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

July 29, 2011

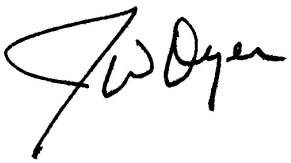
Mr. Charles F. Bolden, Jr.
Administrator
National Aeronautics and Space Administration
Washington, DC 20546

Dear Mr. Bolden:

The Aerospace Safety Advisory Panel (ASAP) held its Third 2011 Quarterly Meeting at Goddard Space Flight Center on July 14-15, 2011. We greatly appreciate the participation and support received from the subject matter experts and support staff.

The Panel submits the enclosed Recommendations with Minutes resulting from this meeting for your consideration.

Sincerely,



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

Enclosure

ASAP RECOMMENDATIONS, THIRD QUARTER 2011

2011-03-01 Abort Effectiveness Requirement

Finding: In addition to top level Loss of Crew (LOC) probability, the current commercial crew safety requirements include a specific requirement for an abort system with a specified effectiveness. During discussions with the Commercial Crew office, it was revealed that consideration was being given to deleting the abort effectiveness requirement and relying on the top level LOC probability calculations to drive whatever abort effectiveness is required to meet the 1/1000 ascent LOC requirement.

Recommendation: The Panel recommends that requirements for abort system effectiveness be retained as a safety requirement.

Rationale: While theoretically, LOC probability calculations will include abort effectiveness contributions, the failure to specify an abort effectiveness minimum requirement could allow utilization of an ineffective abort system if high levels of booster reliability are predicted by Probabilistic Risk Assessment (PRA) analyses. Unfortunately, PRAs cannot include consideration for unknown or unpredicted failure modes. An abort system is the "last line of defense" against such failure. There is little benefit to even requiring an abort system if its minimum effectiveness is not specified.

2011-03-02 Partner Integration Team (PIT) Rotation

Finding: The Commercial Crew Program (CCP) will utilize embedded PIT members to closely follow and guide commercial partner design processes to help ensure that their result meets NASA expectations and requirements. The Panel recognizes the importance of this method of obtaining insight and encourages it. However, caution must be exercised to prevent these government representatives from psychologically and culturally becoming part of the partner's team mentality, or "going native."

Recommendation: 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.

Rationale: History has shown that buyer representatives embedded with supplier development teams are subject to "bending the rules" to aid the development team that they begin to feel part of. Preplanned rotation is one means of minimizing this effect.

2011-03-03 Responsibility, Authority, and Accountability for System Requirement Approval and Design Risk Acceptance

Finding: NASA's CCP provided an update at the ASAP's 3rd Quarterly Meeting at the Goddard Space Flight Center on 14 July 2011. Discussion among the Chief, Office of Safety and Mission Assurance, the CCP Manager, and the ASAP highlighted apparent uncertainty regarding how risk trades and risk acceptance will be managed within the CCP.

Recommendation: NASA's Chief of the Office of Safety and Mission Assurance, Chief Engineer, and Associate Administrator for the Exploration Systems Mission Directorate should clarify who has responsibility, authority, and accountability to approve system requirements and accept design risk associated with the CCP program.

Rationale: Work over the last four years has clarified the roles of program managers, technical authority, and NASA executives in accepting risk for classic NASA programs. The NASA-commercial relationship is more complex and clouded by the desire to afford greater freedom to commercial producers.

AEROSPACE SAFETY ADVISORY PANEL
Public Meeting
July 15, 2011
Goddard Space Flight Center
Greenbelt, MD

2011 Third Quarterly Report
Minutes

Aerospace Safety Advisory Panel (ASAP) Members Present
VADM (Ret.) Joseph Dyer (Chair)
Ms. Joyce McDevitt, P.E.
Dr. James Bagian
Ms. Deborah Grubbe, P.E.
Mr. John Frost

ASAP Staff and Support Personnel Present
Ms. Katherine Dakon, ASAP Executive Director
Ms. Susan Burch, ASAP Administrative Officer
Ms. Paula Burnett Frankel, Reports Editor

Attendees, Public Session
Patrick Hancock, GSFC
William Bihner, NASA HQ
Scott Spencer, consultant (via telecom)

VADM (Ret.) Joseph W. Dyer, ASAP Chair, called the ASAP's First Quarterly Public Meeting of 2011 to order at 10:15 a.m.

Public Comment
Upon prior request, Mr. Scott Spencer, Transportation Management Consultant and co-author of an open letter to the NASA Administrator, connected to the meeting via telecom (due to unforeseen traffic delays en route), and was granted the floor to make a public comment at the beginning of the meeting. He noted that the letter was co-authored by Christopher Kraft, former Director of NASA's Johnson Space Center, and was endorsed by the following: Space Shuttle astronauts Robert Crippen and Frederick Hauck; Apollo astronauts Neil Armstrong, James Lovell, and Eugene Cernan; the former Director of Mission Operations and Flight Director, Gene Krantz; and other space industry experts. Copies had been provided to ASAP members prior to the meeting. His verbal statement paralleled the letter's content, which expressed concerns with the Space Shuttle fleet's retirement from service vis-à-vis International Space Station (ISS) operations. Specifically, the authors and endorsers of the letter cited the following issues: the inability to make repair spacewalks to restore safe and reliable operations if an incident rendered the ISS uninhabitable; and an uncontrolled, catastrophic reentry (with risks to populated areas around the world and the attendant ramifications to foreign relations) from an abandoned ISS. Mr. Spencer stated that the Space Shuttle fleet is the only spacecraft now operating or under development that is equipped with the airlocks, life support supplies, and robotic arm needed to support the required two-person spacewalking repair crew. He noted that the letter's authors and endorsers also believe that the loss of the ISS would destroy the commercial viability of commercial cargo and crew, which is essential for the U.S. return to manned spaceflight if the Shuttles are retired. Keeping the Space Shuttles in service would maintain vital backup contingency for possible risks to U.S. manned spaceflight and the ISS business for the emerging commercial space industry. In addition, the letter recommended establishing a new, internationally accepted flight safety criterion: Any object in orbit that is too large for an uncontrolled reentry must have a spacecraft available to support independent extravehicular activity (EVA) repairs. With regard to costs associated with the Shuttle fleet, he contended that use of private capital would make it financially and technically feasible to reverse the retirement of the Shuttles and restore U.S. manned spaceflight capabilities in as little as 18 months.

Mr. Spencer requested that the ASAP issue an immediate recommendation for NASA, Congress, and the White House to reverse the decision to retire the Space Shuttles. Mr. Spencer thanked the Panel for its time and indicated he would be happy to answer questions.

VADM Dyer provided Mr. Spencer with some feedback. In the Panel's opinion, there was a time for this debate, but it has passed. In the latter part of the last decade, the ASAP highlighted in its reports to both Congress and the NASA Administrator that if the Shuttle's continuation beyond the planned retirement was to be discussed, the subject needed to be taken up at that time--not only because of knowledge loss, but especially for the second and third tier suppliers of piece parts and critical components, which have now been out of business--well over three years in many cases. VADM Dyer noted that the Panel understood Mr. Spencer's message and what he highlighted, but in the Panel's opinion, the time has passed for implementing Shuttle's continuation.

Mr. Spencer stated that that issue was addressed before the letter was written and endorsed, and it was confirmed that the ability to reconstitute and return Shuttle to flight could be accomplished safely and successfully in about 18 months. That would be a faster return-to-flight than what is anticipated for commercial alternatives. He agreed that there would be a delay, but opined that it would not be technically insurmountable.

VADM Dyer asked about his thoughts with regard to the safety risks associated with the reconstitution of Shuttle operations at this point in time. Mr. Spencer noted that the Shuttle's ability to continue to fly safely is not without risk. However, in his opinion, the safety of the subsequent spacecraft will not be determined until they pass a 100-flight threshold themselves. In terms of relative risk, tradeoffs would have to be accepted. He felt that the potentially uncontrolled ISS reentry threat to populated areas around the world is an unacceptable risk. Even if the ISS remains safely in orbit after being abandoned, the hearing and review boards that would result would criticize NASA's decision to leave the ISS without any way of being restored. Mr. Spencer opined that neither the Soyuz nor any of the commercial vehicles on the drawing boards would ever have that capability.

In response to a question from VADM Dyer, Mr. Spencer agreed with the Panel's long-standing position that the Shuttle needs to be replaced; however, he stated that at a minimum, the Shuttles should fly until there is a proven and independent EVA repair capability in place by another spacecraft. This is a clear and present safety problem that was not discussed or considered with the ISS partners and could put the U.S. in a very difficult position if a backup capability is actually needed. Mr. Spencer noted that this is why the call is coming at this time. He felt that no one specifically discussed this before Congress or the ISS partners. The ISS was designed and built to be operated, maintained, and de-orbited with the support of the Shuttle's capability.

VADM Dyer indicated that the ASAP has had some opportunity to look at the de-orbit issue, which the Panel highlighted in prior reports. He asked Mr. Spencer to provide his insight with regard to the following trade: How would you make the trade between being able to reconstitute the Shuttle, at a considerable expense, to keep an older system operating if that takes the funds needed to design, develop, and deploy the new system? Mr. Spencer replied that plans for commercial operation of Space Shuttles have been proposed, but they were never presented to Congress. One aspect is the use of private capital and revenue from countries that would want to have space-faring capabilities, which would ultimately neutralize the additional budget that would be required to fly the Shuttles. Interest is already being expressed from capital sources who say that with a 20- to 30-year flight service agreement, a significant amount of private capital could be funded to reconstitute the Shuttle program and its operations and minimize the impact on the NASA budget. When safety is at stake, cost is a lower issue to consider in the criteria.

In response to a question from VADM Dyer on what he estimated it would cost to reconstitute the Shuttle and what the revenue projections would be, Mr. Spencer indicated that he was not knowledgeable about that specifically. United Space Alliance (USA) was looking at about $1.5B per year for at least two Shuttle flights per year, as well as a Shuttle being available for launch-on-need capability. At least $500M would be required up front to restart the parts and tanking line. Private capital could put these funds into place to

supplement NASA's efforts. Mr. Spencer could not say specifically what return-on-investment rate would be required for investors; however, in the discussions that USA had, they were satisfied with the business case. The U.S. return-to-flight depends on the success of commercial operators, and the Shuttle is very complementary to them. If the ISS is disabled, that would destroy the business case that is the key for the U.S. return-to-flight for commercial vehicles.

In response to a question, Mr. Spencer indicated that he was aware of the USA proposal, although USA was not a party to the letter. USA offered the idea on a proposal to CCDev2. *Aviation Week* also wrote about it.

VADM Dyer thanked Mr. Spencer for his comments and indicated that the ASAP noted his recommendations. Mr. Spencer disconnected from the telecom.

Mr. John Frost observed that based upon reports from and discussions with NASA, if the ISS is in control, it can be reboosted without the Shuttle; however, if it is out of control, even the Shuttle would not be able to solve the problem. VADM Dyer suggested that the ASAP consider creating a recommendation on ISS de-orbit. He encouraged Mr. Bill Gerstenmeier, Associate Administrator for the Space Operations Management Directorate, to investigate ways to mitigate potential de-orbit scenarios.

At this time, VADM Dyer proceeded with the public meeting agenda items.

WELCOME/OPENING REMARKS

VADM Dyer thanked the Goddard Space Flight Center (GSFC) Director, Mr. Rob Strain, for hosting the ASAP meeting. GSFC is intimate with America's history in space—it was NASA's first Center and has had some 300 successful missions. There are 9400 civil servants and contractors working at the Center. It is well known for its work with the Hubble Space Telescope, sample analysis, and its engagement with NOAA in providing infrastructure support for weather observations. A major new program includes the James Webb Space Telescope (JWST). The annual budget runs about $3.6B plus $700M reimbursable from NOAA, Air Force, and others. A quote from Dr. Robert Goddard (1882 – 1945), publicly displayed at the Center, is worth noting*: "It is difficult to say what is impossible, for the dream of yesterday is the hope of today and the reality of tomorrow."*

This meeting's fact-finding agenda included an update on Soyuz, extensive discussion on the Commercial Crew Program (CCP), safety metrics, GSFC as a learning organization and their efforts in knowledge management, the safety program, and a very accomplished Constellation Lessons Learned Program.

VADM Dyer briefly highlighted the "big rocks" of the third quarterly meeting, some of which have been noted before. There is still tremendous uncertainty associated with the CCP cost estimate. The range extends from $1B to $10B, and the estimate's fidelity continues to be less than satisfying. The budget is the "elephant in the room." The budget to sustain at least two competitors, operating under fixed-price contracts, into design and development looks to be exceedingly challenging. There is an issue with risk acceptance. Over the last four years, the work on classic NASA programs has clearly articulated the responsibility, authority, and accountability for risk trades and requirements approvals, but that has become clouded as we move into the commercial space era. The ASAP will recommend that some work be done on clarifying that and promulgating where risk will be accepted. There continues to be an issue, often highlighted by the Panel, that "the cart is before the horse" in terms of requirements vis-à-vis the progress that commercial partners are making on design. In other words, design is outpacing a clear articulation on what is needed and how safe it needs to be.

SOYUZ UPDATE

VADM Dyer briefly reviewed the discussions on Soyuz. Soyuz is operating with acceptable risk. It is a very robust system, long in service, and is robustly overdesigned. A number of issues that have been topical over the last few months are what in aviation we would call "gripes," i.e., there are maintenance items that need to be worked. The one exception concerns an upgrade to digital systems, but there are redundancies and work-arounds. These are being watched carefully. At this time, the Panel finds no critical or significant issues.

COMMERCIAL CREW UPDATE

Dr. Jim Bagian reported on the discussions with Mr. Ed Mango, Commercial Crew Program Manager, and Mr. Phil McAlister, Special Assistant to the Associate Administrator. He noted that VADM Dyer had already highlighted most of the points, and that he would amplify on some of them. The Panel received a very good briefing from Mr. Mango. They continue to move forward with how they are going to manage through CCDev 2, which is where they are now, to go to the third stage, which will be certification and integration one year from now. There are several issues. They will have a two-board structure to manage this—a Technical Review Board and a Program Control Board. Most of the actual, detailed activities will be handled by the commercial partners themselves. NASA will perform oversight at a high level, consistent with the more "hands-off" commercial approach that is being taken; however, it does raise concerns with the ability to have adequate insight to provide appropriate oversight. To this end, they are putting in place Partner Integration Teams (PITs) that will have the technical ability to work side by side with the various partners to understand what is going on. This raises some challenges. Will they have adequate insight to get what they need? Specific requirements for how they will get information have not yet been developed. The standards for certification are still only 80 percent complete. For three years, the ASAP has been stressing the need to have documentation that specifies how safe is safe, what the certification requirements will be, how they will be verified, as well as give NASA a robust way to evaluate whether or not the requirements are being met. With those elements not being complete, especially at this advanced point in the program, it is virtually impossible for the partners to be reasonably confident that they will satisfy standards that are not yet official and for NASA to develop a mechanism to monitor that which they have yet to explicitly define. This is a longstanding problem. The PIT raises other issues—the ability to have the granular insight into what is going on is vital; however if the PIT is constantly working with a given partner, over time there is a tendency to "go native" and inadvertently be less objective since they will be less likely to see issues with "fresh eyes". What is the plan to mitigate this risk? When the Panel raised the question on whether there is a plan or a formal way to rotate the PIT members, Mr. Mango indicated that he has a very large budget for travel, which would enable PIT members to go back and forth, and he indicated that at this time there is no formal mechanism by which that would be achieved. This is a concern to ASAP. There should be a formal plan, so that everyone knows explicitly how PIT members will be rotated to maximize the PIT's objectivity.

The safety certification process requirements are still draft. This is a problem that makes the Program increasingly challenging as time goes by. Along the way, if NASA finds that the partner is unable to meet certain standards, how would that be handled? Mr. Mango alluded that there were several mechanisms, one of which would be adding funding. The Program is already concerned about not having enough funds for the effort. Would they be forced into making decisions that compromise performance and/or safety? The longer the requirements are not solidified, the higher the risk becomes, and NASA may find itself pushed into a corner where pressures may be brought to bear that can compromise safety and performance. This is a risk to the Program, and relates to the huge variance in cost estimates ($1B to $10B). Although NASA's share of the costs is estimated at $2B to $4 B, the Program office is not even sure about that number. This lack of certainty in requirements and the mechanisms by which certification will be obtained looms large in determining how the Program will ultimately fare.

Mr. Frost noted that in this area, the ASAP has had a number of concerns. (1) The importance of adequate budget. There are two ways one can buy a large system like this--clear requirements up front with a relatively precise budget; or, lacking that, good reserves to handle issues in the event the design does not meet what is really wanted. Today, we are in the environment of "I'll know safe enough when I see it," which will leave NASA in a posture possibly requiring large management reserves. In a budget-constrained environment, if there are not sufficient reserves, NASA will be in a position where it may have to accept more risk. (2) The safety requirements include a LOC probability number and a number of specific safety requirements that, regardless of the LOC calculations, NASA wants, such as certain safety factors on structure, guidance on redundancy, and a launch abort system to take care of unexpected failures. The current requirements include the requirement to have a launch abort system, as well as how effective the launch abort system must be. The issue has been raised that mathematically, once you meet the LOC probability, you don't need to specify the launch abort system effectiveness because it is part of the LOC-on-ascent calculation. This puts all the pressure on an accurate assessment of the failure probability of the

booster, a key element of the equation. If the booster is shown on paper to be more reliable than 1/1000, then no abort system effectiveness is needed to meet the LOC requirement. Mr. Frost strongly recommended that NASA maintain an effectiveness criterion for the launch abort system. (3) Another issue arose on how the decision will be made on what is acceptable risk. The Program now has an interesting concept on how that will be done, which will include risk acceptance decisions by the partners, with oversight and insight by NASA, who will make an independent risk acceptance decision. That will be done in accordance with the classic NASA model, with the Program Manager with the concurrence of the Technical Authority (TA) making that decision. It appeared during discussions that there was some confusion about how that process would work. It revolved around who "owned" the requirements. The Program may be thinking that if they adopt the Level 0 or Level 1 requirements, they then own those requirements and can waive them independently without concurrence of the TA. This would be against the model that NASA has developed and adopted for the Program. Clarification on how those decisions will be made would be useful.

Dr. Bagian noted that one example of the issue on how top-level requirements would work came about in discussions with Mr. Mango concerning cabin depressurization. There is a top-level requirement that says there must be systems in place to deal with cabin depressurization. Mr. Mango stated that some partners have maintained that they do not need to deal with a depressurization event because they think they have enough robustness in their design so that there will never be a cabin depressurization and as a result don't need to make any additional provisions. This is clearly at odds with something that is very clear in the requirements, i.e., that they must deal with cabin de-pressurization. However, Mr. Mango related that there has been debate with the partners who contend that they don't have to provide for a depressurization event. Although this appears to be a very clear-cut issue, the Program has not yet put this issue to rest. This does not inspire much confidence for a less clear issue.

VADM Dyer emphasized the Panel's significant concern with regard to the wide spread in the cost estimate and the uncertainty and shrinking size of the budget for commercial space execution. Clearly, the adverse impact and stress on safety increases inversely to the budget—as the budget goes down, things get tighter, shortcuts are pursued, and bad things can happen.

SAFETY METRICS UPDATE

Ms. Deborah Grubbe reported on the safety metrics update. Mr. Kenneth O'Connor from the NASA Safety Center (NSC) reviewed the current statistics. ASAP thanked him for the NSC's progress and data updating. The Panel was pleased to hear that the NSC is preemptively taking action to put together educational videos to support NASA's leadership and emphasis on safety. For example, last year the NSC, noting a large number of slip, trips, and falls, put out a video and educational packet on walking safety. This is exactly the kind of work that a safety center should be doing of support the larger NASA organization. The ASAP was also pleased to see the duration of mishap investigations shrink to an average of 60 days versus 75. While looking at the data, the Panel noted a large level of ergonomic injuries. There is not enough data to make any formal recommendation at this time; however, it was noted that given some additional information, and should NASA Safety and Mission Assurance (SMA) choose to address ergonomics in a more formal way, they need to gain more data on the affected body part and the nature of the circumstances in which these injuries occurred. While soft tissue injuries are a real cost and represent a loss in workforce productivity, one cannot see a soft tissue injury, and so one must rely on the injured party coming forward and reporting. Currently, the data on ergonomics injuries are coming from the medical organizations at each Center, in an anonymous way. This different reporting process, however, coupled with a more invasive type of mitigation, known as "work hardening," or exercising on the job, will change the work that the NASA SMA presently does. Also, KSC is transitioning towards a lease facility where there may be multiple partners and a growing contractor custodial relationship. This may require some discussion on how safety requirements and accountabilities are articulated in the contracts, the roles of the NASA employees on the site, the contractors on the site, the partners on the site, and any lessees. The ASAP left this discussion with the fact that SMA is already starting to cover this as a normal part of their daily business, and ASAP expects that OSMA will bring that plan to the Panel formally.

The ASAP is pleased with the work being done by NASA around injuries and statistics reporting, and encourages two things: (1) that the metric package continue to be discussed at the most senior levels of the

organization; and (2) that the NSC continue to monitor the feasibility of IRIS to effectively handle the data on close calls (already an action in an open ASAP recommendation). The ASAP is looking forward to seeing the multi-year plan on how NASA will improve its metrics and data collection processes.

Dr. Bagian agreed that NASA has shortened its investigation time. When looking at root causes, the quality varied. This is a challenge for every organization. Mr. O'Connor and the ASAP talked a little about the tools being used to assess quality. There are tools that are available that they should consider formalizing their use in a more uniform way across the board to achieve consistency and higher quality products.

Mr. Frost added his congratulations to the NSC for its work on metrics. A few years ago, the ASAP found good analysis at a few Centers, but not across the Agency. The Panel has seen a sea-state change—there is a use of rates instead of just raw numbers, they have honed in on causes, and they are implementing corrective actions. Now, the next step is to use that data, implement programs targeted at the "low-hanging fruit," and move on from there. VADM Dyer concurred with Mr. Frost's comments. He observed that it is also worth noting that the back-log and extended periods of time seen in prior years in work accident investigations and reports has significantly improved.

GSFC SAFETY PROGRAM OVERVIEW

Ms. Grubbe reviewed the Panel's discussion with Ms. Judy Bruner, who reported on GSFC's safety program. She reviewed the site safety-incident metrics and talked about new safety initiatives and approaches that have improved the participation and awareness of the GSFC contractor workforce.

Ms. Bruner also reviewed the Wallops Flight Facility (WFF) balloon mishap that occurred in Australia. There were a number of corrective actions that came out of that and are still in process. Progress is good and the investigation revealed that there were additional opportunities for SMA people to have their leadership felt. In this case, specifically, the WFF safety leadership was more involved. The safety statistics are good at GSFC; however, like any program, improvements are the name of the game. The ASAP congratulated GSFC for the significant reduction in OSHA-recordable cases vs. last year. Even though the fiscal year is not over, there is statistical improvement in the OSHA recordables —nineteen recordables in FY 2010 versus ten recordables so far in FY 2011. The ASAP noted that there appears to be a trend of electrical issues across the Agency—this is attributable in part to aging infrastructure. The situation at GSFC reflects the rest of the Agency with respect to these issues. The current U.S. government budget woes do not give the ASAP any comfort or reassurance. NASA is managing its infrastructure issues as best as possible; however, the trend continues and is of concern. People are aware of the situation and are mindful of the issues, which is important.

Ms. Bruner has also been improving investigations and has hired a full-time mishap investigator. The rigor that this investigator brings should highlight investigations and the importance of lessons-learned to the organization, as well as make the investigations more visible. However, as Dr. Bagian noted earlier, it is still not clear that NASA is getting down to root causes in some of the smaller investigations (the class C and D and near misses). It does get down to root causes in the class A and B investigations. This may be a time and training issue. It bears some additional investigation and review on ASAP's part. Another area for improvement is in the risk management area. Risk management flows throughout the work process at GSFC, but it looks different depending on where one sits. It is not always a 5 x 5 matrix. ASAP experience shows that root cause analysis can be improved, not only here but across the Agency; however, no formal recommendations will be brought forward at this time. The ASAP will discussion this with SMA.

CONSTELLATION LESSONS LEARNED UPDATE

Ms. Joyce McDevitt reported on the discussions with Mr. Dale Thomas, Associate Center Director at Marshall Space Flight Center (MSFC) and formerly the Deputy Program Manger for Constellation. This discussion was the "gem-briefing" of the meeting. The topics and the subject matter aligned with the ASAP recommendations. A lessons-learned document for the Constellation Program has been put together, drawing from hundreds of inputs across the Program. The purpose of the document is to provide topics that could benefit Agency-wide programs, e.g., new flagship programs and multi-center projects, by learning

from the Constellation experience. The lessons learned should not be viewed as either positive or negative; their value lies in understanding what was done and learned. In the discussion, Mr. Thomas stressed the importance of context and perspective, which varies depending on where one sits in the organization. The work completed to date (Volume 1) is just the tip of the iceberg. It is an executive summary. There are plans to publish a Volume 2 that will cover the topics in much greater detail as well as other lessons learned that did not make the first cut. To give an indication of the subject matter, Ms. McDevitt noted some of the descriptions used. One can see the close linkage between issues and concerns on the Commercial Crew Program that might benefit from looking at Constellation Lessons Learned; for example, robust versus optimal planning—the only certainty is that the funding will not match the plan; tailoring of design and construction standards—drinking from a fire hose; and decision making—it is only as effective as the roles, responsibilities, and authorities are clear and understood. There are about ten lessons learned in Volume 1. The ASAP has had recommendations in many of these areas. Mr. Thomas pointed out that a lessons learned document like this should be used in conjunction with reports from blue-ribbon committees, advisory committees, etc. Once one starts looking at all the documents, one does see a commonality in the themes. The accumulation of those kinds of documents provides the best insight into areas that need to be improved. The ASAP felt strongly that Administrator Bolden, as well as appropriate external organizations, should be briefed on the Constellation lessons learned. Mr. O'Connor thought that OMB and Congressional staffers could also benefit, especially on the topics related to budget. The document has been approved for public release as NASA/SP-2011-6127-Vol-1; "Constellation Program Lessons Learned, Volume 1: Executive Summary".

VADM Dyer agreed with Ms. McDevitt's comments. He noted that it is rare to see this kind of retrospective work be done at all, as well as this kind of quality. Dr. Bagian further emphasized the importance for people at the top levels to hear this. Mr. Dale furnished numerous examples where people further down the chain were trying to be heard and weren't, resulting in conflicting demands that would force them into bad technical decisions or in less than ideal use of resources. Without the sensitization of the top level people, they might not ever hear the "weak signals" of a problem, and people may be forced into decisions that are not in NASA's best interests. This sensitization and listening is also needed at the Hill and policy levels.

Mr. Frost noted that many of Constellation's problems had root causes outside the Program's control. People in charge of resources and schedules need to understand the impact of their decisions and demands. A concern is that the lessons learned can potentially be repeated in the current redirection of the program. One example is the issue of contracting for subsystems before establishing a program office or top-level requirements. This causes sub-optimization of the subsystems, and they may or may not meet the overall system requirement. The concern is that the Space Launch System (SLS) will be prone to that with the urge to get long-lead items and other activities going. The program office and the top-level requirements should be established before NASA gets too far into the subsystems. Another lesson learned that could easily be repeated is the use of a delayed funding profile. If there is not enough funding up front, then the overall costs skyrocket and the entire program could be in jeopardy. In today's budget environment, this will be a major issue. Lastly, there is the importance of flight test. The Constellation Program did a 1-x flight and an abort demonstration. They pointed out that the value is far beyond the statistical confidence that is obtained. Early flight test is important in terms of the exercise of the systems, the pressure it puts on to get problems resolved early, and the confidence that it provides for other than flight hardware. This is especially important for the flight testing in the commercial arena.

VADM Dyer observed that foundational in the Constellation Program's woes were uncertainty about what it was going to cost and the insufficient budget that was reduced over time.

THE GSFC LEARNING ORGANIZATION MODEL

Mr. Frost discussed the briefing that the Panel received from Dr. Ed Rogers, Chief Knowledge Officer at GSFC. This is specifically a model aimed at knowledge management, which is another way of saying "lessons learned." The ASAP has been concerned about the potential for all this body of data and the knowledge learned going out the door with the wholesale change of personnel and missions. Dr. Rogers briefed the ASAP on the Goddard Learning Organization Model, one of the better ones in the Agency and even outside the Agency. He is focusing on how to share and utilize the knowledge that is collected. Dr.

Rogers presented a unique "nuclear reactor" model, where the system's fuel is the creativity and competencies of the engineers and scientists. In his analogy, the rods of the reactor are the controls—the policies and processes, and the support systems and requirements of the knowledge management program. If the rods (controls) are pushed in too far, the reactor shuts down; if the controls are pulled out too much, the reactor explodes. This is a good model for knowledge sharing; it is also a good model for the insight/oversight discussion and how to control and work with industry. His model is based on case studies, and he had good explanations of why that is an effective way of transmitting knowledge. Mr. Frost congratulated Dr. Rogers on such a good program and encouraged NASA to review his techniques to see how they could be implemented Agency-wide.

Dr. Bagian noted that a number of the lessons learned are not unique to GSFC—they are basic principles about interaction, how to conduct business, etc. Some of these should be made available to other Centers—e.g., via Webcast. The cost of doing this would be small and the potential upside is huge. Mr. Frost added that there are many ways to broaden the audience to the lessons learned; for example, there could be a link to the STEP program, which is already using case studies as a required element at some certification levels. If they have not already, the NSC should take a look at some of the case studies that are safety-related.

RECOMMENDATION UPDATE

Ms. McDevitt reviewed the discussion on the update to ASAP recommendation 2010-01-07—Methodology for Performing Integrated Abort Risk Analyses. The briefing was provided by Dr. Homayoon Dizfuli, NASA Technical Fellow, Systems Safety/Flight. This recommendation was the result of a meeting at MSFC in 2010, in which Ames Research Center (ARC) presented the analysis done on the Constellation Program. This analysis was a dynamic simulation analysis based on techniques modeling the problem of evaluating the consequences of potential vehicle failures on the separating abort system. The ASAP concern was that the Commercial Crew Program partners would have to do this type of analysis, and they wouldn't have the skill sets or information to do it in a manner that would be acceptable to NASA. ASAP recommended that NASA prescribe the methodology for performing integrated abort risk analysis and develop the supporting tools as needed so that these types of analyses are performed uniformly across the industry. NASA has completed providing the guidance in Chapter 14 of the PRA Procedures Guide (now in draft revision) and plans to publish a separate "Special Publications" document that would facilitate wider distribution to the industry. These efforts are now in work, and ASAP will close out this recommendation when completed. The Panel was very pleased with the response to the recommendation and the work done to date.

There were no further comments or questions, and the meeting was adjourned at 11:30 a.m.