

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

June 13, 2012

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

Dear Mr. Bolden:

The Aerospace Safety Advisory Panel (ASAP) held its Second 2012 Quarterly Meeting at Marshall Space Flight Center on May 24-25, 2012. We greatly appreciate the participation and support received from the subject matter experts and support staff.

The Panel submits the enclosed Minutes from this meeting for your consideration. We do not have any formal recommendations at this time; however, we have noted several topics on which we intend to follow up throughout the year: technical authority, Commercial Crew Integrated Capability (CCiCAP) certification, and issues associated with Space Launch System (SLS)—Loss of Crew (LOC) criteria, the risk acceptance process, and Exploration Systems Development (ESD) program management at NASA Headquarters.

Sincerely,

A handwritten signature in black ink, appearing to read "J W Dyer". The signature is fluid and cursive, with the first letters of the first and last names being capitalized and prominent.

VADM Joseph W. Dyer, USN (Ret.)
Chair

Enclosure

**AEROSPACE SAFETY ADVISORY PANEL
Public Meeting
May 25, 2012
Marshall Space Flight Center
Huntsville, AL**

**2012 Second Quarterly Meeting
Report**

Aerospace Safety Advisory Panel (ASAP) Attendees

VADM (Ret.) Joseph Dyer (Chair)
Dr. James Bagian
Mr. John Frost
Dr. Donald McErlean
Dr. George Nield
Mr. Bryan O'Connor
Dr. Patricia Sanders

ASAP Staff and Support Personnel Attendees

Ms. Harmony Myers, ASAP Executive Director
Ms. Susan Burch, ASAP Administrative Officer
Ms. Paula Burnett Frankel, Technical Writer/Editor

NASA Attendees

P.W. Allen, Marshall Space Flight Center (MSFC), Safety and Mission Assurance (SMA)
Ron Cantrell, MSFC, SMA
Scott Chandler, NASA Human Exploration and Operations Mission Directorate (HEOMD)
Ken Crane, NASA Safety Center (NSC)
Kristie French, NSC
Pat Fuller, MSFC, External Relations
Arthur E. Goldman, MSFC Director
Wil Harkins, NASA Headquarters
Sherry Jennings, MSFC, SMA
Chana Johnson, MSFC, SMA
Jim Rogers, MSFC SMA
Fayssal Safie, MSFC
Jody Singer, MSFC, Space Launch Systems (SLS) Program
Rosalynne L. Strickland, MSFC, SMA
Paul Teehan, MSFC, SMA
Dena Yell, MSFC, External Relations

There were no public attendees at this meeting.

OPENING REMARKS

VADM (Ret.) Joseph Dyer called the ASAP's Second Quarterly Public Meeting of 2012 to order at 10:00 am. He introduced the two new ASAP members who were present: Dr. Patricia Sanders, who comes with a long and distinguished technical career in the Department of Defense (DoD), including ten years with the Missile Defense Agency, and is a subject matter expert in test and evaluation; and Mr. Bryan O'Connor, formerly the Chief of NASA's Office of Safety and Mission Assurance and the subject matter expert in NASA safety. Absent from this meeting were the other two new members: Capt. Robert Conway, Chief Operating Officer at the School of Aviation Safety; and the Hon. Claude Bolton, retired Air Force General and former senior acquisition authority for the U.S. Army. The other Panel members were introduced as VADM Dyer proceeded through the agenda.

VADM Dyer commented that it was a pleasure to be at MSFC. The Panel has great respect for the Center and the workforce here, and the progress with the Space Launch System (SLS) is but one example of why that respect is well placed.

VADM Dyer noted that the ASAP recognized the successful launch of the SpaceX Dragon capsule and its rendezvous with the International Space Station (ISS) today, and he conveyed the Panel's compliments to both SpaceX and NASA for achievement of this important milestone. Progress in other areas includes significant advancements in the management of the Commercial Crew and Cargo Program. Important aspects that have been discussed by this Panel are showing progress: cost estimation, budgeting, and planning; advancement in success criteria and certification; and development of acquisition options. There are still some anxieties associated with commercial crew—how to move forward both expeditiously and safely and how to certify for human spaceflight.

Technical authority is a renewed topic. It has been one in which this Panel has invested much discussion and has made recommendations in the past. In the Columbia Accident Investigation Board (CAIB) report and Space Shuttle return to flight, proper implementation of technical authority in its prior embodiment has been an important part of safety progress. For years, NASA made a distinction between projects and programs when it came to the technical authority of the Center Director. In the discussion of the MSFC-hosted SLS program, there appeared to be some changes afoot; the ASAP does not fully understand them yet, but is dedicated to doing so.

SLS and Multi-Purpose Crew Vehicle (MPCV)

Mr. John Frost discussed the update the Panel received from Mr. Daniel Dumbacher, Deputy Associate Administrator for Exploration Systems, the previous day. The Exploration Systems Development (ESD) Program, which includes SLS, MPCV, and ground systems, is very important to NASA, just as Constellation was. The state of the art in the Agency is advanced on the shoulders of the highly funded, highly motivated, and highly action-oriented programs such as ESD. The ASAP will follow the ESD Program very closely over the years to come. Mr. Frost observed that the program has made considerable progress; he summarized some of the accomplishments: Orion has completed acoustic and vibration testing; computer data flow has been exercised; and parachutes have been tested. First flight, using a Delta IV launcher, will occur in 2014. There have been many success stories and much activity. SLS uses the Space Shuttle Main Engines (SSMEs) for the first stage, and the program has moved forward there also. The SLS core will be the most interesting part of the system. Many new systems are being developed, and they will require the most attention. Ground systems are also making good progress. The launch complex at Kennedy Space Center (KSC) is coming along nicely, and the mobile launcher is being modified.

Several areas warranted the Panel's discussion. First is the EM-1 flight, currently planned as an uncrewed flight to validate the integrated system in flight. The ASAP has discussed the importance of such uncrewed flight to buy down risk and understand the integrated system's performance in the real environment. Mr. Frost noted that, for technical reasons, NASA did not do an uncrewed flight on the Shuttle Program. NASA believed the Shuttle crew on the first flight represented substantial risk mitigation for the extended communications blackout during high-risk, hypersonic entry; however, NASA will probably not have a similar risk trade with ESD. One issue that came up for discussion is what needs to be demonstrated on EM-1. The ASAP believes that it is important to demonstrate performance as much as practical, including Environmental Control and Life Support Systems (ECLSS). The more critical systems the test can exercise, the more confidence it will give the Agency to fly the first crewed test flight. The ASAP encouraged NASA to complete the plan as early as possible and maximize the fidelity of the flight system for the first full-up test. The ASAP was also concerned that NASA carefully weigh the utility of maintaining the schedule for the completion of the EM-1 flight if doing so adversely impacts the risk on the proposed 2021 (EM-2) crewed flight. Taking the time to do EM-1 right will maximize the safety of the crewed flight. The Panel requested future briefings on the requirements surrounding the EM-1 flight and the trade-offs related to schedule and future risk to the 2021 flight. The second topic was the probability of Loss of Crew (LOC) threshold requirement, which has been particularly important to the Panel. The number is a primary driver to the safety of the design and works hand in hand with other drivers, such as levels of redundancy, reliability, and hazard controls. The Panel is finding that NASA is proceeding on SLS with great alacrity, and decisions have already been made on architecture and other issues; however, the program has not yet established the final requirements for mission LOC. Ideally, on a large system such as this, one would try to establish requirements before starting the trade space decisions. The ASAP encourages getting those requirements established as soon as possible so as to inform subsequent design and operational trades. There are efforts underway to do that, and the Panel advises that it be accomplished sooner rather than later. For low Earth orbit (LEO), the Agency has criteria for LOC, both initial and eventual target, but the capabilities and requirements for SLS are still being established. Because of higher re-entry velocity (e.g., in a lunar-type mission), more risk will be involved than with re-entry from LEO. It is important to factor in the environment and the architecture "givens" (solid rocket boosters, SSMEs, Orion, etc.) to provide the designers with appropriate guidance. Lastly, the ASAP noted the management of the ESD Program at NASA Headquarters, which is not what we are used to seeing for human spaceflight. Given the integration lessons-learned from previous complex DoD and NASA program successes and failures, the Panel would appreciate further

discussion on the ESD management plan, including systems integration, systems safety, and risk management, at the next quarterly meeting.

Commercial Crew

VADM Dyer reviewed the Panel's discussions with the Director of Commercial Space Flight Development, Mr. Phillip McAlister, and the Program Manager, Mr. Edward Mango. He acknowledged the hard work done by that team. The stated goal of the Commercial Crew Program (CCP) is to facilitate the development of U.S. commercial crew space transportation capability with the goal of achieving safe, reliable, and cost effective access to and from LEO and the ISS. This has been a recent topic in the press. At the last quarterly meeting, the Panel referred to a "sea change" in the goal. NASA has pointed out that this has been a long-stated goal, but the ASAP has noted that there has been a sea change driven primarily by budget. Early on, the emphasis was transportation to ISS, with facilitation of the commercial space industry as a secondary goal. At the last quarterly meeting, that order was reversed, although both are Program goals and both continue. The next phase of the Program, Commercial Crew Integrated Capability (CCiCAP), has the following strategic goals: to advance multiple integrated crew transport systems into orbit by mid-decade; to garner commercial provider investment; and to affordably develop cost effective access to LEO. With those goals in place, the following progress is noted: SpaceX, in addition to the success this morning, has received \$381 million (M) out of \$396 M; before the events today, they had achieved 37 out of 40 milestones. Orbital Sciences has completed 24 out of 29 milestones and has received \$266.5 M out of \$288 M. Orbital Sciences flight test hardware is currently at Wallops Flight Facility, and the date for the maiden flight is under review for the near future. In addition, the Commercial Crew Development Phase 2 (CCDev2) has the following players and NASA investments: Blue Origin--\$11.2 M out of \$22 M; The Boeing Corporation--\$85 M out of a funding cap of \$112.9 M; Sierra Nevada Corporation--\$68.8 M out of \$105.6 M; and SpaceX--\$55 M out of \$75 M.

The CCiCap is divided into two periods. The base period is 21 months, beginning in August 2012, and extending through May 2014. Multiple awards are planned, with an expected range from \$300 M to \$500 M per award. NASA, challenged financially, is asking providers to develop two profiles: an optimal, most efficient profile; and a profile based on a fixed funding amount of \$400 M per year, reflecting another set of constraints and a less efficient funding plan. The CCiCap extends through FY 2014; at that point, there are decisions to make. One option forward is a more classic plan, which is to transition from Space Act Agreement to a classic Federal Acquisition Regulation (FAR)-based requirement with a NASA certification program, the completion of which would enable missions with NASA and NASA-sponsored crew members. Another option is being discussed: at the end of the CCiCap base period, the potential commercial providers would continue to perform optional milestones that would include an industry program for validating that requirements have been met and might even include company test pilots flying on crewed test flights. The Panel's interest was piqued at this juncture. The ASAP strongly believes that NASA certification must be accomplished before the transport of NASA astronauts. Could it proceed concurrently with a partner validation? Perhaps, although funding limitations have been recognized. While either approach is potentially successful, the ASAP believes that NASA certification is a requirement and is on record as stating that a FAR-based requirements contract is the better way to proceed. The ASAP cautions against an option that would detract from, or in the minds of some, negate the necessity for a full NASA certification.

Mr. Frost amplified on VADM Dyer's comments. He noted that we all want success in the upcoming commercial flights. Interestingly, success could create friction. If the commercial partners have a number of successes and fly commercial crew successfully, some who don't understand the process might think that there would be no need for NASA insight and certification. It is important that NASA lay out the requirements early, and that they be tailored as appropriate for each company and design concept so as to be firm and clear and not subject to debate later in development. The plan for how NASA will certify is expected in September 2012, with final approval in October. Mr. Frost strongly encouraged NASA to keep that schedule firm and get the plan approved. NASA should avoid the illusion of no need for certification because of a few early successes. Certain flight successes can play an important role in developing confidence in the design, but should not negate the need for a formal certification by the government. VADM Dyer added that deciding prescriptively how to do this will be more rational than crowding it into a near-term decision where other factors come to bear. In other words, "plan the flight and fly the plan."

Mr. Bryan O'Connor commented that certification has three fundamental pieces: validating the requirements, verifying compliance with those requirements, and validating the full-up system design in flight. This is how the NASA policy on certification is laid out. When the Panel heard that there are some potential optional approaches, i.e., industry led requirements validation, it leads us to wonder how that applies to the NASA requirement for certification. Is there an "equivalence" that will be done? What about safety requirements tailoring, exceptions and waivers, accepted risk hazards, critical item approval, etc.? How does NASA plan to accept associated residual risks? The Panel has many questions. It would be easier if NASA had done this before, but they have not. Shuttle is the only Earth-to-orbit system that NASA has certified past Preliminary Design Review

(PDR) for many years. There will probably be a lot of give and take on requirements during acquisition. The ASAP will be following closely and asking questions as time goes on.

Mr. Frost noted an “attaboy” to MSFC related to Dragon’s success. Dragon was launched on a Falcon 9 rocket, which is powered by nine Merlin engines. The ASAP learned today that those engines have a heritage traceable to the MSFC Fastrac engine design.

Safety Metrics

Dr. Jim Bagian discussed the update on safety metrics that was presented by Mr. Alan Phillips, Director of the NASA Safety Center (NSC). Comparing the first quarter this year with the same period last year, there has been a substantial improvement in the metrics—15 percent fewer injury/illness mishaps and 53 percent fewer damage mishaps. Comparing NASA with all federal agencies, NASA’s rate is one-sixth to one-eighth that of the federal government in general. Lost time rate is very low. Motor Vehicle Operations lead the list of damage mishaps, although the incidence rate is low, e.g., thirteen NASA-wide. The NSC will continue to look at this and see how to intervene to further reduce the rate. NASA continues to improve the manner and speed of the mishap investigations, but the timeliness of the concurrence process has room for further improvement.

Mr. Frost added that he was happy to see that the rates have come down every year for the last five—this is a great trend. The NSC is now briefing all of these metrics to NASA’s Associate Administrator, Mr. Robert Lightfoot, whose background at MSFC includes the zero-incident approach.

MSFC Engineering Technical Capabilities and Support to Commercial Space Industry

Mr. Bryan O’Connor reviewed ASAP’s discussion with Mr. Christopher Singer, MSFC Engineering Director, who talked about MSFC’s core products, cross-cutting laboratories (one of which was toured by the ASAP earlier in the day), engineering disciplines, and science capabilities. MSFC continues to work with the resident programs and projects in a matrix manner (a traditional approach), with appropriate checks and balances. Mr. Singer discussed the current environment after the down-sizing and the transition to more commercial partnerships—currently, there are about 200 agreements in place. There is an emphasis on affordability, and they are examining ways to streamline and use more modern approaches to getting the work done. During all of this, they are working to minimize risk. Mr. Singer discussed the culture and how MSFC is changing from an operational focus to earlier development/design work where innovation and risk tolerance are key aspects. The work with the commercial partners is raising a few questions because there seem to be various interpretations, both by the partners and the government, on how things should work. This is natural; the team is asking the right questions and working with the right attitude as they make these transitions.

MSFC SMA Status

Dr. George Nield reviewed the discussions with Mr. Stephen Cash, MSFC SMA Director, on SMA status. MSFC has changed the basic safety review process in the SLS program. There is no longer a Safety Review Panel, but instead MSFC uses Safety Assessment Teams—a more efficient yet more effective review process. Mr. Cash mentioned changes in the size of the work force. They have lost 35 percent contractor and civil service over the last couple of years. There were some interesting discussions about reporting chains and the level of senior technical authority on various programs, and they discussed what is known as “closely-coupled” programs and “non-closely-coupled” programs. Today, there are no new center-hosted, closely-coupled human spaceflight programs (such as Shuttle and Station have been in the past), and the Center Director is now the senior technical authority for the programs at MSFC. The Panel is particularly interested in this because of its possible impact on openness and the route that the workforce has to bring forward safety issues and concerns. The ASAP will continue to watch this to ensure that we understand how it is operating in the new environment. MSFC continues to work on safety culture, which has always been world-class. They have adopted an injury/incident-free philosophy that is very challenging and sounds exciting. They would like to have everyone at MSFC take a four-hour discussion group program. The goal is for 95 percent of the civil servants and 75 percent of the contractor workforce to complete participation in a discussion group program by the end of the year.

Starting in FY12, MSFC plans to use the focus group approach to assess employee satisfaction rather than surveys, which have been used in the past. They want to maintain discipline expertise, and 100 percent of the workforce has completed the Safety and Mission Assurance Technical Excellence Program (STEP) Level 1, which is impressive. They have also identified several challenges: budget, manpower, and maintaining the right balance between rigor and affordability, especially for SLS.

Mr. Frost noted that on the question of technical authority (a primary ASAP subject for a number of years), it is important for the ASAP to understand any changes. He suggested putting this on the agenda for a future meeting. VADM Dyer agreed.

SLS Safety Review Process and In-Line Assessment

Dr. Donald McErlean stated that Mr. Paul Teehan from the SLS SMA Program Office provided the ASAP with two very good briefings on the SLS safety review process and In-Line Assessment (ILA). Mr. Teehan demonstrated excellent knowledge on the process and the changes. A review of the safety review process was conducted to see what changes could be made from the Shuttle era process to the current SLS process. Discussions among the SMA personnel, the SLS Program personnel, and the contractor personnel resulted in some streamlining and the elimination of the Marshall Safety and Engineering Review Panel (MSERP) that, to all intents and purposes, appeared to be redundant. They have removed that particular review process and, for integration level risk documents, are utilizing an SMA Assessment Team (SAT) process; element level tasks are now performed by the element SMA team. Integration risk assessments move from the element review directly to the program review without the intervening step of the MSERP. It appears to be a more streamlined process. They are "beta testing" this new approach and preliminary indications are that the new safety review process will enhance efforts, be more efficient, and not require the assignment of permanent staff to the MSERP because the SAT will simply call upon the necessary subject matter experts depending on the topic. They have gone through various process reviews and have not discovered that the new approach produces any gaps, but will continue to monitor this process and adjust it as necessary.

The ASAP had an adjacent discussion on whether this had changed the level of acceptance for particular risks. It was stated that the process change does not in itself drive changes in the level of risk acceptance; however the SLS Program stated that recommendations for some changes in risk acceptance level have been made, but they have yet not been finalized or approved. The Panel will be interested in whether any of the acceptance levels change for a given level of risk, and if so, would like to be given the chance to comment on such changes before they are approved. That discussion, however, was not really germane to the subject presented, which was about more efficient processing.

The next discussion concerned the Government Mandatory Inspection Points (GMIPs) and In-Line Assessments (ILAs). GMIPs are what industry identifies as "call-out" inspections—after a process is performed or a parameter is inserted into a production process, and the contractor has performed an inspection, the government oversight person validates that the work was done correctly. In effect, the oversight inspector provides a second inspection of the parameter in question. It was noted that the Space Shuttle Program had a high reliance on GMIPs—thousands of them—causing a great deal of redundant work and a high demand on quality personnel. In review of this process, there was an expressed concern by all parties that this over-reliance on GMIPs may not be providing the requisite increase in the level of quality that their expense entailed. Because of this concern, a risk based analysis (RBA)—in terms of looking at all the GMIPs—has been initiated, and the ASAP applauds NASA for this approach. So far, they have shown excellent success. In their approach they have utilized not only themselves, but the support contractor and the Defense Contract Management Agency (DCMA) personnel in putting this process together. All three parties are pleased with the fact that, in the example processes so far, they have demonstrated an equivalent level of process assurance and quality while reducing the number of GMIPs that must be employed.

The other process that they are beginning to employ is called ILA, which is a Statistical Process Control (SPC)-type approach where one may start out inspecting a parameter at 100 percent, and then based on whether that parameter ever shows any difference between the contractor inspector and the government inspector, moving to a sampling process, and then gradually extending the number of times that particular element is required to be inspected by both the contractor and the government. In an SPC approach, one tracks that metric and if it goes off track, there are more inspections; if it continues to show control, one can reduce the number of inspections. This is an excellent approach and very innovative when there are enough data points (not always possible for low production rates). All of the beta-testing so far has shown an opportunity to greatly reduce the number of GMIPs while sustaining the quality. It looks very promising and the ASAP applauds MSFC for the innovation.

Closing Thoughts

Mr. Frost added some thoughts on system safety. The process of system safety is really based on managing hazards. There are three primary elements in doing this: first, finding or identifying the potential hazards; second, managing those (the hazard review process that was described by MSFC); and third (the most powerful piece), the formal acceptance process, where an individual puts his name on the line and says that the options have been considered and the residual risk is worth taking. The third element adds power to the other two elements. Mr. Frost noted that, as Dr. McErlean had indicated in the prior discussion, the risk acceptance process was not part of the briefing on the safety risk review process; however, the formalization of the risk acceptance process for SLS and ESD is being formulated, and it would be very useful for the Panel to see it, perhaps at the draft stage. He asked that the Panel follow up on this. Dr. McErlean agreed that if there is a proposed change to risk acceptance level (relative to that used for the Space Shuttle and ISS), the ASAP would like to see it before the decision is made so that the Panel can make input to the leadership.

VADM Dyer commented that one topic that hadn't been discussed here—but should be—is a topic that was discussed with regard to Ares, Commercial Crew, and ESD: the LOC probabilities. Is it—and should it be—an input function or an output function?

Dr. Jim Bagian commented that obviously, it is an iterative process. One of the biggest concerns is if there is a lack of clarity among all those parties participating on what the major driver (schedule, resources, and performance) is, and if none are fixed, it is hard to know what the priorities are or should be. The Panel has heard over the past days that architecture decisions were made, and it is not clear what priority was assigned to the impact on safety. It is possible that NASA believed that it was heavily constrained by schedule or funding and hence was forced to consider compromise on system designs. While these trades are recognized as a necessary reality, it was not apparent whether that discussion was always clear in identifying the alternatives and at what level the decision was finally approved. If the alternatives are not clearly set out for a decision, we could start down a road that was not intended based on assumptions that may not be valid—for example, a schedule that, while it is desirable, may, in fact, not be a requirement. The iteration around critical choices should be an open process where everyone clearly understands all the aspects and impacts of the decision. Then, if the LOC requirement changes, we are not simply moving the requirement to meet constraints that were assumed to be in force rather than really in force.

With regard to the iterative process, Mr. Frost added that ideally one would like to have requirements before the system is designed, but one doesn't want to set requirements that cannot be met. We have an architecture now; it is very important to set clear, firm requirements as early as possible to guide future decisions on safety factors, reliability, and redundancy. Each designer needs to know what to expect from the Agency. It is a hard question, but the Agency is up to the challenge of establishing a good requirement. NASA may find in a year or two that the number may have to be adjusted, as was done on Constellation, but we need a target, and the target needs to be a reasonably challenging one.

Dr. Nield commented that along those lines, the ASAP was told that by the first of the year, NASA may be able to identify the LOC for the design for the in-space phase of the EM-2 lunar orbit test mission. Dr. Nield proposed that the ASAP request a briefing on this when it is completed. That will allow the LOC for the integrated design for the entire missions to be shared.

VADM Dyer likewise supported the goal/threshold approach to LOC. He noted that Mr. O'Connor was one of the stakeholders in developing this. The Panel was pleased to see that NASA has settled on the 5x5 risk matrix as a way of reporting risk. A standard way of embracing the LOC topic would be helpful to the Panel and, more importantly, a step in the direction of better communication and clarity. VADM Dyer offered this as a good idea and indicated that the Panel may propose a recommendation on this topic in the future.

VADM Dyer asked Dr. Sanders (who was not given a specific presentation assignment at this meeting) for her comments. She reiterated the need to clearly understand the trade-offs as programmatic decisions are made. Especially when performance trades are made due to budget and schedule constraints in managing the program, it is important to be explicit about the decisions made, to understand the impact of the trade off and why it was made, and then to revisit it periodically to confirm the validity of the decision.

VADM Dyer thanked MSFC for hosting the ASAP meeting and the Panel members for their attendance and participation. He adjourned the meeting at 10:55 am.