OSMA has a thorough Programmatic Audit and Review (PA&R) program, and OCE is leveraging that process to establish an Engineering audit program.

The OCE and OSMA have developed the Safety and Mission Success Review (SMSR) process, which provides engineering and safety and mission assurance readiness status prior to major milestones. The SMSR is primarily prior to launches, is co-chaired by the Chief OSMA and the Chief Engineer, and is briefed by applicable Center Engineering and SMA.

Lastly, the Chief OSMA is a member, and participates in, the Engineering Management Board; and the Chief Engineer participates in the SMA Directors Board.

Nasa Congressional Question for the Record Re: Technical Authority
March 20, 2006

Questions for the Record from Chairman Boehlert

Question #16:

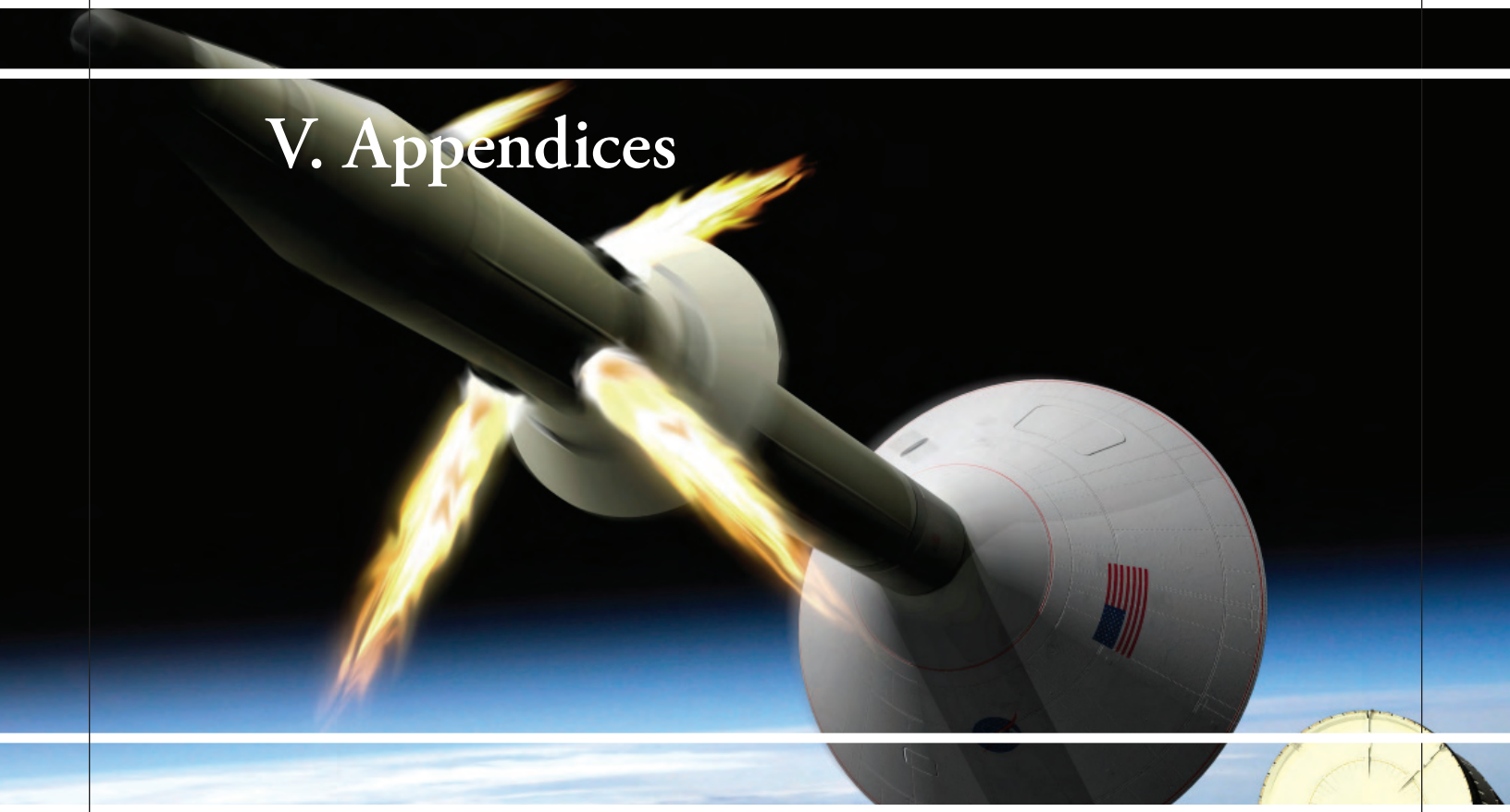
16. NASA has decided to alter its implementation of the Independent Technical Authority (ITA). What were the issues that drove you to conclude that the ITA construct was not adequate and required modification? Explain how the latest implementation of the ITA complies with the recommendations of the Columbia Accident Investigation Board. If you have decided to take exception to any portion of the recommendation of the CAIB, please explain the rationale for the exception.

Oce Answer:

CAIB R7.5-1 recommended establishing an independent Technical Authority for Shuttle.

NASA established independent Technical Authority (iTA) for the Shuttle and expanded TA (Technical Authority) across NASA. The Technical Excellence initiative will expand the Technical Authority concept across NASA, consistent with NASA Governance NPD 1000.3. The new model will fully institutionalize technical authority into the day-to-day practices and processes at NASA. Key attributes of Technical Authority (consistent with CAIB recommendations) include: (1) Organizational independence from programs and projects and (2) Funding independence from programs and projects. Technical Authority is part of Technical Excellence, and builds on the lessons of the independent Technical Authority and other CAIB recommendations. The goal of Technical Excellence is to refine our way of doing business so that over the long-term, technical excellence, safety and mission success are part of our institution. The initiative will institutionalize the necessary processes and organizational culture changes to enhance and maintain technical excellence to enable safety and mission success.

V. Appendices



Appendix A: Charter of the Aerospace Safety Advisory Panel

1.0 Official Designation

This charter sets forth the purpose for the panel officially designated as the Aerospace Safety Advisory Panel originally established under Section 6 of the National Aeronautics and Space Administration Authorization Act, 1968, as amended (P.L. 90-67, codified at 42 U.S.C. § 2477). Having determined that it is in the public interest in connection with the performance of Agency duties under the law, and with the concurrence of the General Services Administration, the NASA Administrator hereby renews and amends the Panel's charter, pursuant to the Federal Advisory Committee Act (FACA), 5 U.S.C. App. §§ 1 et seq.

2.0 Objectives and Scope

The Panel will review, evaluate, and advise on elements of NASA's safety and quality systems, including industrial and systems safety, risk management and trend analysis, and the management of these activities. Priority will be given to those programs that involve the safety of human flight.

3.0 Period

The Panel will perform its duties for the period specified in Section 9.0.

4.0 Reporting

The Panel will function in an advisory capacity to the Administrator, and through the Administrator, to those organizational elements responsible for the management of the NASA safety and quality activities.

5.0 Panel Organization and Support

5.1 Panel Members: As originally set forth in 42 U.S.C. § 2477, the Panel will consist of a maximum of nine members who will be appointed by the NASA Administrator. Consistent with the two-year duration of this Charter, members will be appointed for two years and could be reappointed by the NASA Administrator up to a maximum of six years.

5.2 Panel Chairman: As originally set forth in 42 U.S.C. § 2477, one member shall be designated by the Panel as its Chairman.

5.3 Panel Composition: The Panel will be comprised of recognized safety, management, and engineering experts from industry, academia, and other government agencies.

5.4 NASA Membership: As originally set forth in 42 U.S.C. § 2477, not more than four Panel members shall be chosen from the officers and employees of the NASA.

5.5 Panel Support: NASA Headquarters will provide a staff, to be comprised of full-time NASA employees, to provide support to the Panel.

6.0 Panel Duties

6.1 The duties of the Panel, as originally set forth in 42 U.S.C. § 2477, shall continue: "The Panel shall review safety studies and operations plans referred to it and shall make reports thereon, shall advise the Administrator with respect to the hazards of proposed or existing facilities and proposed operations and with respect to the adequacy of proposed or existing safety standards and shall perform such other duties as the Administrator may request."

6.2 Quarterly Report: The Panel shall submit quarterly reports to the Administrator Findings that are time critical will be reported immediately.

6.3 Special Reviews and Evaluations: The Administrator may request certain special studies, reviews, and evaluations. The Panel will submit reports with comments and recommendations as deemed appropriate by the Panel to the Administrator within the timeline specified by the Administrator.

7.0 Estimated Annual Costs

The NASA Headquarters will provide the budget for operation of the Panel. The estimated annual operating cost totals $555,000 including 2.5 work-years for staff support.

8.0 Estimated Number and Frequency of Meetings

8.1 Meetings: There will be four full Panel meetings each year to perform their duties as described in Section 6.0.

8.2 Special Meetings: Special meetings of the Panel may be required.

9.0 Duration

This Charter shall become effective upon the filing of this Charter with the appropriate U.S. Senate and House of Representative oversight committees. It shall terminate two years from the date of the filing of this Charter unless renewed or terminated earlier by the NASA Administrator.

Signed — November 18, 2005
Michael D. Griffin
NASA Administrator

Appendix B: ASAP Panel Members and Staff

Panel Members

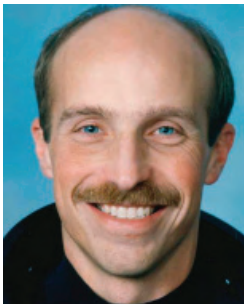
Vice Admiral Joseph W. Dyer, USN (Ret.)

- Aerospace Safety Advisory Panel Chair
- President, Military Government & Industrial Division, iRobot Corporation
- Former Commander, Naval Air Systems Command

Vice Admiral Joseph W. Dyer was commissioned through the Aviation Reserve Officer Candidate Program following graduation from North Carolina State University with a Bachelor of Science Degree in chemical engineering. He subsequently earned a Master of Science Degree in financial management from the Naval Post Graduate School, Monterey, CA. He received his wings in March 1971 and was selected as one of the first "Nuggets" (first tour aviators) to fly the Mach 2, RA-5C *Vigilante*. He flew nationally tasked reconnaissance missions in both the eastern and western hemispheres.

From April 1991 to December 1993, Admiral Dyer was the U.S. Navy's chief test pilot. From January 1994 to April 1997, he served as F/A-18 program manager, leading the engineering and manufacturing development (E&MD) effort on the new F/A-18E/F, the continued production and fleet support of the F/A-18C/D and all F/A-18 foreign military sales. The F/A-18 program won the Department of Defense Acquisition Excellence Award and the Order of Daedalian during this period. Admiral Dyer was assigned as the Commander, Naval Air Warfare Center Aircraft Division, Patuxent River, in July 1997 and one month later assumed additional responsibilities as the Naval Air Systems Command, Assistant Commander for Research and Engineering. In June 2000, he was assigned as the Commander, Naval Air Systems Command.

Admiral Dyer is President of the iRobot Corporation's Military Government & Industrial Division. In this position, he works closely with the U.S. Department of Defense to develop reconnaissance robots that will change the way wars are fought in the future.



Dr. James P. Bagian

- Director, National Center for Patient Safety, Veterans Health Administration, U.S. Department of Veterans Affairs
- Medical Consultant and Chief Flight Surgeon, Columbia Accident Investigation Board
- Former Space Shuttle Astronaut

Dr. James P. Bagian is a physician and researcher who has combined his medical expertise with a variety of other disciplines. He has served as: a NASA physician and astronaut; a U.S. Air Force flight surgeon; and an engineer with the U.S. Department of Housing and Urban Development, the U.S. Navy and the Environmental Protection Agency. He now serves as the Director of the National Center for Patient Safety in the Veterans Health Administration, U.S. Department of Veterans Affairs.

During his 15-year tenure with NASA, Dr. Bagian flew on two Shuttle missions. He also took part in both the planning and provision of emergency medical and rescue support for the first six Shuttle flights. He led the development of a high-altitude pressure suit for crew escape, along with other crew survival equipment. In addition, he was the first to employ a treatment of space motion sickness that has become the standard of care for astronauts in distress. Following the *Columbia* accident, he was appointed as Medical Consultant and Chief Flight Surgeon for the Columbia Accident Investigation Board.

Dr. Bagian's contributions to military service include advancing new methods of military aircraft ejection seat design and serving as a colonel in the U.S. Air Force Reserve. As the Special Consultant for Combat Search and Rescue to the Air Command Surgeon General, he was a leader in standardizing pre-hospital combat rescue medical care across all Air Force major commands.

In his current position at the Veterans Health Administration, Dr. Bagian developed and implemented an innovative program aimed at protecting patients from hospital-based errors. This patient-safety program has been put into practice at all 173 VA hospitals, and it is considered to be the benchmark for patient safety in hospitals worldwide. Recognizing this contribution, Harvard University's John F. Kennedy School of Government awarded Dr. Bagian's program its Innovations in American Government Award in 2001.

Dr. Bagian received a Bachelor of Science Degree in mechanical engineering from Drexel University in 1973 and a Doctorate in medicine from Thomas Jefferson University in 1977.

Major General Charles F. Bolden Jr. (Ret.)

- CEO, JACKandPANTHER LLC
- Former Space Shuttle Astronaut
- Former Commanding General, Third Marine Aircraft Wing

Major General Charles F. Bolden, Jr. was a NASA pilot astronaut for 13 years, flying four Space Shuttle missions. Following the Shuttle *Challenger* accident in 1986, he was assigned as the Chief of the Safety Division at the Johnson Space Center, overseeing the efforts to ensure safety as the Shuttle Program returned to flight. He later served as NASA Assistant Deputy Administrator. After leaving the Space Program and returning to service he had begun earlier with the operating forces of the U.S. Marine Corps, General Bolden was assigned as Deputy Commanding General, 1 Marine Expeditionary Force (MEF), Marine Forces, Pacific, in 1997. He served as Commanding General, 1 MEF (Forward) for Operation Desert Thunder in Kuwait from February to June 1998. In July 1998, he was promoted to Major General, serving as the Commanding General of the Third Marine Aircraft Wing.

General Bolden retired from the United States Marine Corps on January 1, 2003, after 34 years of service. He has been awarded a number of military and NASA decorations, and he was inducted into the U.S. Astronaut Hall of Fame in May 2006. He is currently the CEO of JACKandPANTHER LLC, a small business enterprise providing leadership, military and aerospace consulting, as well as motivational speaking.

General Bolden received a Bachelor of Science Degree from the U.S. Naval Academy and a Master of Science Degree in systems management from the University of Southern California. He is a graduate of the U.S. Naval Test Pilot School at Patuxent River, Maryland and has received honorary doctorate degrees from several distinguished universities.

Dr. Dan Crippen

- Former Director of the Congressional Budget Office
- Former Member of the NASA Stafford-Covey Return to Flight Task Group

Dr. Dan Crippen has a strong reputation for objective and insightful analysis. He served, until January 3, 2004, as the fifth Director of the Congressional Budget Office. His public service positions also include: Chief Counsel and Economic Policy Advisor to the Senate Majority Leader (1981-1985); Deputy Assistant to the President for Domestic Policy (1987-1988); and Domestic Policy Advisor and Assistant to the President for Domestic Policy (1988-1989), where he advised the President on all issues relating to domestic policy, including the preparation and presentation of the federal budget. He has provided service to several national commissions, including membership on the National Commission on Financial Institution Reform, Recovery and Enforcement.

Dr. Crippen has substantial experience in the private sector as well. Before joining the Congressional Budget Office, he was a principal with Washington Counsel, a law and consulting firm. He has also served as Executive Director of the Merrill Lynch International Advisory Council and as a founding partner and Senior Vice President of The Duberstein Group.

Dr. Crippen received a Bachelor of Arts Degree from the University of South Dakota in 1974, a Master of Arts Degree from Ohio State University in 1976 and a Ph.D. in public finance from Ohio State in 1981.

Dr. Amy K. Donahue

- Assistant Professor of Public Administration in the Department of Public Policy, University of Connecticut
- Founding Director, Stephenson Disaster Management Institute, Louisiana State University
- Former Member of the NASA Stafford-Covey Return to Flight Task Group

Dr. Amy K. Donahue is Assistant Professor of Public Policy at the University of Connecticut, where she teaches in the Master of Public Administration and Master of Survey Research programs. She is also the founding director of the Stephenson Disaster Management Institute at Louisiana State University. Dr. Donahue's research focuses on the productivity of emergency services organizations and on the nature of citizen demand for public safety services. She is the author of published work about the design, management and finance of fire departments and other public agencies.

For the past four years, Dr. Donahue has served as a Technical Advisor to the Department of Homeland Security's Science and Technology Directorate, helping to develop research and development programs to meet the technological needs of emergency responders. From 2002-2004, Dr. Donahue served as Senior Advisor to the NASA Administrator for Homeland Security. She was the Agency's liaison to the Department of Homeland Security and the Homeland Security Council, and she identified opportunities for NASA to contribute to homeland security efforts across government. In 2003, Dr. Donahue spent three months in Texas helping to manage the Shuttle *Columbia* recovery operation, an intergovernmental response that involved 450 organizations and 25,000 responders. She has also served on the National Mining Association's Mine Safety Training and Technology Commission, tasked with identifying ways to improve safety in the wake of recent miner deaths. Dr. Donahue has many years of training and field experience in an array of emergency services-related fields, including managing a 911 communications center and working as a firefighter and emergency medical technician in Fairbanks, Alaska and upstate New York.

As a Distinguished Military Graduate of Princeton University's Reserve Officer Training Corps, Dr. Donahue served in the U.S. Army on active duty for four years in the 6th Infantry Division, rising to the rank of Captain. Dr. Donahue holds her Ph.D. in public administration and her M.P.A. from the Maxwell School of Citizenship and Public Affairs at Syracuse University. Her B.A. from Princeton University is in geological and geophysical sciences.

Mr. John C. Frost

- Former Chief, Safety Office, U.S. Army Aviation and Missile Command
- Former Chief, Safety Office, U.S. Army Missile Command

Mr. John C. Frost is an independent safety consultant who retired from federal service with 33 years of safety engineering experience. Mr. Frost was the Chief of Safety for the U.S. Army Aviation and Missile Command (AMCOM), with worldwide responsibility for missile and aircraft safety. Mr. Frost directed and implemented a comprehensive system safety program for all aspects of a major high-technology organization that developed, fielded and supported state-of-the-art aircraft and missile/rocket systems for the Army worldwide and provided facilities and services for approximately 20,000 residents, workers and visitors at Redstone Arsenal. Before that, he served as the Chief of the Missile Command (MICOM) Safety Office and held other supervisory positions leading various MICOM System Safety, Radiation Protection, Explosive Safety, Test Safety and Installation Safety program elements. Mr. Frost began his federal career in the Safety Office of the Army's Electronics Command at Fort Monmouth, New Jersey, where he became Chief of System Safety Engineering.

Mr. Frost earned a Bachelor of Science Degree in electrical engineering from the University of Virginia, where he was a DuPont Scholar. He completed a Master of Science Degree, specializing in safety engineering, from Texas A&M University and an additional year of advanced safety engineering training. Mr. Frost is a Senior Member of the International System Safety Society, a Professional Member of the American Society of Safety Engineers, and remains active in various system safety organizations and initiatives. He was previously registered in Massachusetts as a Professional Engineer in the specialty of safety engineering and as a Certified Safety Professional.

Ms. Deborah L. Grubbe, P.E.

- Former consultant, Columbia Accident Investigation Board
- Vice President–Group Safety, BP p.l.c.
- DuPont Corporate Director–Safety and Health (retired)

Ms. Deborah L. Grubbe is Vice President – Group Safety, for BP plc. Based in London, she is accountable for providing global safety leadership in all business areas, including: exploration and production; refining and marketing; gas, solar and renewables. Formerly, Ms. Grubbe was employed by DuPont in Wilmington Delaware, where she held corporate director positions in safety, operations and engineering. Her many assignments have included capital project implementation, strategic safety assessments, manufacturing, management and human resources.

Ms. Grubbe received a Bachelor of Science Degree in chemical engineering from Purdue University and was a Winston Churchill Fellow at the University of Cambridge, England. She is the former Co-Chair of the Benchmarking and Metrics Committee of the Construction Industry Institute and is Vice Chair of the National Institute of Standards and Technology Visiting Committee on Advanced Technology. Affiliated with the National Research Council, she has also advised the U.S. Army on the demilitarization of the U.S. chemical weapons stockpile. In 2002, Ms. Grubbe was honored as Engineer of the Year in the State of Delaware.

Mr. John C. Marshall

- President, JMAR Consulting, LLC
- Former Vice President, Corporate Safety and Compliance, Delta Airlines

Mr. John C. Marshall is President of JMAR Consulting, a consulting firm whose services and areas of expertise include: aviation/transportation operational issues; aircraft accident investigation; regulatory compliance and safety audits; airline operations; maintenance oversight; technical writing; and technical assistances to legal counsel. Among the firm's clients are: state and federal agencies; charter operators; international and domestic passenger and cargo carriers; and corporate aviations groups.

Mr. Marshall formerly served as Vice President - Corporate Safety and Compliance for Delta Air Lines. He had responsibility for six departments at Delta, including: Flight Safety; Industrial Safety; Environmental Services; Emergency Planning and Operations; Safety Analysis and Quality Assurance; and Security. Central to the mission of each of these organizations are FAA, DOT, DOD, OSHA, EPA, TSA and DHS compliance-driven programs for accident prevention, accident investigation, accident response and a wide range of security programs. Mr. Marshall also had collateral responsibilities for integrating safety, compliance and security programs for Delta's wholly-owned subsidiaries, including Comair, Atlantic Southeast Airlines, Delta Global Services and Delta Technologies, into Delta's mainstream programs. Under his leadership, Delta was routinely recognized for industry-leading programs focused on reducing aircraft mishaps, employee injuries and aircraft ground damage, while enhancing environmental compliance programs and fostering the highest standards of security for worldwide commercial airline operations.

Mr. Marshall served as the industry Co-Chair of the Commercial Aviation Safety Team (CAST). CAST is a joint industry-government program to develop and implement an integrated, data-driven strategy to reduce the U.S. commercial aviation fatal accident rate by 80 percent by 2007. Participants include: aircraft and engine manufacturers; passenger and cargo airlines; labor unions; the Flight Safety Foundation, the Air Transport Association; the Regional Airline Association; NASA; DoD; and the FAA. Mr. Marshall is also the past Chairman of the Air Transport Association of America's Safety Council and the Society of Automotive Engineers' Aerospace Symposium. He currently serves on boards for the National Defense Transportation Association's Military Subcommittee, Safe America (a nationwide non-profit organization focusing on safety awareness), the Flight Safety Foundation and the Nature Conservancy's International Leadership Council.

Mr. Marshall gained worldwide aviation experience through his 26-year career with the U.S. Air Force. His Air Force assignments included duties as a fighter pilot, special assistant to the Air Force Vice Chief of Staff, fighter squadron commander, base commander and fighter wing commander. During his career, he primarily flew F-4s, F-15s, A-10s and F-16s, but has experience in a variety of other aircraft as well. Mr. Marshall later served as the Inspector General of the Pacific Air Forces and then became the Director of Operations of the Pacific Air Forces. While in the Pacific, he oversaw the safe and efficient operations of more than 400 combat aircraft, including development of plans and policies used for executing his command's annual flying program. In his last assignment, he served as the U.S. Director of Security Assistance for the Middle East, where he was responsible for all sales, marketing, training and logistic support between the United States and 11 countries in the Middle East, Africa and Southwest Asia during and immediately after the Gulf War.

Mr. Marshall received his Bachelor's Degree in civil engineering from the Air Force Academy in Colorado, and he is also a graduate of the National War College. He holds a Master of Arts Degree in personnel management from Central Michigan University and a Master of Science Degree in civil engineering (environmental) from the University of Hawaii.

Ms. Joyce A. McDevitt, P.E.

- Systems Safety Consultant
- Former Safety Program Manager, Futron Corporation and Computer Sciences Corporation
- Former NASA System Safety Engineer (retired)

Ms. Joyce McDevitt is a systems safety consultant who recently worked with the Johns Hopkins University's Applied Physics Laboratory (APL) to develop and launch the Pluto-New Horizons Mission Spacecraft. Prior to entering consulting full-time, she was a program manager with Futron Corporation, Bethesda, MD, and Computer Sciences Corporation, Springfield, VA, where she provided range safety and system safety support to government and commercial clients, including project safety responsibilities for APL's Midcourse Space Experiment Spacecraft. She also supported the Commercial Space Transportation Licensing and Safety Division of the Federal Aviation Administration. In addition, she served as a National Research Council committee member for studies of space launch safety and safety of tourist submersibles.

During her nearly 30 years of Civil Service to NASA Headquarters, the Air Force Systems Command and the Naval Ordnance Station, Ms. McDevitt's safety experience included space, aeronautical, facility and weapons systems, as well as propellant, explosive and chemical processes. She has developed and managed: safety programs; hazard analyses; safety risk assessments; safety policies and procedures; investigations of mishaps; and safety training. She retired from the federal government in 1987.

Ms. McDevitt received a B.S. in chemical engineering from the University of New Hampshire and an M.S. in engineering from Catholic University. She is a registered Professional Engineer in Safety Engineering and a Senior Member of the International System Safety Society.

Dr. Donald P. McErlean

- Technical Director, The Patuxent Partnership
- Former Chief Engineer, Naval Aviation

Dr. Donald P. McErlean served on military active duty as an aerospace engineering officer, U.S. Air Force Systems Command, from 1970 to 1973. He joined the Air Force Aeropropulsion Laboratory in 1973 as an aerospace engineer. In 1979, he joined the Aeronautical Systems Division as a systems engineering manager and was subsequently promoted to Systems Program Office Director. He then led a wide variety of Air Force propulsion programs and applications.

Appointed a member of the federal Senior Executive Service (SES) in 1987, Dr. McErlean joined the Naval Air Development Center, as Director of Air Vehicle and Crew Systems Technology. In 1994, Dr. McErlean was jointly selected by both the Navy and Air Force as Technical Director for the Joint Strike Fighter Program. In 1997 he joined the engineering management of Naval Air Systems Command, where he was head of the Air Vehicle Engineering Department, as well as Executive Director for Command-Wide Test and Evaluation and Executive Director, Naval Air Warfare Center Aircraft Division. He then served as the Deputy Assistant Commander for Logistics and Fleet Support, overseeing Naval Aviation's build-up for operations in Iraq and Afghanistan. In 2003, he was appointed Deputy Assistant Commander for Research and Engineering and Naval Aviation's Chief Engineer.

Dr. McErlean left federal service in 2005 after a career of more than 35 years and is currently the President and CEO of the Center for Strategic Analysis (CSA), which provides high-level expertise to both industry and government in areas of national interest, emerging technology and public policy. CSA is a division of The Patuxent Partnership, a not-for-profit consortium of government, industry and academia, and Dr. McErlean serves also as that organization's Technical Director.

Dr. McErlean is the recipient of several SES awards for exceptional performance. In 1987 he received the Exceptional Civilian Performance Medal from the Air Force. He received the Presidential Rank Award from President Clinton in 1993 and 1999 and from President Bush in 2005. He is the recipient of the Navy Superior Civilian Performance Medal and the Navy Distinguished Civilian Performance Medal (the Navy's highest civilian award for performance).

Dr. McErlean was named to the U.S. delegation to the Flight Vehicle Integration Panel of NATO's Advisory Group for Aerospace Research and Development (AGARD), eventually being elected Vice Chairman of that panel. He also served as the Navy member of the U.S. delegation to the Aerospace Group of the Technology Cooperation Program (TTCP).

Dr. McErlean has served on numerous technical advisory panels for NASA, DOD and the Office of Science and Technology Policy (OSTP) and was Chair of the Tri-Service Science and Technology Reliance Panel on fixed-wing aircraft research. He is a member of the Science and Technology Advisory Panel for the Johns Hopkins Applied Physics Laboratory. He was appointed by the Governor of Maryland to both the Commission for the Development of High Technology Business and to the Board of the Southern Maryland Higher Education Center.

Dr. McErlean was born in Orange, New Jersey. He received his Ph.D. in aerospace engineering (fluid dynamics major and applied mathematics minor) from Rutgers University and a Master's Degree in business/management from the Sloan School of Management at M.I.T. He is married to the former Sally Kathryn Shindell of North Arlington, New Jersey. They have two children, Timothy and Michael.

ASAP Staff Members

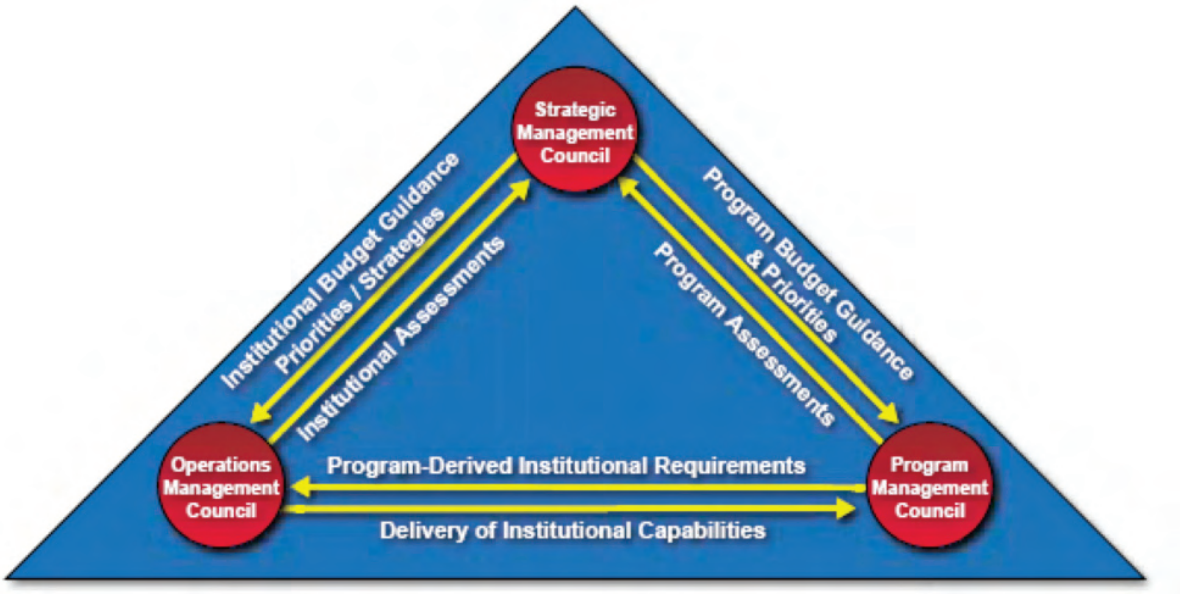
- John D. Marinaro, Executive Director
- Susan M. Burch, Staff Assistant
- Lester A. Reingold, Annual Report Editor

Appendix C: ASAP Activities– January-December 2006

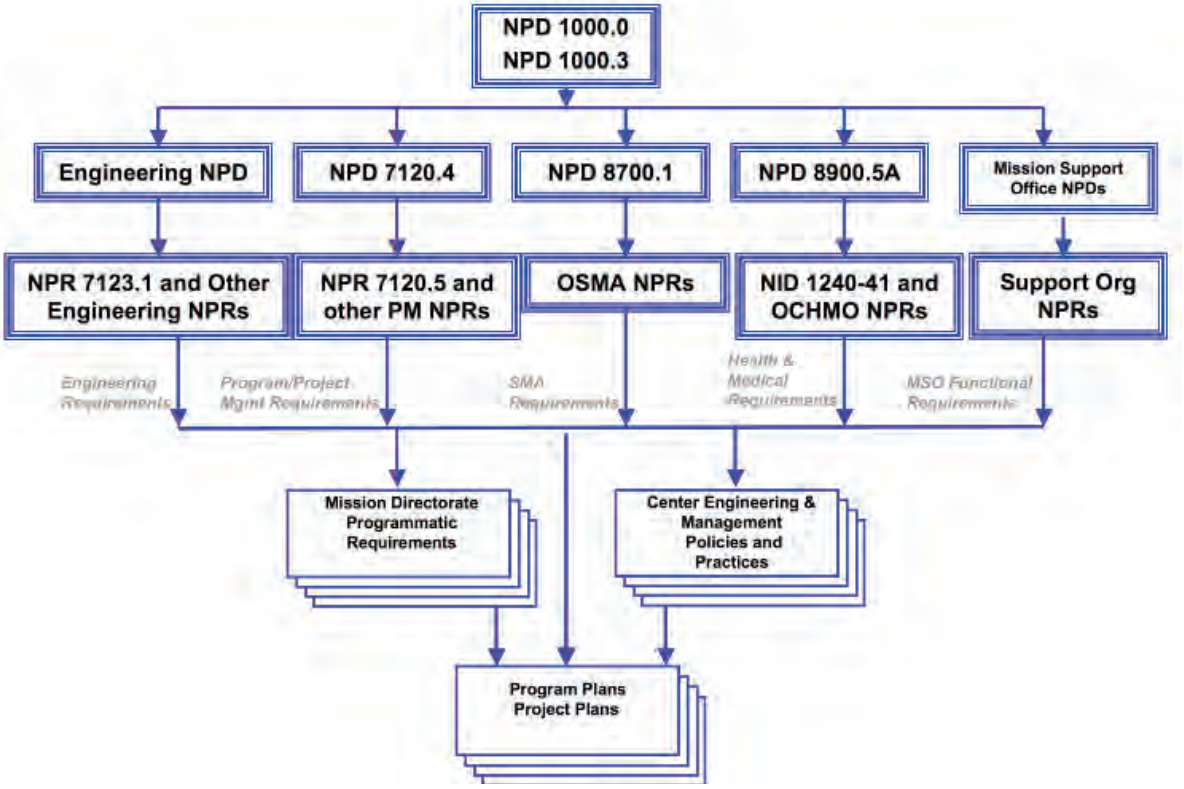
DATES WORKED	PURPOSE	LOCATION
February 1-2, 2006	2006 1st Quarterly Meeting	MSFC
February 21-23, 2006	CMMI/G48 Meeting	Huntsville, AL
February 27, 2006	Fragola Senior Advisor Meeting	HQ
February 7-9, 2006	Intercenter Aircraft Operations Panel —Semi-Annual Meeting	Orlando, FL
March 8-9, 2006	Fragola Senior Advisor Meeting	HQ
March 27-28, 2006	Fragola Senior Advisor Meeting	HQ
April 6-7, 2006	2006 2nd Quarterly Meeting	HQ
April 18, 2006	Fragola Senior Advisor Meeting	HQ
April 26-27, 2006	Meeting w/Administrator and Fragola —Overview of the NASA Exploration Safety Study	HQ
June 7-10, 2006	STS-121 SMSR	HQ
June 27, 2006	Participate in L-4 SMSR telecon	HQ
June 28-30, 2006	STS-121 Launch Reviews	KSC
July 31-Aug 4, 2006	System Safety Conference & G48 Meeting	Albuquerque, NM
August 15-16, 2006	Attend STS-115 FRR	KSC
August 16-18, 2006	2006 3rd Quarterly Meeting	KSC
August 25-28, 2006	STS-115 (L-2 - Launch)	KSC
October 11-13, 2006	2006 4th Quarterly Meeting	JSC
November 21-22, 2006	ASAP Annual Report Prep Meeting	HQ

Appendix D: Technical Governance Diagrams

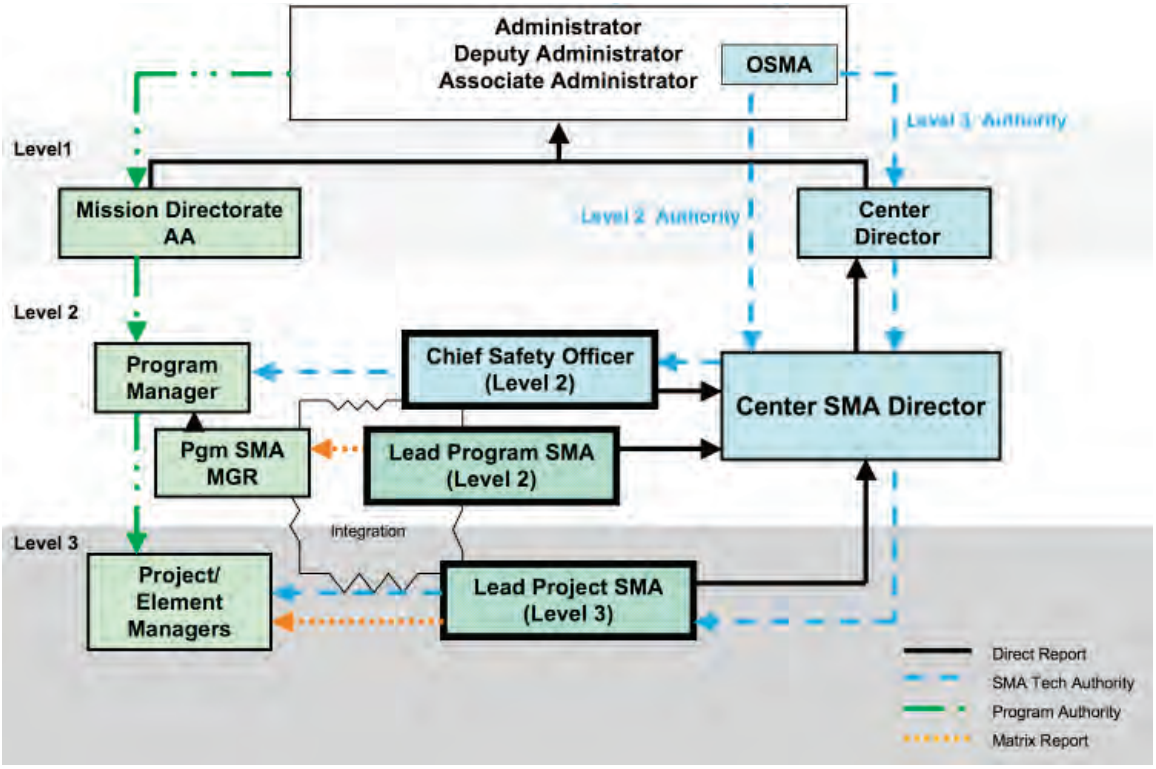
Governance Structure



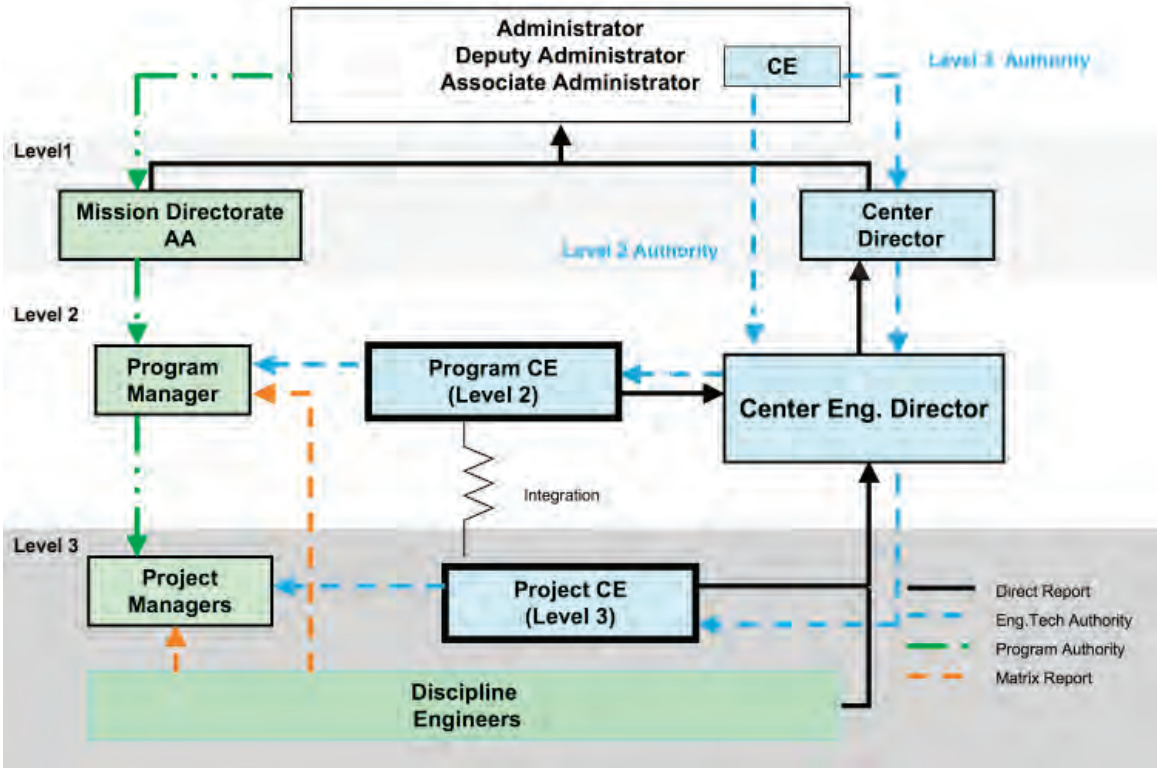
Technical Authority Document Hierarchy



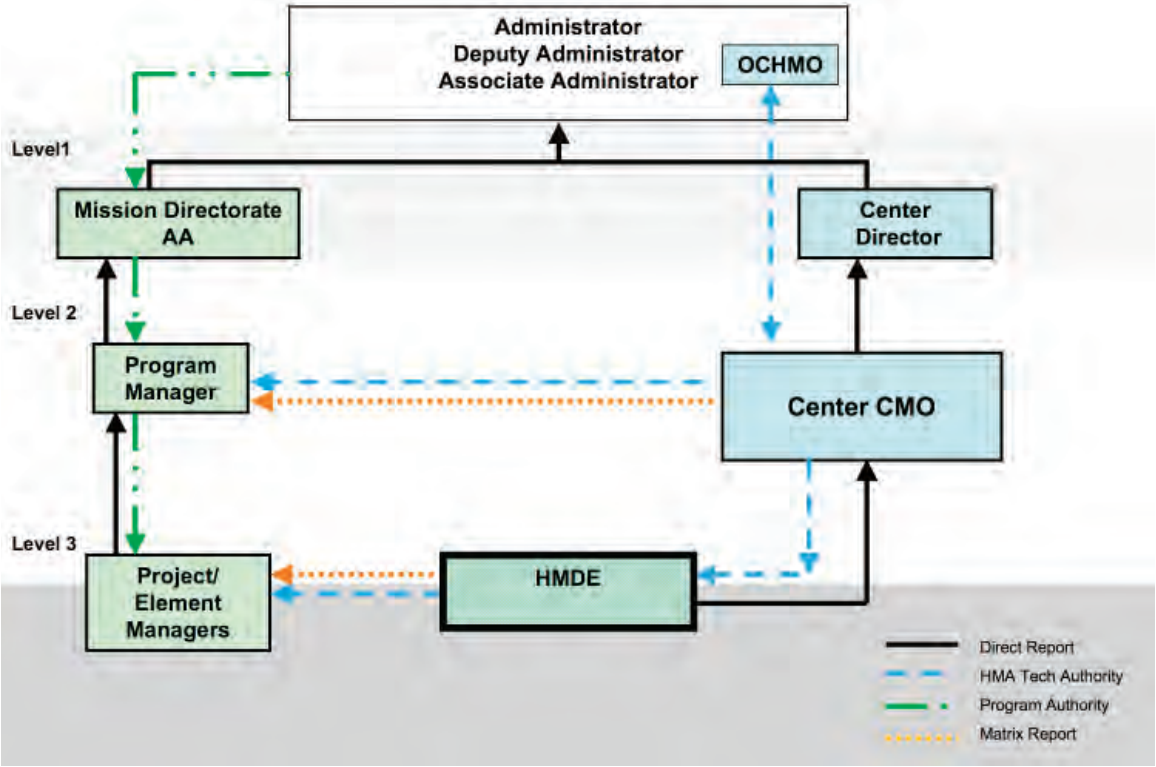
Safety and Mission Assurance Technical Authority for Programs



Engineering Technical Authority for Programs



Health and Medical Technical Authority for Programs



Appendix E: NASA Performance Evaluation Profile Occupational Safety and Health Survey FY 2006 Results

Background

PEP Survey Results and Associated Graph

Background

I. Introduction

During Fiscal Year 2006, NASA conducted the Performance Evaluation Profile (PEP) survey of its Occupational Safety and Health program. Included in this report are the civil service data for the NASA Centers that participated in the FY-06 survey.

PEP SURVEY PARTICIPANTS	NUMBER OF PARTICIPANTS
Civil Service Managers	568
Civil Service Employees	4,205
Contractor Personnel	7,521
Total	12,294

This report presents the overall results of this FY-06 survey effort for civil service employees and civil service managers only. Not included in this report is the evaluation of anonymous civil service personnel comments. The comments are referenced in each NASA Center-level PEP data results report.

II. Occupational Safety and Health Administration (OSHA) Voluntary Protection Program (VPP) and NASA Agency Safety Initiative (ASI)

"OSHA established the Voluntary Protection Programs (VPP) to recognize and promote effective worksite-based safety and health management systems. In the VPP, management, labor, and OSHA establish cooperative relationships at workplaces that have implemented comprehensive safety and health management systems. Approval into VPP is OSHA's official recognition of the outstanding efforts of employers and employees who have created exemplary worksite safety and health management systems." [OSHA TED 8.4, "Voluntary Protection Programs (VPP): Policies and Procedures Manual"]

NASA established the ASI program to become the nation's leader in safety and occupational health and in the safety of the products and services it provides. To achieve the program's goal, NASA categorized four Core Process Requirements (CPR's):

- Management commitment and employee involvement
- System and worksite hazard analysis
- Hazard prevention and control
- Safety and health training

III. PEP Survey Element Descriptions

The PEP survey consists of various OSHA safety and health categories that are termed "elements." The elements addressed in the survey are listed below, utilizing the descriptions present in the survey form.

Management: Visible management leadership provides the motivating force for an effective safety and health program.

Employee Participation: Employee participation provides the means through which workers identify hazards, recommend and monitor hazard abatement, and otherwise participate in their own safety and health program.

Implementation: Management provides implementation tools that include budget, information, personnel, assigned responsibility, adequate expertise and authority, means to hold responsible persons accountable (line accountability), program review procedures, directives, and methods criteria analysis.

Survey and Hazard Analysis: An effective safety and health program will seek to identify and analyze all hazards. In large or complex workplaces, components of such analysis are the comprehensive survey and analyses of job hazards and changes in condition.

Inspection: An effective safety and health program will include regular site inspections to identify new or previously missed hazards and failures in hazard controls.

Reporting: A reliable hazard-reporting system enables employees, without fear of reprisal, to notify management of condition(s) that appear to be hazardous and to receive timely and appropriate response.

Mishap Investigation: An effective safety program will provide for investigation of mishaps and close-call incidents so that their causes, and the means for their prevention, are identified.

Data Analysis: An effective program will analyze injury and illness records for indications of sources and locations of hazards and will identify jobs that experience higher number of injuries. By analyzing injury and illness trends over time, patterns with common causes can be identified and prevented.

Hazard Control: Workforce exposure to all current and potential hazards should be prevented or controlled by using engineering controls, work practices, administrative controls, and personal protective equipment (PPE).

Maintenance: An effective safety and health program will provide for facility and equipment maintenance so that hazardous breakdown is prevented.

Medical: An effective safety and health program will include a medical program appropriate for the size and nature of the workplace and its hazards.

Emergency Preparedness: Appropriate planning, training/drills, and equipment should be in place for response to emergencies.

First Aid: First aid/emergency care should be readily available for any injury or illness.

Training: Safety and health training should cover the safety and health responsibilities of all personnel who work at the site or who affect its operation.

IV. PEP Survey Rating System Explanation (figure 1)

The PEP rating system uses a 1-5 numeric score for each element, category, and overall safety program, with 5 being the highest rating possible. The definition of each rating is described in figure 1.

V. PEP Scores vs. Program Effectiveness (figure 2)

The safety program effectiveness level, as a function of the PEP rating, is shown in figure 2. Utilizing a numerical 1-5 rating system, PEP survey results are analyzed to establish their compliance with OSHA VPP certification requirements and other applicable OSHA standards. The following thresholds are based on the data shown in figure 2.

- The minimum acceptable PEP survey rating that reflects an adequate Safety and Health Program is 3.0.
- A PEP survey rating between 3–3.5 is classified as a "basic program."
- A PEP rating between 3.5–4.3 is classified as a "superior program," which may qualify for the OSHA VPP Merit Program.
  - The Merit Program recognizes worksites that have good safety and health management systems and that show the willingness, commitment, and ability to achieve site-specific goals that will qualify them for Star participation.
- A PEP rating between 4.3–5.0 is classified as an "outstanding program," which may qualify for the OSHA VPP Star Program.
  - The Star Program recognizes the safety and health excellence of worksites where workers are successfully protected from fatality, injury, and illness by the implementation of comprehensive and effective workplace safety and health management systems. These worksites are self-sufficient in identifying and controlling workplace hazards.

VI. NASA Agency Civil Service Employee and Manager PEP Survey Ratings for Elements, Benchmark Comparative Analysis (figures 3, 4)

The PEP Survey was fully implemented agency-wide initially in 1999. This report compares the survey results from FY-02 through FY-06 for a 5-year comparison. Benchmark Comparative Analyses of the Employee and Manager Survey results are shown in figure 3 and figure 4. Figures 3 and 4 show the combined Center rating averages for the elements since FY-02. The survey results are illustrated for each of the survey elements independently.

- In FY-06, Employee ratings exhibited a *favorable increase* in seven survey elements since FY-05, while seven elements exhibited no change.
- The Employee perception of the survey elements has been above the 3.0 minimum acceptable level since FY-02.
- In FY-06, Manager ratings exhibited a *favorable increase* in nine survey elements since FY-05, while five elements exhibited no change.
- The Manager perception of the survey elements has been above the 3.0 minimum acceptable level since FY-02.

VII. FY-06 NASA Agency Civil Service Employee and Manager PEP Survey Ratings for Elements, Comparison (figure 5)

The Employee and Manager PEP ratings independently measure the perception of the employees and managers of the Safety and Health program(s), as shown in figure 5. A difference of 1.0 or greater may indicate a difference in perception between managers and employees.

- For the survey elements, the employee and manager average ratings differed by a 0-0.5 margin in FY-06.
- No survey element differed by a value greater than 0.5, indicating consistent perceptions of NASA's safety and health program.

VIII. Civil Service Employee and Manager PEP Survey Ratings for Each Reporting NASA Center, 5-years (figures 6, 7)

The overall average PEP survey ratings for employees and managers at the NASA Centers that participated in the PEP survey are shown in figures 6 and 7 from FY-02 to FY-06, respectively.

- In FY-06, the Employee rating for one Center *favorably increased* by a 4.7 percent change since the FY-05 survey.
- The Employee ratings of three Centers exhibited no change and remained consistent with ratings of 4.2, 4.3 and 4.4 since FY-05.
- In FY-06, the Manager rating for one Center *favorably increased* by a 2.3 percent change since the FY-05 survey.
- The Manager ratings of two Centers exhibited no change and remained consistent with ratings of 4.2 and 4.4 since FY-05.

IX. FY-06 Civil Service Employee and Manager PEP Survey Ratings for Each Reporting NASA Center (figure 8)

The Employee and Manager PEP ratings independently measure the perception of the employees and managers of the Safety and Health program(s), as shown in figure 8 for FY-06. A difference of 1.0 or greater may indicate a difference in perception between managers and employees.

- Employee ratings at the five participating Centers are above the 3.0 minimum acceptable level.
- Manager ratings for the five participating Centers are above the 3.0 minimum acceptable level.
- Employee ratings at the five Centers ranged from 3.8-4.5.
- Manager ratings at the five Centers ranged from 4.0-4.5.
- The Employee and Manager ratings at each Center differed by less than 0.3, indicating close agreement in Employee and Manager perceptions.

X. NASA Agency Civil Service Lost-Time, Incident and Severity Rates, 5-years (figure 9)

Mishap Statistical Analysis

The true measure of the effectiveness of any Occupational Safety and Health Program is to analyze the program's impact in terms of the reduction in number of incidents that occur in the workplace and the severity of these incidents. The PEP survey system has the capability of performing this analysis. For the NASA Agency-level analysis, the number of incidents and the severity of these incidents (as measured by the number of lost workdays per incident) were obtained from the Incident Reporting Information System (IRIS).

The analysis of the incident data required that it be converted into rates consistent with the OSHA standardized method of reporting such information. Each rate was computed using the following equations:

(This method yields a rate that is standardized per 100 employees.)

Total Case Incident Rate (TCIR):

$$\text{TCIR (Ri)} = \frac{\text{(Total OSHA Reportable Cases) X (200,000)}}{\text{Total Hours}}$$

Severity Rate for Lost-time and Restricted Duty Days:

$$\text{Severity Rate (Rs)} = \frac{\text{(No. of lost-time and restricted duty days) X (200,000)}}{\text{Total Hours}}$$

Lost-Time Case Rate (used for ERASMUS reporting):

$$\text{LTCR} = \frac{\text{(No. of OSHA lost-time cases) x (200,000)}}{\text{Total Hours}}$$

The results of this conversion of data are shown in figure 9.

- In FY-06, the Total Case Incident Rate (TCIR) exhibited a *favorable decrease* of 33.2 percent since FY-05.
- In FY-06, the severity rate exhibited a *favorable decrease* of 28.7 percent since FY-05.
- In FY-06, the Lost Time Case Rate (LTCR) exhibited a *favorable decrease* of 15.4 percent since FY-05.

XI. NASA Agency Civil Service PEP Total Case Incident and Severity Equivalency Ratings (figure 10)

The Total Case Incident Rate (TCIR) and Severity Rate for Lost-time and Restricted Duty Days (Rs) previously shown in figure 9 were converted into a rating system equivalent to the PEP survey ratings. The PEP rating system uses a 1-5 numeric scale, with 5 being the highest rating possible. The conversion is based on the goal that a 10% reduction in mishap rates, compared to the average of previous years, will be achieved in the new year. (This percentage is a variable with the default value of 10%, which is consistent with the ASI initiative and higher than the "Federal Worker 2000" initiative requirement of 3%.)

Figure 10 illustrates the converted Total Case Incident and Severity ratings on the 1–5 scale (referred to as PEP Ri and PEP Rs respectively). Values above 3.0 indicate that the 10% reduction (in incidents and severity) was achieved in the specific year. Whereas, values below 3.0 indicate that the 10% goal was not achieved. The PEP equivalºent ratings reflect whether the 10% reduction goal was achieved in the individual year and do not offer contrastable values between years.

- In FY-06, the PEP Ri *did* meet the 10% mishap reduction goal of previous years.
- In FY-06, the PEP Rs *did* meet the 10% mishap reduction goal of previous years.

XII. NASA Agency Civil Service Employee and Manager PEP Survey Ratings and PEP Equivalent Sum Mishap Ratings Comparison (figure 11)

Average Rating for Civil Servant Employees and Managers

The aggregate scores for all NASA Centers participating in the PEP Occupational Safety and Health Survey from FY-02 through FY-06 are listed in the following table, using a 1-5 scale:

YEAR	EMPLOYEE	MANAGER
FY 2002	4.2	4.3
FY 2003	4.1	4.1
FY 2004	4.3	4.4
FY 2005	4.3	4.3
FY 2006	4.3	4.4

- In FY-06, the Agency-wide Employee average rating exhibited no change since FY-04.
- In FY-06, the Agency-wide Manager average rating *favorably increased* since FY-05 by a 2.3 percent margin.

A comparison of the total average of the Employee and Manager PEP Survey ratings against the PEP Sum Mishap ratings from FY-02 to FY-06 is shown in Figure 11.

- In FY-06, the PEP Sum Mishap rating *did* meet the 10% mishap reduction goal of previous years.

XIII. NASA Agency Property Damage, 5-years (figure 12)

The property damage cost at NASA Centers from FY-02 to FY-06 is illustrated in Figure 12.

- In FY-06, a *favorable decrease* in property damage cost by $1,374,194 since FY-05 was observed.
- In FY-03, the cause of the spike was attributed to the following:

ITEM	COST
STS 107 Space Shuttle	$ 1,076,332,029.00

XIV. NASA Agency PEP Survey Report Recommendations

The PEP survey results for all NASA Centers were analyzed to ascertain the safety issues common to the Centers. The survey analysis also offers recommendations for areas that may benefit from additional emphasis across the entire agency. The following recommendations are based on ASI and OSHA guidelines reported by the PEP Analyzer Get Well Plan:

A. Management Leadership and Employee Participation

1. Managers should establish and communicate clear goals for the safety and health program and the objectives for meeting these goals.

B. Workplace Analysis

1. A job hazard analysis should be conducted on every job to ensure that all hazards are identified and that any necessary controls are in place.

C. Mishap Record Analysis

1. Employers should analyze injury and illness trends over time so that patterns with common causes can be identified and prevented.

D. Hazard Prevention and Control

1. Employer shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees.

E. Emergency Response

1. Periodic re-evaluation of workplace emergency preparedness requirements should be carried out at least annually and after each significant incident.

Figure 1: PEP Survey Rating Exlanation

- **Ratings of 1-5 Consistent with OSHA PEP Rating System**
- **Definitions**
  - Level 1: No problem or ineffective program
  - Level 2: Developmental program
  - **Level 3: Basic program.** Represents minimal acceptable compliance level for OSHA for a safe and healthful workplace.
  - **Level 4: Superior program.** Represents safety and health programs that have a planned strategy for continuous improvement and a goal of achieving an outstanding program level.
  - **Level 5: Outstanding program.** Represents safety and health programs that are comprehensive and are successful in reducing workplaces hazards.

Figure 2: PEP Scores vs. Program Effectiveness

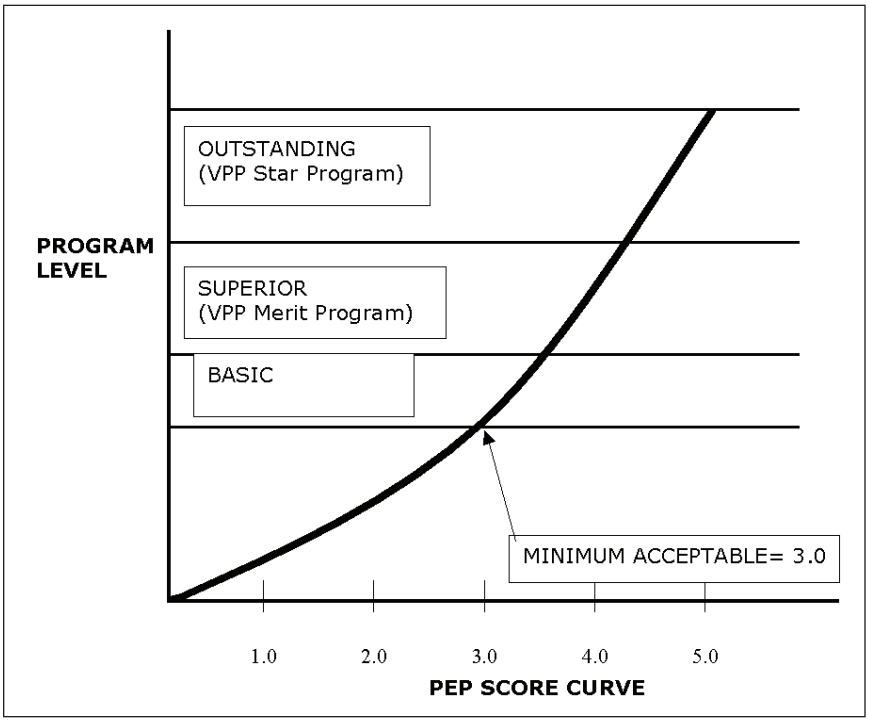
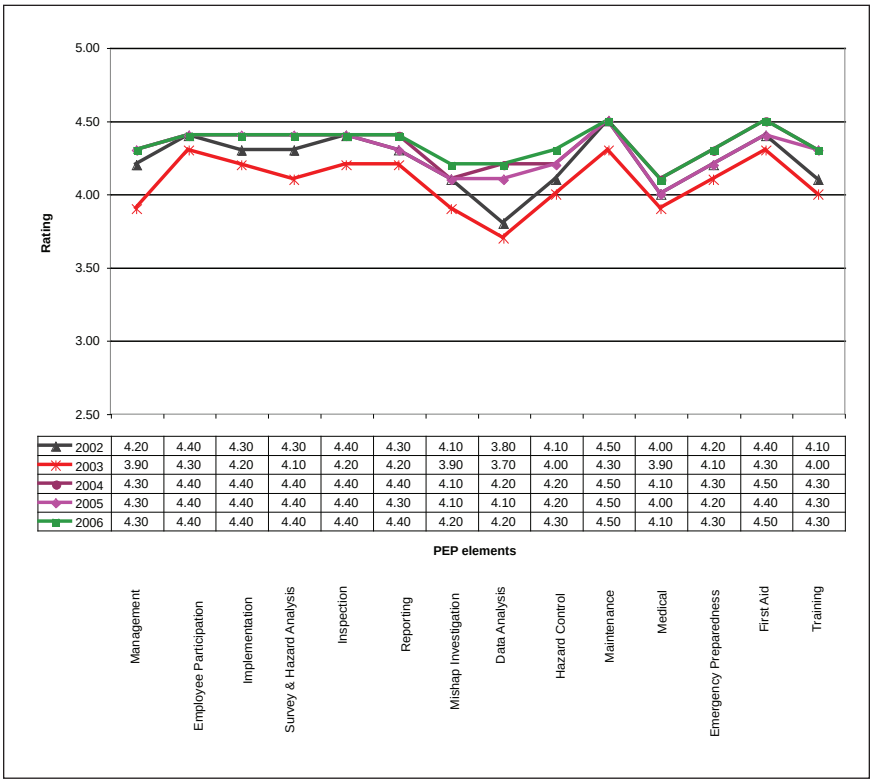
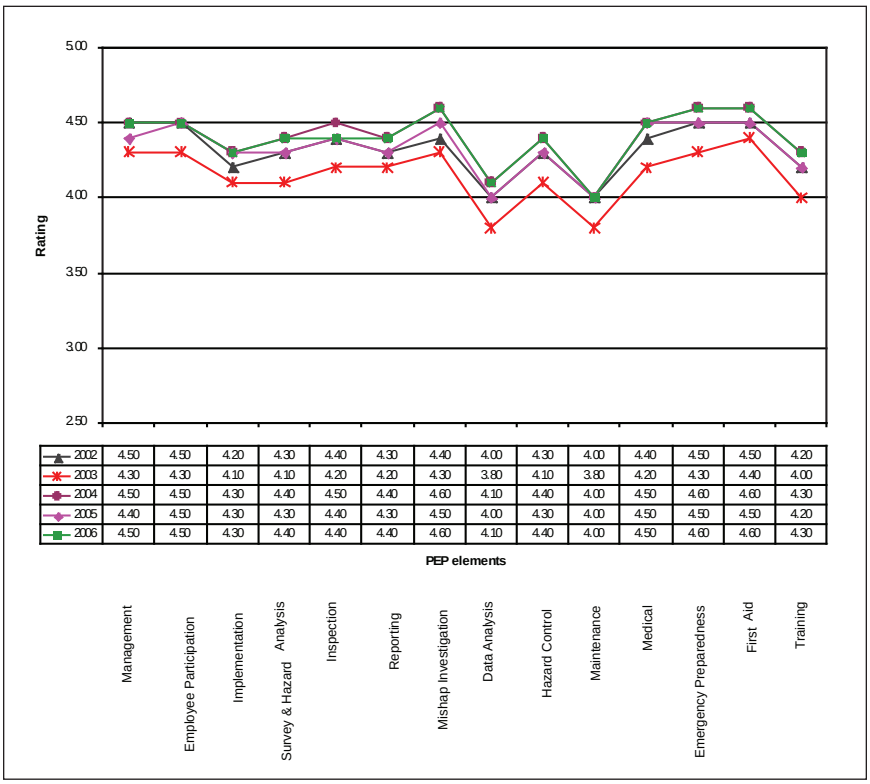


Figure 3: PEP Scores vs. Program Effectiveness
(Center employee rating averages for the elements since FY-02)



	Management	Employee Participation	Implementation	Survey & Hazard Analysis	Inspection	Reporting	Mishap Investigation	Data Analysis	Hazard Control	Maintenance	Medical	Emergency Preparedness	First Aid	Training
2002	4.20	4.40	4.30	4.30	4.40	4.30	4.10	3.80	4.10	4.50	4.00	4.20	4.40	4.10
2003	3.90	4.30	4.20	4.10	4.20	4.20	3.90	3.70	4.00	4.30	3.90	4.10	4.30	4.00
2004	4.30	4.40	4.40	4.40	4.40	4.40	4.10	4.20	4.20	4.50	4.10	4.30	4.50	4.30
2005	4.30	4.40	4.40	4.40	4.40	4.30	4.10	4.10	4.20	4.50	4.00	4.20	4.40	4.30
2006	4.30	4.40	4.40	4.40	4.40	4.40	4.20	4.20	4.30	4.50	4.10	4.30	4.50	4.30

Figure 4: NASA Agency Civil Service Manager PEP Survey Ratings for Elements, Benchmark Comparative Analysis *(Center manager rating averages for the elements since FY-02)*



	Management	Employee Participation	Implementation	Survey & Hazard Analysis	Inspection	Reporting	Mishap Investigation	Data Analysis	Hazard Control	Maintenance	Medical	Emergency Preparedness	First Aid	Training
2002	4.50	4.50	4.20	4.30	4.40	4.30	4.40	4.00	4.30	4.00	4.40	4.50	4.50	4.20
2003	4.30	4.30	4.10	4.10	4.20	4.20	4.30	3.80	4.10	3.80	4.20	4.30	4.40	4.00
2004	4.50	4.50	4.30	4.40	4.50	4.40	4.60	4.10	4.40	4.00	4.50	4.60	4.60	4.30
2005	4.40	4.50	4.30	4.30	4.40	4.30	4.50	4.00	4.30	4.00	4.50	4.50	4.50	4.20
2006	4.50	4.50	4.30	4.40	4.40	4.40	4.60	4.10	4.40	4.00	4.50	4.60	4.60	4.30

Figure 5: FY-06 NASA Agency Civil Service Employee and Manager PEP Survey Ratings for Elements, Comparison *(Combined Center rating averages for the elements)*

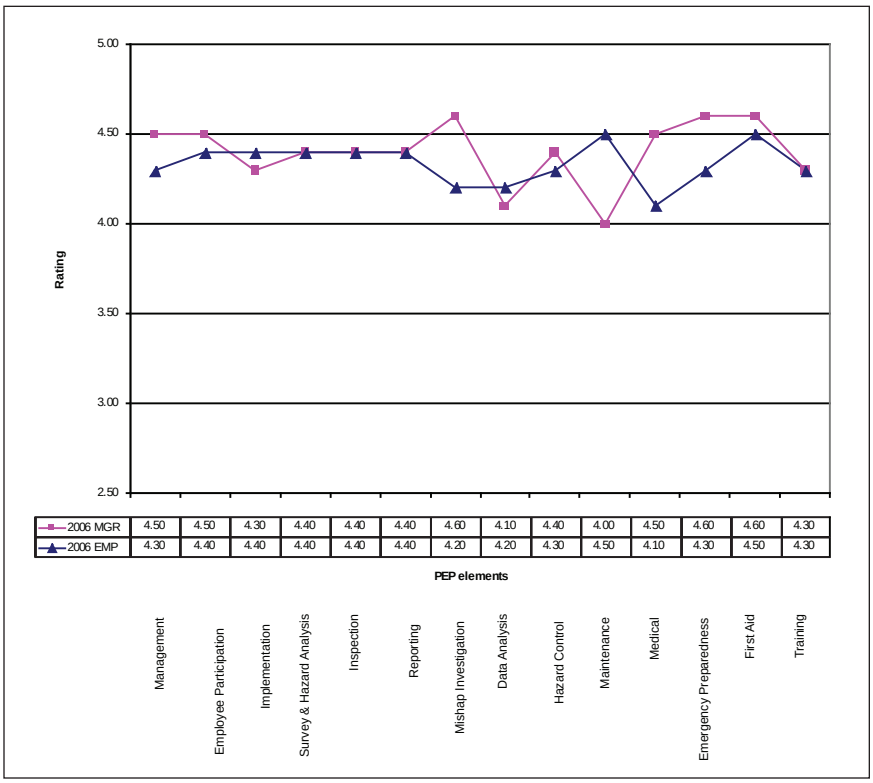
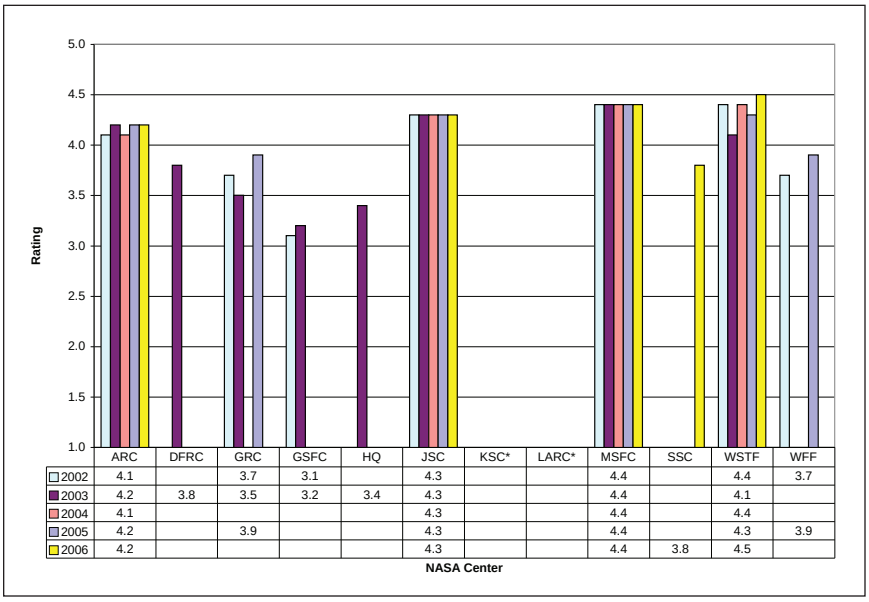


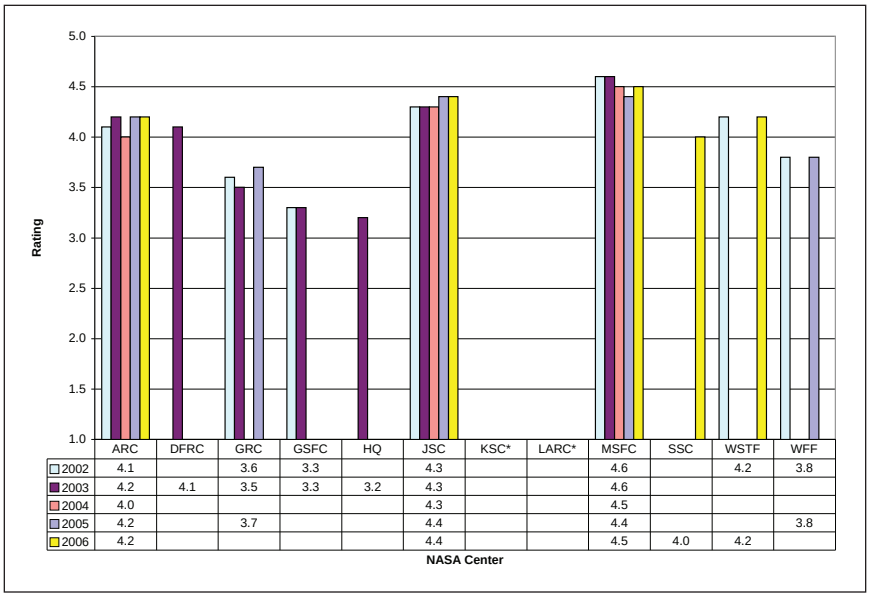
Figure 6: Civil Service Employee PEP Survey Ratings for Each Reporting NASA Center, 5-years *(Center rating averages since FY-02)*



	ARC	DFRC	GRC	GSFC	HQ	JSC	KSC*	LARC*	MSFC	SSC	WSTF	WFF
2002	4.1		3.7	3.1		4.3			4.4		4.4	3.7
2003	4.2	3.8	3.5	3.2	3.4	4.3			4.4		4.1	
2004	4.1					4.3			4.4		4.4	
2005	4.2		3.9			4.3			4.4		4.3	3.9
2006	4.2					4.3			4.4	3.8	4.5	

* Last participated in the PEP Survey in FY-01.

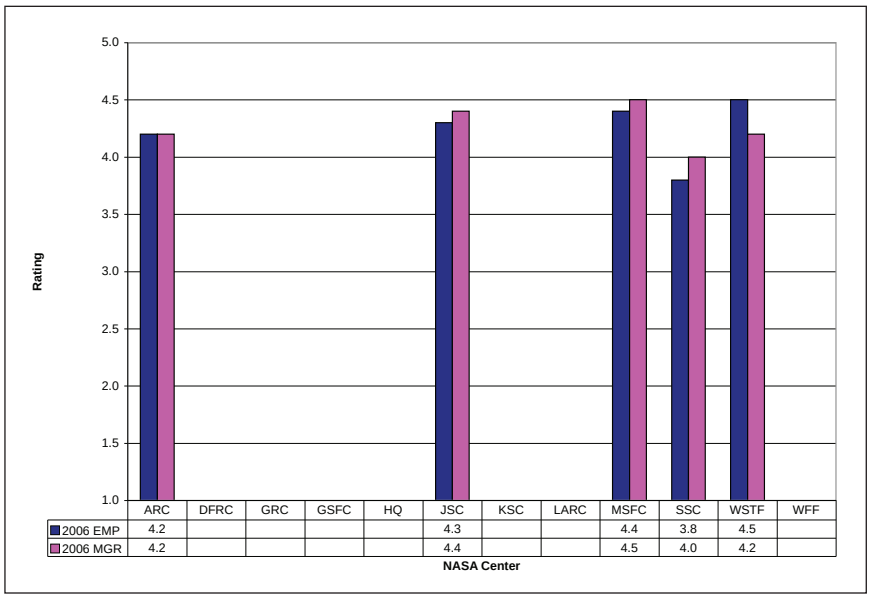
Figure 7: Civil Service Manager PEP Survey Ratings for Each Reporting NASA Center, 5-years *(Center rating averages since FY-02)*



	ARC	DFRC	GRC	GSFC	HQ	JSC	KSC*	LARC*	MSFC	SSC	WSTF	WFF
2002	4.1		3.6	3.3		4.3			4.6		4.2	3.8
2003	4.2	4.1	3.5	3.3	3.2	4.3			4.6			
2004	4.0					4.3			4.5			
2005	4.2		3.7			4.4			4.4			3.8
2006	4.2					4.4			4.5	4.0	4.2	

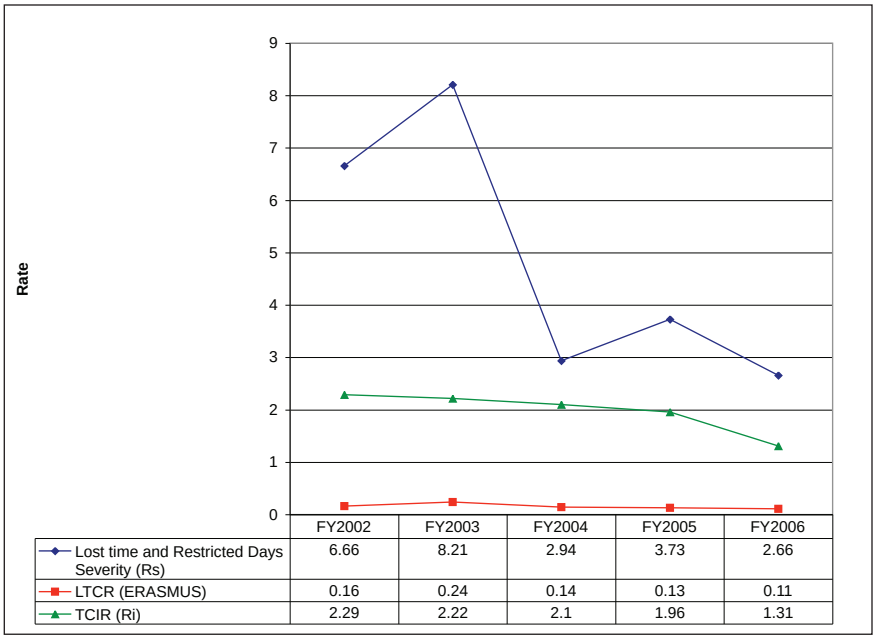
* Last participated in the PEP Survey in FY-01.

Figure 8: FY-06 Civil Service Employee and Manager PEP Survey Ratings for Each Reporting NASA Center *(Center rating averages since FY-02)*



	ARC	DFRC	GRC	GSFC	HQ	JSC	KSC	LARC	MSFC	SSC	WSTF	WFF
2006 EMP	4.2					4.3			4.4	3.8	4.5	
2006 MGR	4.2					4.4			4.5	4.0	4.2	

Figure 9: NASA Agency Civil Service Lost-Time, Incident and Severity Rates, FY02-FY06, PEP Update, Data from IRIS



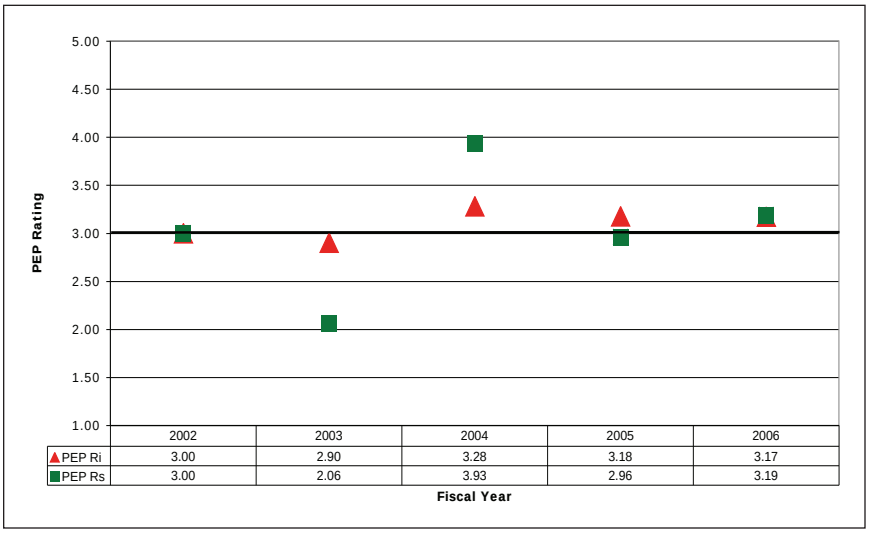
	FY2002	FY2003	FY2004	FY2005	FY2006
Lost time and Restricted Days Severity (Rs)	6.66	8.21	2.94	3.73	2.66
LTCR (ERASMUS)	0.16	0.24	0.14	0.13	0.11
TCIR (Ri)	2.29	2.22	2.1	1.96	1.31

LT and Restricted Days Severity Rate (Rs) = (OSHA Recordable Days Away + Restricted Days) x 200,000/ Total Hours

TCIR (Ri) = OSHA Total Recordable Cases x 200,000/ Total Hours

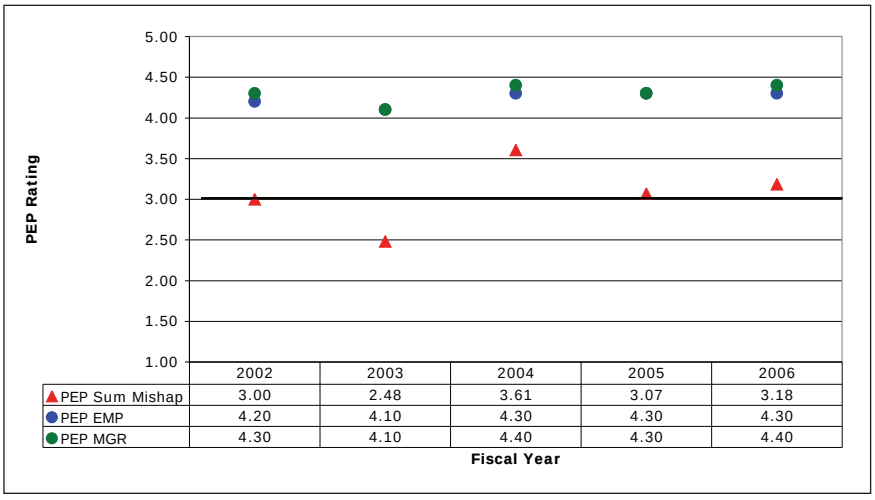
LTCR (ERASMUS) = OSHA Recordable Lost-Time Cases x 200,000/Total Hours

Figure 10: NASA Agency Civil Service PEP Total Case Incident and Severity Equivalency Ratings



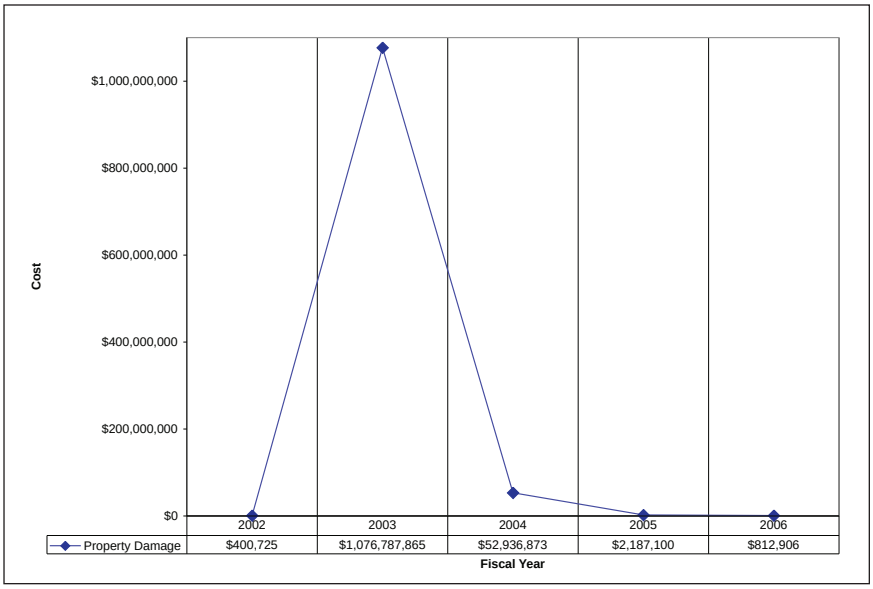
	2002	2003	2004	2005	2006
PEP Ri	3.00	2.90	3.28	3.18	3.17
PEP Rs	3.00	2.06	3.93	2.96	3.19

Figure 11: NASA Agency Civil Service Employee and Manager PEP Survey Ratings and PEP Equivalent Sum Mishap Ratings Comparison



	2002	2003	2004	2005	2006
PEP Sum Mishap	3.00	2.48	3.61	3.07	3.18
PEP EMP	4.20	4.10	4.30	4.30	4.30
PEP MGR	4.30	4.10	4.40	4.30	4.40

Figure 12: NASA Agency Property Damage, 5-years



■ *In FY-03, the cause of the spike was attributed to the following:*

ITEM	COST
STS 107 Space Shuttle	$ 1,076,332,029.00