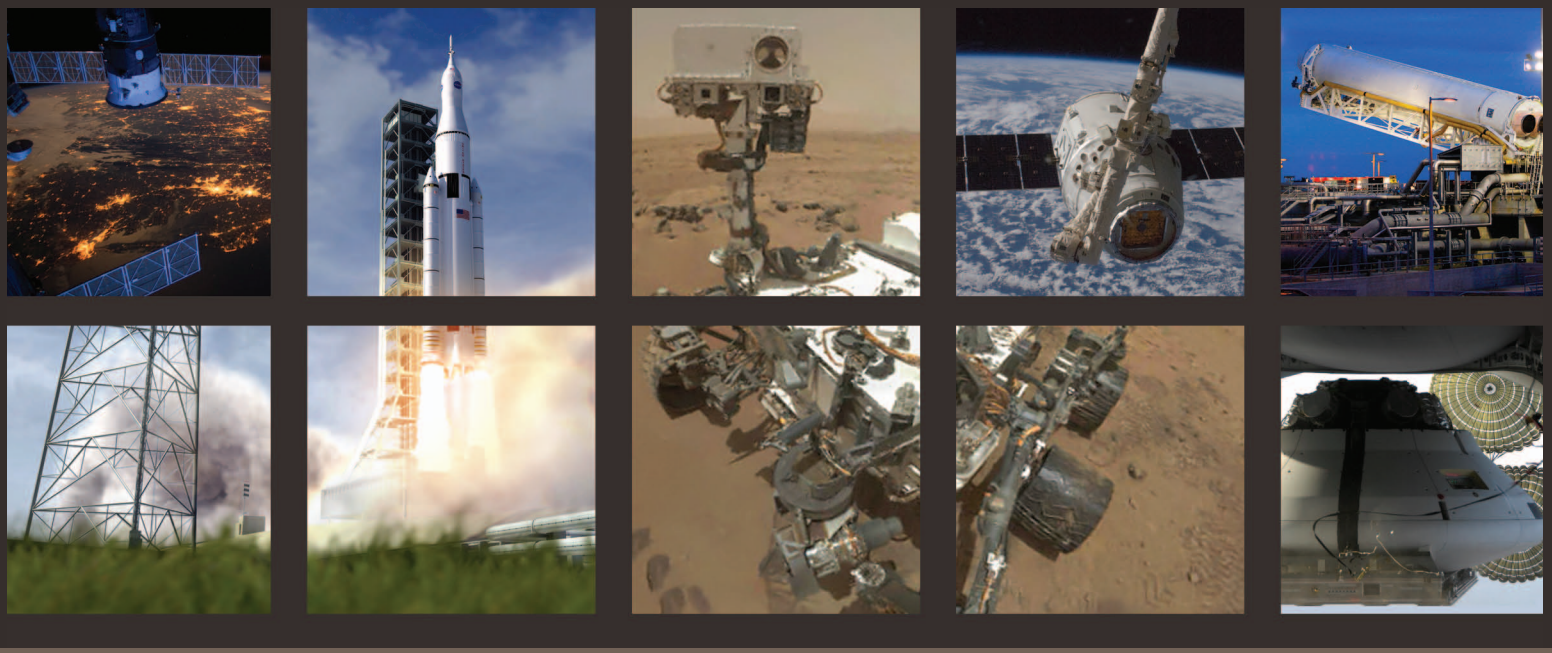


Aerospace Safety Advisory Panel

Annual Report for 2012

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

January 9, 2013

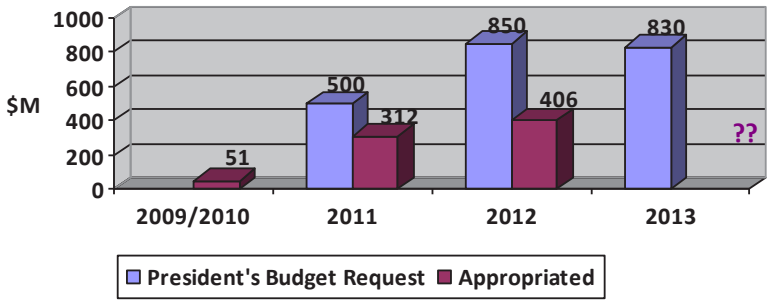
The Honorable Charles F. Bolden, Jr.
Administrator
National Aeronautics and Space Administration
Washington, DC 20546

Dear Mr. Bolden:

Pursuant to Section 106(b) of the National Aeronautics and Space Administration Authorization Act of 2005 (P.L. 109-155), the Aerospace Safety Advisory Panel (ASAP) is pleased to submit the ASAP Annual Report for 2012 to the U.S. Congress and to the Administrator of the National Aeronautics and Space Administration (NASA).

This report is based on the Panel's 2012 fact-finding and quarterly public meetings; "insight" visits and meetings; direct observations of NASA operations and decision-making; discussions with NASA management, employees, and contractors; and the Panel members' past experiences.

In our report we highlight issues related to: a.) Commercial Crew Program (CCP), b.) Exploration Systems Development, c.) Funding Uncertainty, d.) International Space Station, e.) Technical Authority, and f.) Risk Management. Of these, the Funding Uncertainty and Commercial Crew Program are interrelated and of the most concern. Reprinted from the body of the report is a chart depicting the funding history of the CCP:



For the last two years, the CCP appropriation has been approximately one half of the budget request. Informal communications with congressional staffs indicate this will probably be the case again in Fiscal Year (FY) 13.

In carrying out our responsibilities, the ASAP hears both sides of the story. The NASA program team highlights inability to execute the program of record and grapples with the necessity to modify acquisition strategy to adjust for the funding shortfalls. The Congress notes the lack of credible cost estimate, the absence of an integrated schedule, and "program instability." In the Panel's opinion, a consensus between the Congress and NASA will be required to resolve this conundrum.

In FY13, we predict this planning-funding disconnect will again drive a change to acquisition strategy, schedule, and/or safety risk. The ASAP is concerned that some will champion an approach that is a current option contained in the Commercial Crew Integrated Capability (CCiCap) agreement. There is risk this optional, orbital flight-test demonstration with a non-NASA crew could yield two standards of safety—one reflecting NASA requirements, and one with a higher risk set of commercial requirements. It also raises questions of who acts as certification authority and what differentiates public from private accountability. Separating the level of safety demanded in the system from the unique and hard-earned knowledge that NASA possesses introduces new risks and unique challenges to the normal precepts of public safety and mission responsibility. We are concerned that NASA's CCiCap 2014 "Option" prematurely signals tacit acceptance of this commercial requirements approach absent serious consideration by all the stakeholders on whether this higher level of risk is in fact in concert with national objectives.

NASA's senior leaders and staff members offered significant cooperation to support the completion of this document. I submit the ASAP Annual Report for 2012 with respect and appreciation.

Sincerely,

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

Enclosure

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

January 9, 2013

The Honorable Joseph R. Biden
President of the Senate
Washington, DC 20510

Dear Mr. President:

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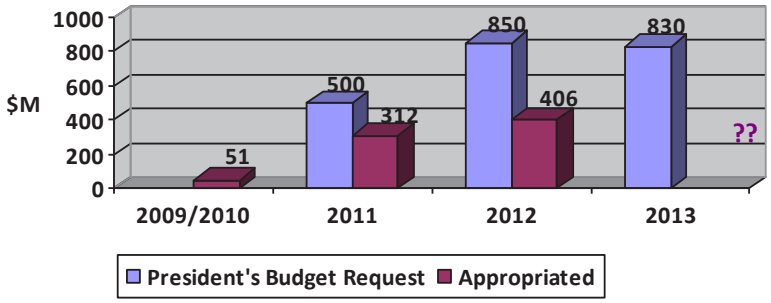

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NASA AEROSPACE SAFETY ADVISORY PANEL
National Aeronautics and Space Administration
Washington, DC 20546
VADM Joseph W. Dyer, USN (Ret.), Chair

January 9, 2013

The Honorable John A. Boehner
Speaker of the House of Representatives
Washington, DC 20510

Dear Mr. Speaker:

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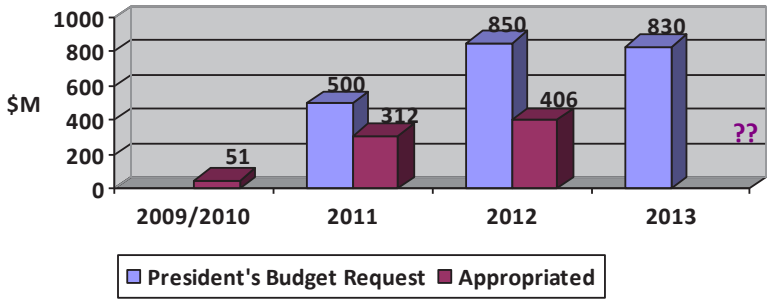

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VADM Joseph W. Dyer, USN (Ret.)
Chair, Aerospace Safety Advisory Panel

Enclosure

CD Table of Contents

I. Introductory Remarks

A. The Aerospace Safety Advisory Panel (ASAP)

The ASAP was established by Congress in 1968 to provide advice and make recommendations to the NASA Administrator on safety matters.[1] The Panel holds quarterly fact-finding and public meetings and makes "insight" visits to NASA Field Centers or other related sites. It reviews safety studies and operations plans and advises the NASA Administrator and Congress on hazards related to proposed or existing facilities and operations, safety standards and reporting, safety and mission assurance aspects regarding ongoing or proposed programs, and NASA management and culture issues related to safety. Although the Panel may perform other duties and tasks as requested by either the NASA Administrator or Congress, the ASAP members normally do not engage in specialized studies or detailed technical analyses. This report highlights the issues and concerns that were identified or raised by the Panel during its activities over the past year. The Panel's recommendations submitted to the Administrator during 2012 are summarized in the Appendix at the end of this report.[2] They are based upon the ASAP fact-finding and quarterly public meetings; "insight" visits and meetings; direct observations of NASA operations and decision-making; discussions with NASA management, employees, and contractors; and the Panel members' expertise.

B. ASAP Observations on NASA Accomplishments in 2012

1. Milestones in Commercial Transportation of Cargo and Crew to Low Earth Orbit (LEO)

During 2012, a number of significant milestones were reached in the development of a commercial transportation system to LEO. In May, the SpaceX Falcon 9 rocket carrying the Dragon spacecraft was launched from Cape Canaveral. Dragon successfully docked and undocked from the International Space Station (ISS) and returned to Earth. Following that demonstration flight, SpaceX accomplished the first Commercial Resupply Services (CRS) mission to the ISS in October. Also in October, Orbital Sciences Corporation began Antares rocket operations at the Mid-Atlantic Regional Spaceport and is preparing for the maiden test flight in spring 2013. Progress has been made in maturing the design and development of the launch vehicles and spacecraft for the U.S. crew transportation systems. Sierra Nevada Corporation completed the Preliminary Design Review (PDR) of its Dream Chaser orbital crew vehicle in June and has successfully completed the captive carry test and the nose landing gear test. Boeing completed the thruster tests for its crew capsule. Blue Origin achieved a successful pad abort test. Three companies—Sierra Nevada, SpaceX, and Boeing—were selected to move forward into the next phase, which should culminate in a system level of maturity approximately equivalent to a Critical Design Review (CDR).

2. Milestones in Exploration Systems Development (ESD)

NASA has achieved several important milestones in development of the Orion Multi-Purpose Crew Vehicle (MPCV), the Space Launch System (SLS), and the Ground Systems Development and

1 The ASAP Charter is included as Attachment 1 on the enclosed CD.

2 The full text of all the 2012 recommendations is included as Attachment 2 on the enclosed CD.

Operations (GSDO). NASA has seen successful tests of Orion's entry, descent, and landing (EDL) parachutes as well as successful splashdown tests of the Orion test article. The Orion spacecraft is currently undergoing integration at the Kennedy Space Center (KSC). The SLS core stage moved from concept to design after major technical reviews were successfully completed. The basic command and control hardware and software capability for the Spaceport Command and Control System has been delivered, and the ground system is proceeding with infrastructure refurbishment and multi-user preparations.

3. Safe ISS Operations and Utilization

The ISS continued its excellent safety and mission assurance record in 2012. There were four Soyuz crew transports to ISS: Soyuz Transport Modified Anthropometric (TMA)-04M in May; Soyuz TMA-05M in July; Soyuz TMA-06M in October; and Soyuz TMA-07M in December. In addition to the Soyuz crew transports and four Progress logistics flights, there were four successful visiting vehicle dockings: the Automated Transfer Vehicle (ATV) *Edoardo Arnalki* in March; the commercial Dragon capsule in May and October; and the H-II Transfer Vehicle (HTV) in July. During 2012, the ISS crew performed three safe extravehicular activities (EVAs) to make repairs.

4. NASA Safety Metrics

The NASA Safety Center has developed a comprehensive record maintenance system for safety metrics. It is faster and less labor-intensive and serves as a useful tool for Center and NASA senior management. They have progressed from limited centralized analysis to robust and comprehensive centralized analysis. The accident rate continues to decrease, and core metrics are improving. NASA continues to improve the manner and speed of mishap investigations.

5. Science Mission Launches and Landings

There were two noteworthy successful launches in 2012: the Nuclear Spectroscopic Telescope Array (NuSTAR), a mission to study black holes and other exotic objects in our galaxy and beyond, launched in June; and the Radiation Belt Storm Probes (recently renamed the Van Allen Probes), the first twin-spacecraft mission designed to explore our planet's radiation belts, launched in August. The *Curiosity* rover ended its 36-week flight in August with a successful landing on Mars to begin a two-year mission to investigate whether the Gale Crater region ever offered conditions favorable for microbial life.

6. Progress on ASAP Recommendations

NASA has continued to improve its response to ASAP recommendations. Eighteen recommendations were open at the end of 2011. The ASAP has received responses to all of these and has closed out 15 of them. In 2012, the ASAP generated 11 new recommendations and has received responses to all but one. Five of the 2012 recommendations have been closed out. At the end of 2012, there were a total of 9 open recommendations.

II. Issues and Concerns

Note on color bars: ■ Red highlights what the ASAP considers to be a long-standing concern or an issue that has not yet been adequately addressed by NASA. ▲ Yellow highlights an important ASAP concern or issue, but one that is currently being addressed by NASA. ● Green indicates a positive aspect or a concern that is being adequately addressed by NASA but continues to be followed by the Panel.

The ASAP offers the following color-coded summary assessment on the issues and concerns discussed in this Report:

▲ A. COMMERCIAL CREW PROGRAM (CCP) —Much progress has been made over the last year, but many challenges remain that will require resolution at the earliest possible time.

▲ B. EXPLORATION SYSTEMS DEVELOPMENT (ESD) —Work is progressing; there are ongoing discussions regarding safety-relevant roles and accountability, safety and mission assurance requirements for the developers, as well as risk management and risk tolerance for the assigned and potential future mission(s).

■ C. FUNDING UNCERTAINTY —For several years, there has been a significant gap between what NASA is attempting to do and what it is funded to do. This funding-planning mismatch, and in particular the uncertainty about future funding stability, has the potential to introduce new risks above and beyond those previously inherent in space travel.

● D. INTERNATIONAL SPACE STATION (ISS) —Significant progress has been made in ISS Micro-Meteoroid and Orbital Debris (MMOD) tolerance and in planning for ISS deorbit. NASA should complete the planning as quickly as possible, especially for unplanned ISS deorbit, in view of the unpredictable timing of potential malfunction scenarios.

▲ E. TECHNICAL AUTHORITY (TA) —The current process may be working, but it is resting on the strength of key individuals. General processes should be established that do not depend on the personalities of the people involved for success.

▲ F. RISK MANAGEMENT —Risk targets must be prudently selected, as well as explicitly articulated to all stakeholders, based upon an assessment of an acceptable level of risk specific to the mission and its counterbalancing value (reward).

▲ A. Commercial Crew Program (CCP)

Of all of the topics reviewed by the ASAP this year, the one receiving the most time and attention was unquestionably the Commercial Crew Program (CCP). NASA provided a status briefing on the program at every quarterly meeting. We also had an opportunity to visit several CCP partners, where we saw hardware being developed and discussed the progress being made and the challenges still remaining.

In September, the ASAP Chairman was invited to share his perspective on the program during a public hearing held by the House Committee on Science, Space, and Technology.

NASA's stated goal for the CCP is "to facilitate the development of a U.S. commercial crew space transportation capability, with the goal of achieving safe, reliable, and cost effective access to and from low-Earth orbit (LEO) and the ISS." In the future, NASA plans to purchase "transportation services" from one or more suppliers to meet its personnel transportation needs for ISS operations and other LEO missions. Although there are many important aspects to the program, the ASAP has primarily focused on three specific areas: the development and communication of design requirements; coming to an agreement on what certification process should be used prior to the flight of NASA astronauts or personnel on NASA-sponsored missions; and the selection of an appropriate acquisition strategy, both during the development phase and for the eventual purchase of Crew Transportation Services (CTS).

Although NASA has been flying its astronauts to orbit for more than 50 years, it was only in August 2012 that the Commercial Crew Transportation (CCT)-1100 Series documents were updated to identify and communicate the processes, requirements, interfaces, and design standards that NASA wants commercial providers to use in developing and operating future human space transportation systems for NASA missions. The challenge that NASA faced was compiling the lessons learned from decades of human spaceflight, while trying to avoid being overly prescriptive and limiting industry's ability to develop innovative approaches. While the ASAP was pleased to finally see the release and update of these requirements documents, we note that all of the commercial partners had already performed considerable design work prior to their official publication. In an ideal world, the requirements would have been established prior to designing and building the hardware. Nevertheless, it is our understanding that industry has accepted and is supportive of most of NASA's requirements. There are a few specific requirements, however, to which one or more of the developers object. Therefore, it will be very important for NASA and the developers to quickly come to an agreement on whether or not those specific requirements can be safely modified or waived or whether alternative approaches would be considered acceptable.

Before NASA crew or personnel on NASA-sponsored missions will be allowed to fly on commercially provided spacecraft, the systems will need to be certified. NASA is still refining the details of the certification process, but as part of the recently awarded Commercial Crew Integrated Capability (CCiCap) Space Act Agreements (SAAs), the partners were asked to provide NASA with recommendations for what they believe it would take to complete a certification milestone, including an "option" to conduct an orbital flight-test demonstration (demo)—under the SAA (outside of a NASA contract)—with a non-NASA crew. Although there is plenty of precedent for contractor test flights in government aviation developments, such flights are always under the certification authority of the government (either the contracting agency, Federal Aviation Administration [FAA], or both). For this NASA option, the demo flight would be outside of NASA's acquisition authority, thus raising several safety-relevant questions: (1) Would the SAA partner's demo flight be conducted outside of NASA's launch and entry certification authority? (2) To the extent that the required FAA license would not cover crew safety systems

and procedures (FAA authority is limited by statute), would any other government agency step in to certify flight crew safety? (3) If not, would NASA be legally obligated to certify for crew safety? (4) If the answers to (1) through (3) leave a gap in government crew safety certification, would Agency stakeholders perceive NASA as irresponsible in its sponsorship/facilitation or tacit acceptance of a high-risk activity? Even if the demo flight is successful, the statistical relevance of one flight (or even a few successful flights) is almost negligible without a thorough understanding of every aspect of the flight data. NASA should be looking for ways to maximize its insight into what will most likely be a short flight-test program, regardless of how it is contracted, incentivized, or facilitated. When asked about the potential exercise of the option, the CCP program manager informed the ASAP that there was no current plan to exercise the option. The ASAP was on one hand encouraged that the option would not be invoked but is concerned that NASA would continue to maintain the option if it truly had no intention of using it. Such a "mixed message" serves to add unnecessary confusion and attendant risk to the program.

A key aspect of the CCP is the acquisition strategy. NASA originally planned to implement a two-part certification process using Federal Acquisition Regulation (FAR)-based contracts, with the first part being an integrated design contract and the second part focusing on development, test, evaluation, and certification. However, because the funding provided was only about half of the requested level, NASA decided to use SAAs for the first part, CCiCap. The second part, involving the actual certification work, was still to be performed under a FAR-based contract. Based on concerns expressed by the ASAP and others that there could be a major disconnect between the systems developed under SAAs and the systems needed to meet NASA's certification requirements under a contract, NASA recently modified its acquisition strategy to add a Certification Products Contract (CPC) in parallel with the development work being accomplished under CCiCap. This new certification approach (see Figure 1), carried out under FAR-based contracts, will be executed in two phases: the first phase, the CPC, will allow earlier formal discussions between NASA and the partners on exactly what deviations from NASA certification requirements, if any, would be requested and allowed; and the second phase, the Certification Contract, will provide the validation, verification, testing, and final certification in order to complete the process. We believe that the Phase 1/Phase 2 certification approach helps to clear the certification "fog" and is a significant step forward.

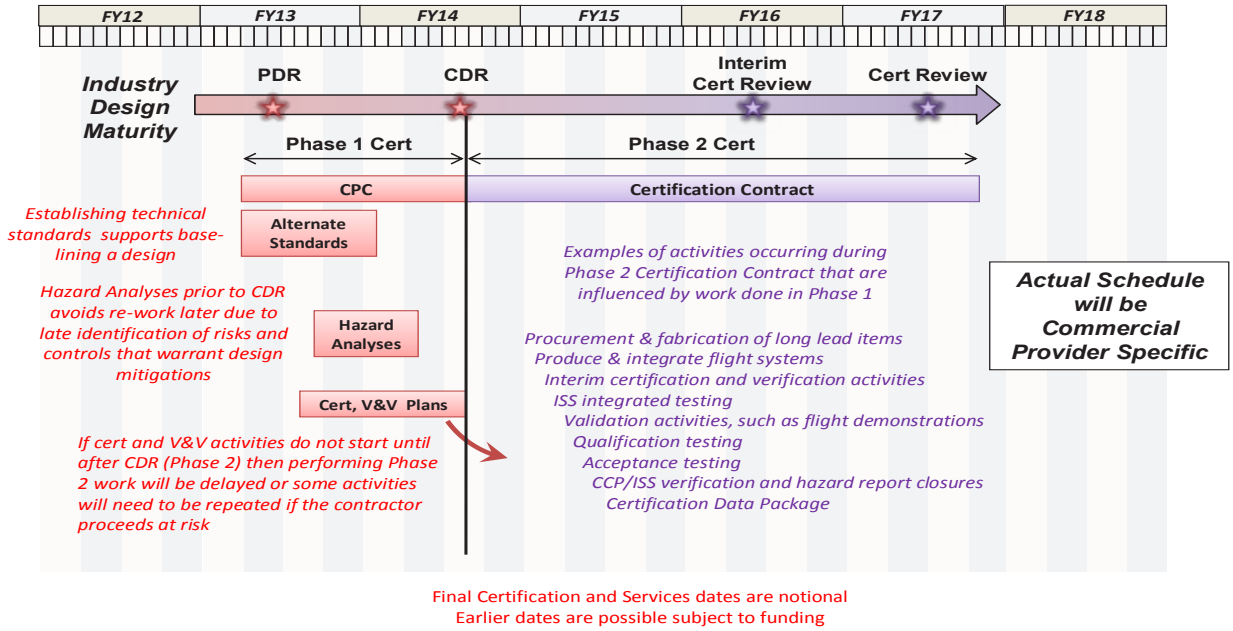


Figure 1: NASA Certification Strategy

The ASAP believes, and NASA concurs, that both Phase 1 and Phase 2 must be FAR-based contracts. The Panel believes the fixed-price contracting approach that is now in place for Phase 1 is satisfactory, where establishing technical standards is the objective. Although there are some uncertainties about the work to be accomplished in Phase 1, NASA has said that rather than modify the contract to handle unforeseen problems, they would most likely defer problematic activities into Phase 2. NASA has not yet decided upon a contract type for Phase 2, which encompasses certification, verification, and validation, as well as any unfinished work from Phase 1. The ASAP strongly believes that a cost type contract is appropriate for Phase 2. Fixed-price type contracts are appropriate for low-risk undertakings where the requirements are clearly understood by both the government and the contractor. Much of Phase 2 is neither, and we believe both schedule and safety would be at risk in a fixed-price environment because of the relative inability to defer or apply resources to problem areas that will inevitably develop. Some sort of hybrid mechanism could be appropriate with fixed price provisions for low-risk products and services and cost type provisions for the higher-risk work.

In summary, NASA has clearly communicated to the commercial partners that NASA certification is a fundamental requirement prior to transporting NASA astronauts and personnel in NASA-sponsored missions into space. Several aspects are improving with the advent of the CPC and the Certification Contract acquisition strategy: the establishment of solid requirements; the tailoring of those requirements for each concept; and how the Agency will verify that requirements are being met. The validation plan that will confirm the required capability is less mature and occurring later in the process than it should be, but it is scheduled to be produced under the CPC. However, NASA has yet to lay out a

process for the contractors to follow on the path to certification, e.g., how waivers and deviations will be approved, who is accountable, and how the process will be administered. The ASAP is pleased to see that progress has been made with the CCP over the last year, but many challenges remain that will require resolution at the earliest possible time. While SAAs may have stimulated new companies to enter the business and have moved the design work forward, by their very nature SAAs cannot contain specific enforceable requirements (beyond ISS proximity operations and public safety for ascent and entry). NASA should resist the temptation to implement SAAs for safety-critical work related to ascent, entry, and landing as a mechanism for accommodating any further budget shortfall. The ASAP plans to continue with our insight activities during the coming year, with particular attention being given to the maturation and communication of requirements, the development of additional details on the plans for certification (including the potential use of SAAs for flight demos), and the acquisition strategy that is actually funded and implemented in the months ahead.

▲ B. Exploration Systems Development (ESD)

To provide the capability for human exploration beyond LEO, NASA plans to develop the launch system, the crew vehicle, and the ground systems under the authority of three program offices: the Space Launch System (SLS) Program hosted by the Marshall Space Flight Center (MSFC); the Orion Multi-Purpose Crew Vehicle (MPCV) Program hosted by the Johnson Space Center (JSC); and the Ground System Development and Operations (GSDO) Program hosted by Kennedy Space Center (KSC). These three programs report to the Exploration Systems Development (ESD) Division, which is part of the recently reorganized Human Exploration and Operations Mission Directorate located at NASA Headquarters.

The Panel came into 2012 with no formal recommendations specific to ESD or its elements, but with several ongoing questions relating to the following: (1) safety-relevant roles and accountability; (2) safety and mission assurance requirements for the developers; and (3) risk management and risk tolerance for the assigned and potential future mission(s). The ESD Director, the Program Managers, and the Center-based Engineering and Safety and Mission Assurance (SMA) Directorates helped the Panel to better understand these issues. As is normally the case for newly emerging programs, new questions were raised as the year progressed.

1. With respect to roles and accountabilities, the NASA Headquarters–based ESD Division performs the system integrator role, with the Division Director accountable to the Directorate Associate Administrator for integrated system safety risks. ESD does, however, plan to delegate to the Center-hosted program offices the authority to accept some (element unique) catastrophic and critical residual risk issues that on past major human spaceflight programs would have been owned by the total systems integrator. ESD also plans to allow the contractor to accept some lower-level risks traditionally owned by the government—an area of continued ASAP concern as it violates the precepts of the traditional check and balance system of oversight and management. It also transfers

what has traditionally been an inherently governmental function—acceptance of risk to government personnel—to a contractor. Therefore, this idea opens a path for considerable unanticipated and unknown risk to enter the system. Finally, because Headquarters is not an engineering Center, ESD has enlisted the aid of various Center Engineering and SMA Directorate personnel to provide systems engineering and integration for a new Cross-Program Systems Integration (CSI) office. For the near future at least, CSI will do this Agency-wide work in-house with no near-term plans to contract for a prime integrator. To the extent that this organizational approach appears to contradict some NASA lessons learned from previous large programs and appears to run the substantial risk of resulting in systems integration by committee, the ASAP will continue to request that the Agency show how this approach will properly protect both safety and mission success.

2. Regarding requirements, the ESD completed its Cross-Program Systems Requirements Review (C-SRR) in the first quarter of the fiscal year. The ESD began last year with some uncertainty in mission (the Moon, Lagrange points, near-Earth asteroid rendezvous, etc.), so it was not surprising that some requirements validation work will continue as the missions are further defined. These developments include some of the driving performance requirements such as crew size, Earth re-entry velocity, Loss of Crew (LOC)/Loss of Mission (LOM) parameters, and others. The current plan out to the 2020 time period is to fly Exploration Flight Test (EFT)-1 as a high-elliptical, Earth-orbital mission to test such things as the heat shield and Orion/Upper Stage separation. This flight test will validate heat shield performance at ~80 percent lunar return velocity. The data from this test will be used as part of the Orion CDR. Exploration Mission (EM)-1 will fly to the Moon to test the heat shield for trans-lunar re-entry velocities as well as most major subsystems. For these missions, the Cross-Program Systems Design Review (C-SDR) is on track for the second quarter of FY13. In support of this C-SDR schedule, all three programs conducted their own Systems Requirements Reviews (SRRs) during 2012, which included safety, reliability, and quality requirements that flowed down from ESD. These were successfully completed, and all the programs are now moving toward their Preliminary Design Reviews (PDRs) in 2013. They have completed several critical path system and subsystem demonstrations and tests as noted in Section I.B. of this report. It was noted, however, that near-Earth asteroid or interplanetary missions still require technology developments, especially in the area of heat shielding, to allow for higher re-entry speeds.

3. In the area of risk management, the Panel reviewed the processes that Engineering and SMA use for element (program) and ESD hazard analysis, failure modes and effects analysis, probabilistic risk assessment (PRA), and other analyses designed to characterize requirements for safety and mission success and/or residual risk. A change that concerned the Panel was combining the system safety and engineering review panels in an attempt to streamline risk decision-making. NASA explained the safety analysis process and where accountability resides. The question that remains, however, is how the combined panels might affect the independent thinking that is inherent when the two organizations hold separate reviews and sometimes present alternate views at the program level change boards.

Another risk topic that extended through the year was the development of LOC/LOM requirements. The Panel questioned whether and how safety parameters such as LOC/LOM probability had played into the 2010/2011 architecture studies for the SLS, as well as the ongoing system design work. NASA stated that safety was a key parameter in the trades and that the two final concept candidates—heritage liquid oxygen/liquid hydrogen (LOX/LH2) and liquid oxygen/refined petroleum (LOX/RP)—both met the placeholder threshold of 1/700 (SLS ascent only). For several reasons, primarily near term affordability, the Agency picked the LOX/LH2 concept for the early exploration test missions and decided to continue development of LOX/RP technologies for potential later booster upgrades. More recently, the Agency proposed LOC requirements for the design team that covered pre-launch, ascent, entry, descent, and landing for the EM-2 (crewed lunar orbit mission) configuration. The LOC requirements were distributed among the system elements, but when combined, they totaled ~1/245. The total mission LOC and LOM are listed as "tbd" based on mission analysis. NASA expects the launch, ascent, entry, descent, and landing values to remain the same for this architecture regardless of mission destination, with each specific mission having its own transit/proximity operations and entry risk values.

C. Funding Uncertainty

The ASAP's primary function is to review all aspects of the NASA mission, both programmatic and technical, that have safety implications and provide assessments and recommendations for improvements. One of these aspects is how funding and budgets impact the safe accomplishment of the NASA mission. In its 2012 quarterly meeting minutes and recommendations, the ASAP highlighted several areas of concern. One of these was funding, both in terms of facility/infrastructure safety as well as program or mission safety. In the ASAP's opinion, these funding levels, and in particular the uncertainty about their future stability, have the potential to introduce new risks above and beyond those previously inherent in space travel.

1. Regarding facilities and infrastructure, NASA has defined the strategy, plan, and metrics to modernize its facilities and sustain its capabilities; however, there is still a large funding shortfall in the facilities repair budget line. Funds needed for preventive maintenance have been used to ease budget shortfalls elsewhere. Centers have been maintaining their facility prioritizations based on mission and safety, but eventually the backlog of needed work must be accomplished or the facility becomes useless, if not unsafe. The ASAP has encouraged NASA to review its metric for both mission success and safety to be certain that it reflects reality, to ensure a regular review of the correlation between the two as budgets decrease, and to make adjustments as needed to ensure continued safe mission accomplishment.

2. Regarding human spaceflight safety, the ASAP specifically focused on the CCP, ISS, and ESD. As the Space Shuttle Program was brought to a close, NASA embarked on a bold new effort to place humans in LEO at much lower cost. That effort relies on commercial partners to innovate with new

approaches that might be more efficient than systems designed using traditional NASA acquisition models. From its inception, this program has been funded at levels far below what would be expected for a traditional program. The rationale has been dependent on "commercial partnerships." Although they are showing promise as cost savers, they have yet to be validated as safe and effective for human spaceflight development.

NASA's original acquisition strategy for the CCP was predicated on receiving the $850 million that was in the President's Budget Request (PBR) in 2012. As described in the CCP section above, it featured a two-part acquisition approach for development and certification, which was subsequently modified when the funding provided was only about half the requested level. To mitigate the risk of delayed certification, NASA is now moving forward with certification activities under the two-phase approach, as depicted in Figure 1, to minimize technical risks and cost or schedule impacts. If NASA were to delay certification activities, the development work could eventually reach the point where any changes necessary to meet NASA requirements might not be technically feasible or affordable. This could potentially extend reliance on foreign systems for crew transportation to the ISS or result in the decision to waive or reduce requirements in order to accept less expensive or more readily available designs that otherwise would not have been accepted as safe.

NASA plans to have at least two contractors through Phase 2 to ensure a safe and affordable ISS CTS through competition. The ultimate number of awards will be driven by technical maturity, funding availability, and mission needs. The ASAP agrees that having two adequately funded contractors through Phase 2 is advantageous; however, absent an independent cost estimate, we are uncertain as to affordability. Even with the new approach, NASA's ability to successfully complete the certification process as currently planned and to begin flying ISS CTS missions by FY17 will require increased funding for the program starting in FY13. It is important that the program's budget be stabilized at a level sufficient to execute the plan, which is shown in Figure 2.

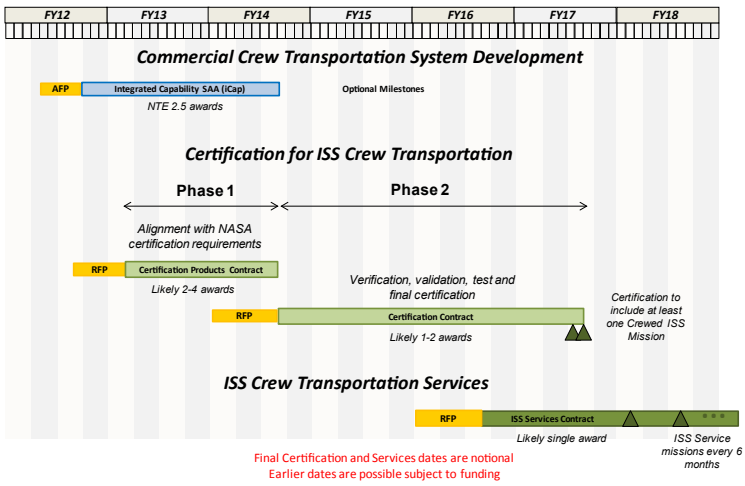


Figure 2: CCP Roadmap

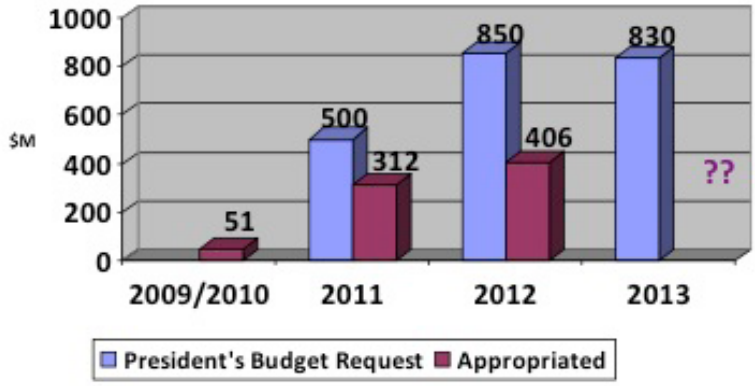


Figure 3: CCP Funding History—Requests & Appropriations

Given the past budget trend shown in Figure 3, the ASAP is concerned about what tradeoffs NASA and the SAA partners will take to accommodate future budget shortfall.

There appear to be few options available to NASA when the budget is reduced. These include stretching the schedule, reducing performance, and/or obtaining additional funding. Given NASA's budget history, it is unlikely there will be additional funding. The likely option will be to make tradeoffs and changes to performance measures that would include accepting additional safety risk. Such changes are allowed under SAAs and are not under NASA's control. NASA would have limited visibility into and no oversight of those tradeoffs and changes, which could lead to unknowingly accepting substantial increases in risk to the safety of crews. NASA would have no way to adequately evaluate and address the critical tradeoffs, which could lead to unknown risks and safety implications. As budgets are reduced and funding uncertainty increases, it is essential that NASA increase its awareness of possible safety implications and address those immediately.

ESD is a program with wide support. The ASAP anticipates that the funding level and rationale for FY13 will be similar to those of FY12. Unlike CCP, ESD funding levels have remained relatively constant. However, ESD has a "flat budget" that by nature causes phasing and integration compromises for a program that needs a classic skewed bell curve for development. NASA should continue to monitor the funding going forward and be prepared to mitigate any mission and safety concerns should future NASA budgets be significantly reduced due to the prevailing fiscal environment.

In conclusion, for several years now, we have seen gaps between what NASA is attempting to do and what it is funded to do. The result has been goals, requirements, schedules, and missions that are ever-changing to fit available budgets. With the current budget uncertainties, major manned spaceflight programs are being conducted at a "Level of Effort" to fit available budgets rather than targeted to a firm mission with a firm schedule. Large scale, high-risk programs are being undertaken using untried acquisition approaches to meet available budgets. In the view of the ASAP, it is time for all stakeholders to reach a consensus on what the Nation is attempting to accomplish in human spaceflight and then fund that effort adequately and

consistently. This disconnect is seen by the ASAP as a major risk driver in human spaceflight, which is why this area is color coded red.

D. International Space Station (ISS)

1. Micro-Meteoroid and Orbital Debris (MMOD) damage has been identified by both NASA and the ASAP as a major safety risk for ISS with respect to LOM and LOC. As recently as 2011, NASA had supplied information to the ASAP that described the chance of LOM due to MMOD over a 10-year period as being greater than 30 percent. Should such an event occur, in addition to the LOC and LOM issues, the situation could arise where the ISS would have to be abandoned—potentially without the possibility of a return to nominal operation. A premature ISS deorbit is one potential outcome. Such a probability represented more than an outside chance and deserved serious examination to ascertain ways that this risk could be mitigated. Since this issue was identified, NASA has taken a number of steps that have mitigated the risks stemming from MMOD. These actions have included activities that range from hardening the ISS against MMOD impact to a more sophisticated analysis that takes into account other improvements in ISS system operational robustness. These improvements also mitigate the overall operational effect an MMOD impact would have. Examples of shielding additions for the Soyuz and Progress vehicles are shown in Figure 4.

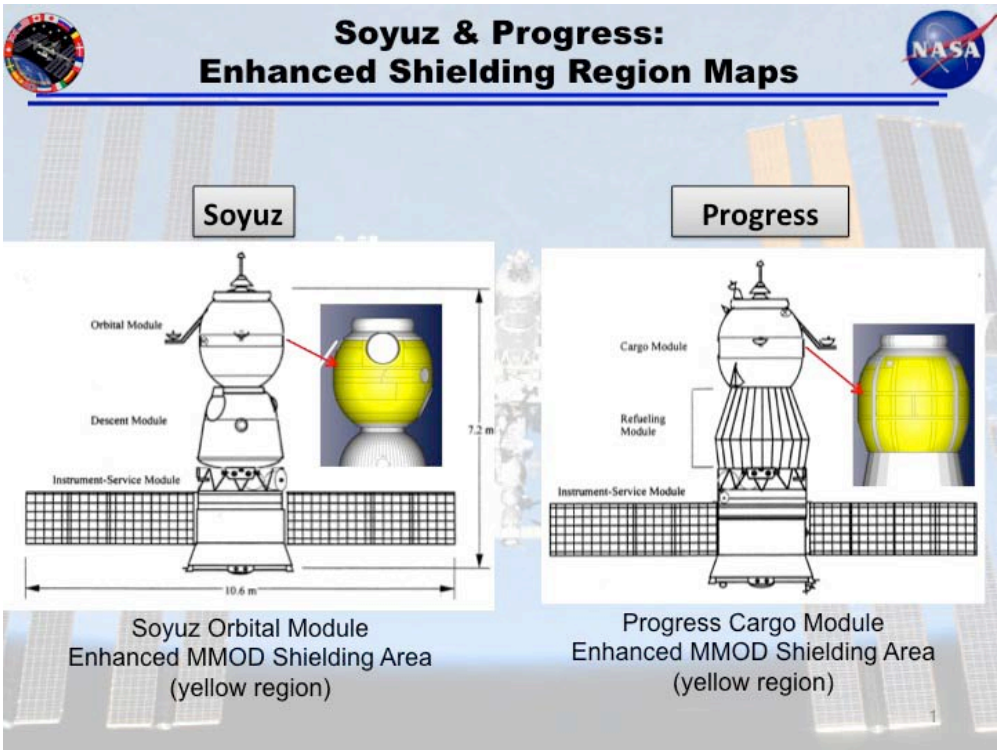


Figure 4: Enhanced Shielding for Soyuz and Progress

In total, these actions reduce the probability of MMOD-induced LOC to approximately 5.1 percent and the probability of an evacuation to 13.7 percent over a 10-year period. These are substantial improvements. The progress on reducing MMOD risks is shown in Figure 5.

ISS MMOD Risk Projected for next 10 years

using ORDEM2000 debris model & MEM meteoroid model

ISS MMOD Risks

10-year future time period, updated with latest NASA results documented in JSC-65837 and JSC-66198

	Date	Penetration Risk	Loss-of-crew (LOC) Risk	Evacuation Risk
Requirement		≤ 24% (PNP=0.76)	≤ 5% (PNCF=0.95)* *Goal, not a requirement	NA
ISS Risk as of March 2012	March 2012	52% (PNP=0.48)	8.0% (PNCF=0.920)	16.1% (PNevac=0.839)
With partial implementation of Progress enhancement beginning with 47P	April 2012	49.0% (PNP=0.510)	7.6% (PNCF=0.924)	14.4% (PNevac=0.856)
With above and Soyuz enhancement beginning with 30S	May 2012	34.5% (PNP=0.655)	5.2% (PNCF=0.948)	14.3% (PNevac=0.857)
Above and 5 SM debris panels installed on RS EVA 31 (Current Configuration)	August 2012	33.9% (PNP=0.661)	5.1% (PNCF=0.949)	13.7% (PNevac=0.863)
Above and full implementation of Progress enhancement beginning with 57P	September 2014	28.0% (PNP=0.720)	4.6% (PNCF=0.954)	11.0% (PNevac=0.890)
Above and commercial crew vehicles beginning in 2017 (reduce Soyuz flights)	2017	26.5% (PNP=0.735)	4.4% (PNCF=0.956)	11.0% (PNevac=0.890)

October 2012

PNCF: Probability of No Crew Fatality PNevac: Probability of No Evacuation PNP: Probability of No Penetration

Figure 5: Projected ISS MMOD Risk

While these improvements have reduced the chance of an unplanned ISS deorbit, this eventuality still does exist. Unfortunately, the MMOD risk to all spacecraft, including the ISS, is expected to rise dramatically in the future as more and more launches take place around the world.

2. NASA celebrated a major milestone last year when, after thirteen years of construction, the assembly of the ISS was completed. At nearly 900,000 pounds, travelling at over 17,000 miles per hour, it is the most massive and energetic object mankind has ever placed in orbit around the Earth.

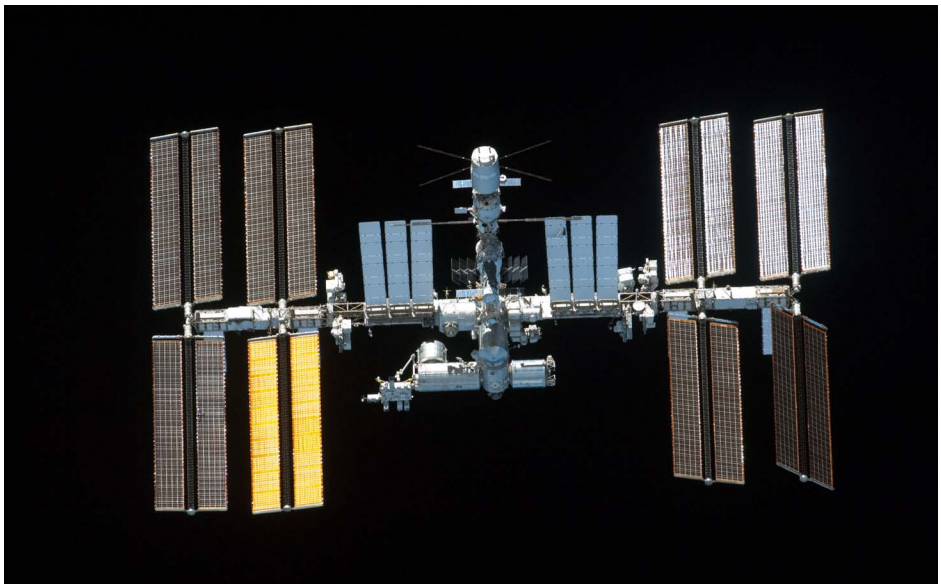


Figure 6: ISS in Orbit

While current plans are to continue ISS utilization through at least 2020, it will eventually fall back to Earth, potentially presenting a significant risk to public safety if it is not done in a controlled manner. It must be recognized that this event could occur much sooner than the planned End Of Life (EOL) if there is a major malfunction that forces the Station to be abandoned. The most likely threat that could cause such an event is critical component penetration by MMOD, as discussed above, but other failure causes are also possible. Built-in redundancies, as well as recently added shielding, greatly reduce the probability of such failure; however, the existing potential threat to public safety must be recognized.

As explained in our 2011 report, neither NASA nor our international partners had in place a comprehensive plan for how to address the safe deorbit of the ISS. We are now able to report that over the last year, NASA and Russia have made significant progress in planning for ISS deorbit, whether it is at the nominal EOL or earlier in a contingency case. Analyses indicate that even without crew, the ISS can safely remain in a stable orbit for up to six months, provided control systems are not damaged. That would provide a window to launch vehicles with the capability to dock and drive the ISS into a controlled and safe deorbit. Initial analyses indicate that up to three Russian Progress vehicles may be required to adequately guide this entry. We are encouraged that work has begun on assessing options for this contingency, but we urge NASA and our partners to complete the required planning as quickly as possible in view of the unpredictable timing of potential malfunction scenarios.

▲ E. Technical Authority (TA)

Clear objectivity and an effective process to deal with problem-resolution are paramount to the safety and success of any endeavor, especially in the case of pioneering space programs such as the CCP and ESD. A systematic process that enables the identification of a safety issue, even if it halts all work until the safety issue is resolved, is a key to long-term success. Such a process should reflect organizational cultural values where reporting a safety issue becomes an obligation rather than an "act of courage," especially in high-risk space endeavors. Based on a Columbia Accident Investigation Board (CAIB) report recommendation, such a process, Technical Authority (TA), was instituted to provide a means to encourage and maintain the independence of technical perspectives and concerns and enable concerns to be raised to appropriate management levels for resolution. A fiscally austere environment, coupled with hard deadlines and milestones, will lead to cost reduction initiatives, and safety margin can be considered for reduction. The independent TA role is critical to maintaining the balance between preserving safety processes in their true spirit and intent and the demands to maintain cost and schedule. It ensures that decisions in controversial areas are made objectively at the proper organizational level. The term "authority" can have several interpretations ranging from subject matter expert to an entity responsible and accountable for resolution of competing viewpoints. The ASAP considers the TA concept to mean the latter.

Over this past year, the ASAP considered three TA issues that have their roots in the CAIB report: 1) schedule and cost management, and the technical expertise to solve questions or concerns; 2) the maintenance of an independent TA chain of command and organization; and 3) the growth or insertion of climatic and cultural impediments.

After the conclusion of Shuttle operations in 2011, the ASAP was concerned about the outflow of NASA expertise in many areas, including both management and technical personnel. While such a large personnel disruption cannot take place in any organization without some expertise loss, we salute NASA for making a proactive and involved effort to sustain the workforce wherever possible. It is a compliment to the many hardworking and involved individuals that the workforce did not suffer the massive losses that many predicted. After our reviews at JSC in the latter part of 2011, and at MSFC and KSC in 2012, we believe that the retention of technical expertise, crucial to the TA program, had been well handled so far, but there are significant challenges to some Agency-level TA budget areas. The ASAP formally recommended that NASA provide a budget line for these technical support functions that is independent of the institutional overhead accounts and more closely aligned with the programs they support. In the case of the other two areas, the concerns were policy related.

The ASAP believes that the clear and independent TA lines have been blurred somewhat in the NPR 7120.5E revision, in which the Center Directors have been inserted into the TA process and hierarchy for hosted programs. Center Directors are the single most powerful management officials in the professional lives of the TA. If the Center Director is responsible for both the technical execution of the work as well as the administrative management of the Center workforce, an inherent or perceived

conflict of interest could be created. Such conflicts must be addressed to ensure that they do not inappropriately impact the TA decision. Most importantly, we must assure that pressure to change a stance on an issue, perceived or otherwise, is avoided.

In its response, NASA's view is that including Center Directors in the TA process in the TA hierarchy revision, especially across multi-Center programs, strengthens the process because the issues can be addressed by the Center Director before they flow to NASA Headquarters. The ASAP would agree that this can be positive; however, the ASAP's major concern is that the new policy could provide an avenue for bypassing the requirement for decision elevation in resolving an issue. This could lead to safety ramifications.

NASA has been assigning well-qualified and strong personnel to the TA positions that mitigate potential undue influence. In the ASAP's opinion, this is currently working in large measure due to the people that have been assigned to the process. However, the TA needs a systemic process with a formal written policy and should not depend on the personalities of assigned personnel. Should there be a conflict or weakening of the placement of strong individuals in the TA position, the system should prevent the introduction of greater risk into the program. It is ASAP's opinion, in accordance with the way we understand the spirit and intent of the CAIB report's TA recommendation, that the TA is the authority and must be considered an equal at the table when discussions are undertaken. Without TA concurrence on matters within their authority, actions should not go forward unless higher authority adjudicates the issue and formally records the decision and reasoning.

In ESD, the roles of TA are not as clear as they were in previous programs hosted at JSC. As noted earlier in this report, the ESD integration is managed from NASA Headquarters, and the assigned TAs come from JSC and MSFC, which have no host role for ESD other than providing people to the Headquarters effort. One key to effective TA is a strong technical organization to back the TA up. No single TA can be technically capable to deal with all the discipline issues that arise in a major program; they are dependent on their home directorate for discipline support. For ESD, it is still unclear to ASAP how this high-stakes, complex, Headquarters-hosted, and "tightly coupled" program of programs will function, and how its assigned TAs will support it effectively.

In summary, the ASAP agrees that the current process may be working, but it is resting on the strength of key individuals with whom we have great confidence. We remain strong advocates of putting general processes in place that do not depend on the personalities of the people involved for success. We understand that in the current fiscally austere environment, there will be many well-intended actions and necessary cost reductions that are suggested and considered. NASA is the organization with the most experience by far in putting people into space and returning them to Earth; however, the Agency must remain vigilant in safeguarding initiatives, such as CCP and ESD, from impacting safety. A sound safety culture is paramount where NASA's sacred values and principles must be made known and adhered to throughout the Agency. Value-based over purely fiscally based decisions allow the organization to stay the course, providing drive and direction to an envisioned conclusion and, most importantly, avoiding

the very real and high safety risk of allowing guiding principles and regulations to be overcome by austere fiscal and schedule pressures. A value mismatch can open opportunities for increased, undesired, and perhaps unrealized risk. The Panel will continue to monitor and discuss this subject in order to trend the revised TA structure's effectiveness.

▲ F. Risk Management

System safety is fundamentally based on managing risks. There are three primary elements: (1) identifying the potential hazards, their consequences, and their likelihood; (2) eliminating, controlling, or mitigating those hazards to the extent feasible with respect to their potential impact on loss of human life, budgets, and mission accomplishment; and (3) perhaps the most important, the formal process for deciding if a residual risk is worth accepting based on the calculated and perceived value to be gained. The ASAP continues to believe that risk targets must be prudently selected as well as explicitly articulated to all stakeholders based upon an assessment of an acceptable level of risk specific to the mission.

1. *Accountability and Documentation of Rationale for Risk Acceptance*

   There is a need to clearly understand overall mission risk and the subsequent tradeoffs between risk and reward as programmatic decisions are made, especially those that involve the acceptance of risk. When performance trades are made due to budget and schedule constraints in managing the program, it is important to understand the impact of the tradeoff and why it was made, to be explicit about the decision made, and to revisit the tradeoff periodically to confirm the validity of the decision.

   The ASAP was pleased to see that NASA's ESD was developing a risk matrix that established the organizational level that will have the decision authority to accept a risk. Although it is not yet clear whether the element programs will have authority to approve catastrophic risk hazards and criticality 1 failure modes that are not designated as "integration" issues, ASAP will continue to address this question in the next year. Beyond that, there will be a challenge in resolving the accountability for lower categories of risk so as to not encumber the entire system with hundreds, or even thousands, of risks to be adjudicated. One approach under consideration is to allow the contractor developer to make the decision on risk acceptability. The ASAP cautions that there may be problems with this approach.

2. *Balancing Risk and Reward (Value)*

   We have, to some extent, a classic debate. On one side, or "bookend," is the need for a significant margin of error to mitigate against the "unknown-unknowns" to create a robust design, but the level of insight and/or the amount of testing that NASA requires could be so expensive that it cannot be adequately funded. The result is a situation that leaves the U.S. without any human spaceflight capabilities far into the future. On the other end is a design and testing program which is scaled back and is more affordable, but potentially unsafe, inadequate, and high-risk. To be

successful, especially now when dealing with commercial partners, it is important to strike the right balance between insight and oversight so that a well-informed risk decision can be made. There must be a balance of accepted risk with respect to the reward (value) which is acceptable to all stakeholders, including taxpayers, and this risk and value must be communicated in ways that the various stakeholders can understand.

Regardless of the best plans and efforts, safety standards generally are the result of iteration. In the process of formulating an architecture, it is essential to set clear, firm requirements as early as possible to guide future decisions on safety factors, reliability, and failure tolerance. Uncertainty is a source of delay, waste, and potential compromise of capability. A target is needed, and the target needs to be a reasonably challenging one that is based on the risk/reward/value proposition.

Problems can arise if NASA sets a standard but has not furnished the standard in a timely manner or has not specified how the vendor will demonstrate that their system can achieve the required safety standard in a manner acceptable to NASA. Such demonstration of capability may require not only end item inspection and testing, but may require a variety of tests and inspections prior to actual completion of a flight-ready system. Early standards definition and the means for their verification is essential so that all parties can come to a consensus on what needs to be done to protect the health and safety of the crew and how to best verify that those requirements are met. For the Certification Products Contract (CPC) effort to be successful, it must tread a delicate line that defines how safe the system in question has to be and a method for assuring that it does so without placing so many obstacles in place that the entire endeavor is not doable from an overall value perspective.

Finally, the government needs to do all it can to enable the development of multiple, independent systems for safe crew transport to and from LEO. Competition not only helps to keep costs down, but in the event of an accident or a complex problem that is uncovered, having other available alternatives allows the use of a different rocket or spacecraft, rather than waiting out a lengthy grounding as we did with Shuttle.

3. *Communication/Transparency Concerning Risk*

Space transportation, like all other modes of transportation, involves risk. In 2009, the most recent year for which data is available, 547 people lost their lives in aviation accidents, most of which involved general aviation aircraft. Accidents related to trains and railroad systems killed 695 people. Recreational boating claimed the lives of 736 participants. On our nation's highways, we experienced 33,868 fatalities involving cars, trucks, buses, and motorcycles. It is not very realistic to assume that space transportation will be able to eliminate accidents completely, no matter how much emphasis we place on safety and mission assurance.

NASA must to do a better job of helping its stakeholders, which include senior political leadership, the news media, and the general public, to understand and manage expectations about the risks

and benefits (the value) involved in human spaceflight. As Congress itself pointed out in the Commercial Space Launch Amendments Act of 2004, "spaceflight is inherently risky." Spaceflight will never, in the foreseeable future, be truly routine, nor will it ever be "safe" when that word is used in the context of our everyday life. Discussions of risk without concomitant discussions of the associated value to be gained are superficial, misleading, and do not permit those involved to arrive at a well reasoned judgment concerning the appropriateness in undertaking this risk. The ASAP recommends that NASA clearly and consistently communicate the hazards involved, their risk of occurrence, and why the value of the goals to be realized warrant taking such risks. This practice will enable the programs to better pursue innovative paths forward to achieve safe, reliable, and cost effective space transportation.

At its heart, the reticence to discuss problems is exacerbated by a failure to proactively explain the risk versus reward—in other words, the net value of the undertaking. It is not surprising that without a clear mission whose importance is understood and is explicitly articulated, stakeholders would be less likely to support an activity which is perceived as having problems without any countervailing benefits that offset the risks. NASA should develop a focused strategic communication plan covering priorities, risks, costs, and benefits.

4. *Robotics and Risk Mitigation*

Recognizing the potential of robotics to minimize the risk to humans, the ASAP has emphasized this technology area. The Panel noted in a 2009 recommendation that there seemed to be a lack of an integrated focus on robotics across NASA. It is clear that much has improved in the last three years. NASA has now made this a focus area. There is a roadmap that is tied to projected missions and a program that is managed and resourced as an integrated entity across the Agency. There is a balance between technology push and mission pull that is resulting in robotic technology successes in operational roles, such as Mars Exploration vehicles and the Robonaut that is now onboard the ISS. Robotics technologies are proving to be sufficiently effective to do real work and safe enough to work side by side with humans. One change that the ASAP appreciated seeing is the movement from "humans versus robots" to "humans plus robots." There has been a clear philosophical shift that is very positive.

ASAP commends the leveraging of partnerships with industry as well as with other agencies through the National Robotics Initiative and cooperation with the academic world. The structures of many of the efforts were non-traditional in terms of government programs—there were a lot of partnerships, collaborations led by other agencies, and work with industry and other federal agencies. It seemed to be a very successful approach, and the ASAP believes that it might be useful to think about whether this kind of approach could be used in other areas.

III. CONCLUSION

NASA is making progress toward reestablishing U.S. provided transportation to the International Space Station (ISS) and to low Earth orbit (LEO) by 2017. The funded Commercial Crew Program (CCP) partners (Sierra Nevada, SpaceX, and Boeing) are working under Space Act Agreements (SAAs). Implicit in the SAA approach is an "arm's length" agreement whereby NASA gains "insight but not oversight." This distance has spurred diverse approaches and has potential to foster competition and cost reduction. It has, however, yielded a complex and sometimes uncertain management interface. Foremost among the uncertainty is: How will NASA intelligently and confidently certify commercial crew systems safe for NASA astronauts and personnel on NASA-sponsored missions? NASA took an important step forward in answering this question with the award of the Commercial Crew Integrated Capability (CCiCap) SAAs in August 2012, and in December 2012, selection of contractors for the Certification Products Contract (CPC), the first phase of certification that will yield hazard analyses, requirements validation and verification, and flight testing needed to certify the system for ISS transport.

NASA is developing the launch system, the crew vehicle, and the ground systems that will provide the capability for human exploration beyond Earth orbit. NASA's approach has spurred discussions related to safety-relevant roles and accountability, safety and mission assurance requirements for the developers, and risk management and risk tolerance for the future missions.

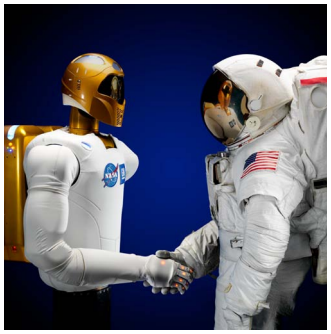
NASA's budget is the "elephant in the room" both for commercial space and for longer term exploration. NASA's CCP reflects a funding plan for FY13 that is approximately twice the appropriations currently being supported in the House and the Senate. This planning-funding disconnect will drive a change to acquisition strategy, schedule, and/or safety risk.

The ASAP is concerned that some in NASA will champion an uncertified approach that is a current option contained in the CCiCap agreement. This could yield two standards of safety—one reflecting NASA requirements, and one with a higher-risk set of commercial requirements. It also raises questions of who acts as certification authority and what differentiates public from private accountability. Separating the level of safety demanded in the system from the unique and hard-earned knowledge that NASA possesses introduces new risks and unique challenges to the normal precepts of public safety and mission responsibility. NASA's continued retention of the SAA flight demo option raises questions in our minds about the government's safety obligations as well as how such an option would move NASA any closer to a certified system. It could also lead NASA down the slippery slope of being forced to curtail their certification program for NASA crewmembers merely because of a small number of possibly lucky, non-certified flights. We do not understand the full implication of the optional approach and are concerned that it increases risk. We intend to pursue much deeper insight of this subject in the coming year.

The ASAP charter includes counsel regarding NASA's safety culture. As in all organizations, lessons learned in the past dim with time. In this regard, the ASAP is concerned that the Columbia Accident Investigation Board (CAIB) recommendation for the Agency to always have an independent Technical Authority is being weakened in the implementation of new organizational and acquisition/investment processes.

There is a need to clearly understand overall mission risk and the subsequent tradeoffs between risk and reward as programmatic decisions are made, especially those that involve the acceptance of risk. When performance trades are made due to budget and schedule constraints, it is important to be explicit about the decisions made, to understand the impact of the tradeoff and why it was made, to document the risk acceptance and the underlying value-based rationale, and to revisit the decision periodically to confirm its validity. Space systems design and risk tolerance are inextricably linked. As in prior years, we call out to NASA to determine what level of risk is acceptable, as a first-order function, and to clearly communicate that risk in tandem with the value to be derived to all stakeholders.

We share the Agency's pride in the important accomplishments during 2012. Prime achievements include safe ISS operations and utilization, the incredibly exciting landing of *Curiosity* on Mars, and the first U.S. commercial supply mission to the ISS. The progress directly related to improving safety includes contingency planning for ISS de-orbit and improvements to ISS Micro-Meteoroid and Orbital Debris (MMOD) tolerance.

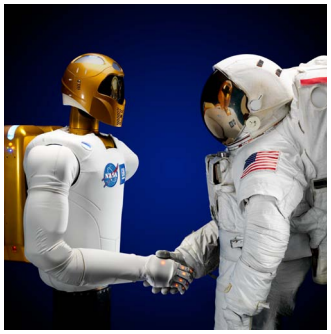



Appendix A:

Summary and Status of ASAP 2012 Recommendations

Rec. #	Description of Recommendation	Status
2012-01-01	**Standardizing and Funding NASA Wellness Facilities:** NASA should develop a standardized wellness program approach that ensures that all employees have an equal opportunity for access to NASA's wellness facilities. NASA should examine ways to standardize and control the level of support for the facilities to a higher degree. The ASAP encourages NASA to explore the funding streams and consider whether they should be centralized.	Report received. Funding will remain de-centralized. CLOSED.
2012-01-02	**International Space Station (ISS) Deorbit Capability:** (1) To assess the urgency of this issue, NASA should develop an estimate of the risk to ground personnel in the event of uncontrolled ISS reentry. (2) NASA should then develop a timeline for development of a controlled reentry capability that can safely deorbit the ISS in the event of foreseeable anomalies.	NASA response & briefing received. OPEN pending updates as plan matures.
2012-01-03	**Extension of Soyuz Lifetime:** NASA should actively pursue with the Russians the plan to extend the Soyuz on-orbit lifetime from six months to twelve months.	NASA response & briefing received. CLOSED.
2012-01-04	**Commercial Crew Safety Certification Process:** NASA should define the safety certification process and standards, down to levels 3 and 4, as quickly as possible. NASA should provide the ASAP forthwith the schedule by which these requirements will be developed and promulgated.	NASA responses received. CLOSED. ASAP will continue periodic review.
2012-01-05	**Maintaining NASA Pilot Proficiency:** NASA should investigate the risk of reliance on its historical approach for maintaining pilot proficiency considering anticipated further budget reductions, including an assessment of the need to develop a centrally-funded flight training budget so as to ensure all NASA pilots maintain flight proficiency.	NASA passed their Level 2 Safety Management System (SMS) with no discrepancies. CLOSED.
2012-03-01	**Software Assurance and Capability Maturity Model Integration (CMMI) Requirements:** All NASA internal safety-critical software development groups should achieve CMMI Level 3 (or an equivalent as established by external validation agent) by the end of FY 14.	NASA response received 10/9/12. OPEN.

Rec. #	Description of Recommendation	Status
2012-03-02	**Software Assurance Metrics:** NASA should provide metrics and trends that demonstrate whether the software assurance provisions are working and provide return on investment.	NASA response received 10/9/12. OPEN.
2012-03-03	**Software Independent Verification and Validation (IV&V) Requirements:** NASA should establish a standard identifying the level of criticality that requires software IV&V, i.e., at what risk level must IV&V be required and therefore either be resourced, or if that is not possible, a formal waiver process be in place for an accountable individual to accept the associated risk and document it.	NASA response received 10/9/12. OPEN.
2012-03-04	**Revised Estimate of Loss of Crew (LOC) and Loss of Mission (LOM) for the International Space Station (ISS):** Revised estimates for both LOM and LOC for ISS due to both Micro-Meteoroid and Orbital Debris (MMOD) and other causes through 2020 (based on the current configuration) should be determined and compared to the data previously supplied in this regard which predated any of the recent MMOD hardening that has been implemented on ISS.	NASA response received. CLOSED.
2012-03-05	**Five Year Roadmap for Continuous Improvement of the Agency's Mishap Investigation Process:** Link status reports of the five year mishap investigations process plan with progress reports on the NASA drug and alcohol policy development. Also, continue to report on the training of the Mishap Investigation Team (MIT) and the investigation Board Chairs in greater detail to include the method, consistency, and quality of training for MIT members and Board Chairs.	NASA response received 11/21/12. OPEN pending update.
2012-04-01	**Alignment of Technical Authorities' Budgets with Line Authority:** NASA should review and determine the appropriateness of having the Technical Authorities—Office of Safety and Mission Assurance (OSMA), Office of Chief Health and Medical Officer (OCHMO), and Office of Chief Engineer (OCE)—in a non-safety-aligned budget line item and office.	NASA response not yet received. OPEN.




Appendix B:

Closure Rationale for Recommendations Closed in 2012

2006-03-04

Random Drug and Alcohol Testing: Recent mishap investigation revelations indicate that there does not seem to be an Agency-wide requirement for random drug and alcohol testing among contractors. 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.

Closure Rationale

NASA has decided not to implement the recommendation and accepted the risk in this area.

2008-01-06 follow-up

NASA Headquarters Mishap Investigation: ASAP has recommended that NASA re-evaluate its mishap investigation process with an eye to producing report results in a timely manner and utilizing the appropriate experts for determining root cause. NASA should consider a 30-day hard number for delivering at least a preliminary mishap report to enable dialogue to begin within the affected organizations. 2008-01-06 Follow-up: ASAP Letter dated Nov 16, 2010 requested that a briefing be provided at the 1st quarterly meeting at NASA Headquarters on February 3, 2011, relating to the status of the NPR and changes to it. Now that the immediate changes required to effect near-term process improvements have taken place, it is appropriate to begin a strategic review of the mishap investigation process. Request that NASA discuss their five year strategic plan to effect continuous improvement.

Closure Rationale

The Office of Safety and Mission Assurance (OSMA) has written a 5-year strategic plan/roadmap for continuous improvement. The NASA Procedural Requirement (NPR) is being rewritten to increase the efficiency and improve the quality of the Mishap Investigation Program (MIP). The ASAP believes that the action has several positive aspects: it is designed to improve the efficiency and quality of the process; it defines a public release/endorsement timeline; it involves a mechanism to resolve endorsements and disputes; the Federal Aviation Administration (FAA) and commercial entities are accounted for (and this will continue to evolve as time goes on).

2009-03-04

Integration of Robotics: The Panel continues to be disappointed in what it sees as a lack of integration of robotics across NASA. Most Centers have some robotic activity because they want to be "in the game". There appears to be a loss of momentum and opportunity in this area. The Agency needs to examine the benefits of developing a consolidated and integrated robotics research program to capitalize on the numerous independent programs that have been developed and more fully exploit robotics utilization throughout all missions.

Closure Rationale

NASA has now made this a focus area. There is a roadmap that is tied to projected missions and a program that is managed and resourced as an integrated entity across the Agency. There is a balance between technology push and mission pull that is resulting in robotic technology successes in operational roles, such as Mars Exploration vehicles and the Robonaut that is now onboard the ISS. Robotics technologies are proving to be sufficiently effective to do real work and safe enough to work side by side with humans. The ASAP commends the leveraging of partnerships with industry as well as with other agencies through the National Robotics Initiative and cooperation with the academic world.

2010-01-03

OSMA Analyze Changing Work and Skills Needed for the Future: NASA OSMA should take a leadership role in beginning to analyze how the SMA work is going to change and what kinds of skills are going to be needed in the future.

Closure Rationale

NASA Safety Center (NSC) has developed an SMA Leadership and cross discipline track for Safety and Mission Assurance Technical Excellence Program (STEP). Rollout by OSMA Chief to all NASA Centers was made on July 11, 2012.

2010-01-04(a)

Integration of Crew Requirements Into Design—Vibration Limits: Research should be initiated to establish and codify crew vibration limits for various phases of flight for future space vehicles.

Closure Rationale

NASA incorporated vibration safety requirements into The Standard and Human Integration Design Handbook (HIDH).

2010-01-07

Methodology for Performing Integrated Abort Risk Analysis and Development of Supporting Tools: NASA should prescribe the methodology for performing an integrated abort risk analysis and develop the supporting tools as needed so that these types of analyses are performed uniformly across the industry.

Closure Rationale

Chapter 14 of the Probabilistic Risk Assessment (PRA) Procedures Guide was released in January 2012. There is linkage to the new PRA Procedures Guide in Section 3.6 of the NPR 8705.2B and into the Commercial Crew Transportation (CCT)-REF-1121 PRA methodology document.

2010-01-08

Leading Indicators for Industrial Safety: The Marshall Space Flight Center (MSFC) SMA organization should spend some time looking at leading indicators that other industries and organizations are using.

Closure Rationale

MSFC SMA developed and implemented six new metric indicators that were approved by MSFC Safety, Health, and Environmental (SHE) Committee and the Center's Institutional Management Systems Council.

2010-02-02

Mishap Investigation Process and Plan: Each of the Center Directors should exercise leadership to make sure other Centers get mishap information. (Related to 2008-01-06 regarding mishap investigation process improvements and 2010-02-03 regarding codification of lessons learned from recent mishap reports.)

Closure Rationale

OSMA has written a 5-year strategic plan/roadmap for continuous improvement. The NPR is being rewritten to increase the efficiency and improve the quality of the Mishap Investigation Program (MIP). The ASAP believes that the action has several positive aspects: it is designed to improve the efficiency and quality of the process; it defines a public release/endorsement timeline; it involves a mechanism to resolve endorsements and disputes; the FAA and commercial entities are accounted for (and this will continue to evolve as time goes on).

2010-02-03

Taurus XL Mishap Documentation: ASAP recommends that NASA examine these eleven Orbiting Carbon Observatory (OCO) findings and determine which of them can be codified in some way that can benefit other future programs. NASA should then expand the process used to do that and integrate it into mishap investigation procedures to ensure that there is a process for sharing the results of mishap investigations and corrective actions across all programs, both NASA and commercial.

Closure Rationale

OCE looked at the three most recent Type A mishap reports including OCO, Glory, and the STS-124 Pad 39A Flame Trench Damage and found none of the recommendations in those reports lend themselves to incorporation into a new standard that would have had a likely beneficial impact.

2010-04-01

Workforce Wellness: NASA should consider the alternatives that are available within the legal and personnel system and examine the best efficiencies to encourage a regular exercise regimen among the workforce.

Closure Rationale

NASA Administrator implemented NASA 2012 Wellness Campaign where employees were given administrative leave to work out for 30 minutes three times a week for 30 days to help employees establish fitness programs.

2010-04-02(a)

Commercial Transportation Documents—Expression of Loss of Crew (LOC) Limits: NASA should publish threshold limits, objective limits, and goal limits to let commercial providers know what the ultimate number is. The goal limit should be put into the contract documents and agreements.

Closure Rationale

On December 8, 2011, NASA baselined the commercial crew requirements in document 1130, 'ISS Crew Transportation and Services Requirements Document'. Section 3.2.1.1 describes the Loss of Crew Risk and section 3.2.1.2 describes the Loss of Mission Risk. Details of these requirements were briefed to the ASAP at CY12 Qtr 1 meeting.

2010-04-03

NASA Alcohol Use and Testing Policy: The lead Headquarters organization responsible for developing the alcohol policy is requested to provide a formal briefing on the status of the policy at the ASAP's first quarterly meeting in 2011. The Office of Inspector General (OIG) should be invited to participate in the briefing. The status report should include a schedule showing a targeted completion and implementation date for the policy.

Closure Rationale

NASA has decided not to implement the recommendation and accepted the risk in this area.

2011-01-01

NASA Alcohol Use and Testing Policy: NASA should implement a post-mishap blood alcohol and drug testing program for all personnel in sensitive positions that are involved in Class A and B mishaps. That includes NASA contractors, civil servants, political appointees, and all affected visitors. This investigative tool will support key organizational learnings and is in line with many legal requirements in the various jurisdictions in which NASA operates. It should be noted that this is NOT a recommendation for a random test program. It is a test for cause after a serious mishap has occurred.

Closure Rationale

NASA has decided not to implement the recommendation and accepted the risk in this area.

2011-02-04

SMA Software Assurance: The Office of Safety and Mission Assurance (OSMA) should do an analysis on what the impact is to NASA's critical programs by not doing 100 percent IV&V for software assurance.

Closure Rationale

ASAP received a briefing during 3rd quarterly meeting on NASA's approach to IV&V for software assurance and its impact to NASA's critical programs. OSMA clarified the processes and criteria used to prioritize safety-critical software for IV&V as well as put IV&V in the overall context of software assurance.

2011-03-02

Partner Integration Team Rotation: The Panel recommends that the CCP develop a written policy specifying team rotation schedules based on tour of duty, milestones, or other appropriate criteria, to ensure a fresh set of eyes are always protecting the government's interest for the insight portion of the acquisition strategy. [NASA letter concurred however after discussion at Oct 20, 2011 meeting, Brent Jett agreed to document a policy or procedures involving current practices, e.g. TIL meetings, supervision, SME involvement, by which objectivity is assured.]

Closure Rationale

NASA has outlined policy and expectations to the PIT members including: "warning signs" list and topic at the mid-term and annual performance review, Partner Managers (and deputies) must be home based at their center (no long term co-location at partner sites), policy that the CCDev2 Partner Managers and teams will not automatically transition into similar roles for CCiCap and the engineering teams that evaluate the partners' work at major milestones is significantly larger than the PIT core team.

2012-01-01

Standardizing and Funding NASA Wellness Facilities: NASA should develop a standardized wellness program approach that ensures that all employees have an equal opportunity for access to NASA's wellness facilities. NASA should examine ways to standardize and control the level of support for the facilities to a higher degree. The ASAP encourages NASA to explore the funding streams and consider whether they should be centralized.

Closure Rationale

The NASA Mission Support Council determined that funding of NASA wellness (fitness) facilities should remain decentralized. OCHMO provided a report to the ASAP that showed the results of surveying all Centers and component facility fitness centers to determine the core operations that are currently in place Agency-wide as well as answered specific ASAP questions.

2012-01-03

Extension of Soyuz Lifetime: NASA should actively pursue with the Russians the plan to extend the Soyuz on-orbit lifetime from six months to twelve months.

Closure Rationale

NASA response and briefing received.

2012-01-04

Commercial Crew Safety Certification Process: NASA should define the safety certification process and standards, down to levels 3 and 4, as quickly as possible. NASA should provide the ASAP forthwith the schedule by which these requirements will be developed and promulgated.

Closure Rationale

Commercial Crew Program has laid out the requirements for certification in their Certification Products Contract (CPC). The certification contracts will be where the verification, validation, test, and final certification efforts are documented. The ASAP requests to see the details as the program moves forward.

2012-01-05

Maintaining NASA Pilot Proficiency: NASA should investigate the risk of reliance on its historical approach for maintaining pilot proficiency considering anticipated further budget reductions, including an assessment of the need to develop a centrally-funded flight training budget so as to ensure all NASA pilots maintain flight proficiency.

Closure Rationale

NASA passed their Level 2 Safety Management System (SMS) with no discrepancies.

2012-03-04

Revised Estimate of Loss of Crew (LOC) and Loss of Mission (LOM) for the International Space Station (ISS): Revised estimates for both LOM and LOC for ISS due to both MMOD and other causes through 2020 (based on the current configuration) should be determined and compared to the data previously supplied in this regard which predated any of the recent MMOD hardening that has been implemented on ISS.

Closure Rationale

The program has been continuing to harden the ISS structure for MMOD, including both the U.S. and Russian modules. They are now predicting a cumulative 5.1 percent chance of LOC and a 13.7 percent evacuation risk over a ten year period. This is substantially below what it was just six to twelve months ago. If there is a need for a total Station evacuation, the program would have a 180-day dwell time to determine what action to take. This adds considerable flexibility in the response time requirement and allows for deliberate planning.

Goodbye, Space Shuttle Program—it's been an incredible ride!

Aerospace Safety Advisory Panel

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