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

October 20, 2015

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 2015 Fourth Quarterly Meeting at Johnson Space Center, Houston, Texas, on October 5-7, 2015. We greatly appreciate the participation and support that was received from the subject matter experts and support staff.

The Panel submits the enclosed Minutes resulting from the public meeting for your consideration.

Sincerely,

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

Enclosure

AEROSPACE SAFETY ADVISORY PANEL
Public Meeting
October 7, 2015
Johnson Space Center
Houston, Texas

2015 Fourth Quarterly Meeting Report

Aerospace Safety Advisory Panel (ASAP) Attendees
VADM (Ret.) Joseph Dyer (Chair)
Dr. Patricia Sanders
Dr. James Bagian
Dr. Donald McErlean
CAPT (Ret.) Robert Conway
Mr. John Frost
CAPT (Ret.) Brent Jett
Dr. George Nield

NASA Attendees

Frank Green	OSMA, NASA HQ
Bill Jordan	NASA, CCP
Lawrence Miller	NASA
Gail Skowron	NASA SMA
Ansley Browns	NASA MLLPV
Chris Radke	NASA – FIRST
Eric Newman	NASA MLLP
Bill McArthur	JSC
Carol Hamilton	NASA GSFC

ASAP Staff and Support Personnel Attendees
Ms. Harmony Myers, NASA ASAP Executive Director
Ms. Marian Norris, NASA ASAP Administrative Officer
Ms. Paula Burnett Frankel, Writer/Editor

Other Attendees
Kenneth Bowersox, NAC HEO Committee

Telecon Attendees
Owen Berger, Senate Congressional Committee
Richard Cederholm, GAO
James Dean, *Florida Today*
Ted Kronmiller, law office
Dava Newman, NASA Deputy Administrator
Erin Preston, GAO
Diane Rausch, NASA HQ
Gerry Schumann, NASA
Kristin VanWychen, GAO

Opening Remarks
The Aerospace Safety Advisory Panel (ASAP) Chair, VADM Joseph Dyer, called the public meeting to order at 12:00 p.m. and welcomed attendees. Ms. Harmony Myers, ASAP Executive Director, stated for the record that Mr. Don Nelson had submitted a written statement to the ASAP, and it had been distributed to the members.

Before starting the meeting reports and discussions, VADM Dyer noted with great sadness that the ASAP had lost one of its members—The Honorable Claude Bolton—who passed away subsequent to the last meeting. Mr. Bolton was a retired Major General who had been the senior acquisition executive for the U.S. Army, a test pilot, and a professor at the Defense Acquisition University, as well as a member of the ASAP. The Panel will greatly miss Mr. Bolton and has the deepest respect for his contribution in all of these areas. Its heartfelt condolences go out to his family.

VADM Dyer thanked the Johnson Space Center (JSC) Director, Dr. Ellen Ochoa, for hosting the ASAP and welcoming the Panel warmly. She did an excellent job in addressing the areas of special interest and expertise at JSC. The Center has a significant role in commercial space, a strong interest and position in exploration, management leadership in the International Space Station (ISS), and is a significant contributor to building the picture for a mission to Mars.

The Panel working sessions were spirited and energetic. Spirited topics included risk acceptance, the budget, and the challenge of trying to do so much under budget constraints. In fact, NASA anticipates being down about five percent via-a-vis the Fiscal Year (FY) 2015 budget. Another topic was the design goals associated with Loss of Crew (LOC). VADM Dyer noted that a couple of things had caught his attention, one of which concerned hazard reports. He noted that ASAP member Mr. John Frost, who is actively engaged in safety consulting work in the commercial sector as well as with NASA and the Panel, has asserted that the purpose of hazard reports is to influence design. That is their value, not administrative history-taking or satisfying the safety oversight people. The ASAP has had debate about cost, schedule, risk acceptance, and safety—how all those interplay in what is very often a fixed-sum game. The ASAP concern is that under reduced funding with increased schedule pressure, the tendency is to accept higher risk. Another topic was the current Congressional requirement that human spaceflight accidents precipitate a Presidential Commission. This occurred with both of the Space Shuttle accidents. Both Commissions were well conducted, but they were protracted in terms of schedule interruption. The Panel believes that NASA, like the Department of Defense, is a very professional organization that can perform accident investigations and, if buttressed by outside, independent review by external participants, can do so very satisfactorily without the long delay that has historically followed a Presidential Commission.

Astronaut Corps Update

CAPT Brent Jett reported on the briefing by Mr. Brian Kelly, Director of the Flight Operations Directorate at JSC. Just over a year ago (August 2014), as part of a larger Center reorganization, the Mission Operations Directorate (previously the organization responsible for the Mission Control facility and the overall planning, training, and execution of human spaceflight missions) was merged with the Flight Crew Operations Directorate (previously the organization with the astronaut corps and the NASA aviation operations at Ellington Field). This new organization has about 600 civil servants and about 1,800 contractors. A similar organization using the same name existed in the distant past (prior to the Challenger accident). One of the first things Mr. Kelly emphasized to the Panel is that today's Flight Operations Directorate is much more integrated than the previous organization. They have made a great effort to mix astronauts, flight controllers, aviation experts, and trainers throughout the organization to take advantage of the integration and cross-communication of operations expertise. It is truly an amazing challenge and responsibility to operate the ISS 24 hours a day, 7 days a week. One statistic Mr. Kelly mentioned was that, on average, the Mission Control Center sends 1000 computer commands to the ISS every day.

The bulk of Mr. Kelly's report focused on a few main topics. The first topic was the size of the astronaut corps today and projections into the future. The Agency uses a theoretical, mathematical model to determine the minimum number of astronauts required to meet the flight manifest. The Panel was interested in the model that they use and would like to see more details on it, which they will provide. Assuming the model is accurate, it appears that NASA is doing a good job managing the number of astronauts currently and for the future. The second topic concerned the operations team interactions with the human spaceflight programs—the ISS, the Commercial Crew Program (CCP), and the Orion/Space Launch System (SLS). Not much has changed with the merger except that now, the flight controllers and astronauts are getting together and agreeing on positions before they go to a program to advocate something. This is more efficient for the programs, and concerns are being effectively communicated to the program managers. Mr. Kelly discussed the training of the astronauts and the use of the T-38s. Finally, Mr. Kelly spent some time talking about the direct return mission that Flight Operations Directorate performs to return the U.S. Orbiting Segment (USOS) astronauts to Houston immediately after a Soyuz landing in Kazakhstan. They perform this mission using a modified Gulfstream III aircraft, which can be challenging due to the somewhat limited capabilities of the aircraft. Despite those limitations, the Panel notes that the Directorate's Aircraft Operations Division has successfully executed this challenging mission four times per year since 2009. The Panel acknowledges the Flight Operations Directorate's efforts to look for ways to acquire a more capable aircraft to improve mission reliability and reduce risk in the future.

Johnson Space Center Facilities Update

Dr. James Bagian discussed Mr. Joel Walker's report on facilities. Mr. Walker, JSC's Director of Center Operations, reviewed a number of operations activities, including using the facilities efficiently and retiring unneeded facilities or refurbishing them as appropriate. Over a half dozen buildings have been totally emptied, returning over 11,000 square feet of office space. They have repurposed Building 18 to act as "construction shelter" for the new Building 21 being built on the Center's west side. Mr. Walker talked about a number of savings that have been yielded. Of particular interest was way they have used a "risk-matrix" chart to look at vulnerabilities (water leaks, loss of power, etc.) to target proactive maintenance. This shows a more systematic approach to facilities maintenance over the past year than the ASAP has seen in the past. This was also observed at the Marshall Space Flight Center (MSFC) on the ASAP's last visit. JSC has moved medical facilities from its traditional location in Building 8 to a more logical location. Mr. Walker also talked about what they are doing in terms of energy efficiency. They are in the process of contracting out electrical power service. They will have gas-turbine generators on site that will supply 70 percent of the power necessary for the Center. This does several things—it increases their energy efficiency, gives them stand-alone capability, and is more cost effective. He also talked about their master plan and how they are going to repurpose their current buildings and where they need new construction. This shows what appears to be a much more systems-based approach to managing facilities to be more energy-efficient, economical, and make more prudent use of the space available.

CAPT Robert Conway seconded Dr. Bagian's comments. Similar to what the ASAP saw at the Langley Research Center (LaRC) this past summer, JSC is taking a long-term approach and working with collaborative partners.

CAPT Jett added that over the past year, the Panel has seen good stories throughout the NASA Centers. NASA is doing a good job in being very proactive and using a systematic approach in looking at facilities.

Exploration Systems Development

CAPT Conway reported on Mr. Bill Hill's review of Exploration Systems Development (ESD), and Dr. George Nield addressed Mr. Hill's specific answers to ASAP questions that were previously sent to his organization. Mr. Hill talked about the status of Cross-Program System Integration (CSI) as well as the status of the individual programs. There has been good progress on the ESD program and it is exciting to see hardware materializing as part of this progress. Mr. Hill presented an ESD rolling milestone chart showing an encouraging number of completed and on-track milestones indicating a relatively on-track program, but one which is budget-dependent. He covered several top concerns—some of them technical and some programmatic. Budget remains a "long pole in the tent" as they await the 2016 appropriations while under the current Continuing Resolution (CR). The specific appropriation is needed to determine the continued momentum and assess shortfalls and therefore program risks for FY16 and beyond. As the Program transitions from design to production, all three programs appear to be on track thus far. One of the significant milestones Mr. Hill reported on was Critical Design Review (CDR). SLS completed its CDR last month; Orion is scheduled for this month, and Ground Systems Development and Operations (GSDO) is scheduled for December. Some CSI metrics were provided. A chart displaying open versus closed interdependencies showed an even level with slight increases, but elevated interdependencies showed a downward slope, which is positive news. With respect to technical issues, shifting from the Orbital Debris Engineering Model (ORDEM) 2000 to ORDEM 3 is driving up the risk in contributions to Loss of Vehicle (LOV) for the Interim Cryogenic Propulsion Stage (ICPS) and will require further evaluation. An example of one of the closed interdependencies that had been an ASAP concern was the crew recovery method involving the Orion capsule recovery in the recovery ship's well deck. This method was experiencing time delays

making the recovery exceed over two hours from splashdown. As a result, an open water recovery has been explored and approved as a second option.

The Orion Exploration Mission (EM)-1 test article has been completed. The EM-1 ICPS test article is ongoing with a delivery scheduled for October 2016. With respect to the core stage, the qualification rings and four of the eight flight rings have been completed, liquid oxygen (LOX) barrels have been completed, the first structural stand will be complete by July 2016, and core stage testing will begin at MSFC in February 2017. There was a successful test firing of a solid rocket booster in March. Qualification Motor-2 is coming up next year. RS-25 engine hot fire testing has been ongoing since February and will continue through summer 2017. They are also working on 3D printing of RS-25 engine components at MSFC to help reduce costs. There has also been significant progress on GSDO—umbilical testing, launch pad modifications, crawler, flame trench, and many others that time does not permit mentioning here. Things are definitely moving forward, and everyone is starting to see the physical reality of the system. There has also been progress on the Launch Abort System (LAS) test article; however the ASAP is concerned about the LAS test plan. CAPT Conway noted that Dr. George Nield would be covering that topic in more depth in his report next.

Overall there is solid progress. ESD is working hard to meet all of its commitments. There appears to be good team morale building as the physical rocket is coming together, and it is exciting to see the continued realizations of progress in the significant milestones that are just around the corner in 2016 and 2017.

Dr. Nield noted that the Panel had asked NASA for additional information on several particular topics. The ASAP was provided with the information and the rationale for the decisions that were made. The four special topics that were reviewed at this meeting were: the Orion heat shield, the altitude for parachute deployment, the Orion acoustic environment, and the ascent abort test in the current plan.

With respect to the heat shield, the original plan involved a monolithic thermal protection system, somewhat loosely based on an upscaling in size of what was used on Apollo. This type of heat shield was flown on Exploration Flight Test (EFT)-1 and performed well. However, during processing of the vehicle and data analysis, challenges with that type of design were recognized. As a result, an alternate design using blocks (a tile system) was examined. The Program decided to change from the monolithic to the block system going forward. However, at the Board meeting, some concerns were raised and a dissenting opinion was presented. After some discussion, the Program decided that both approaches have some significant risks. The intent at this point is to go forward with the block system; as a risk-mitigation, some additional work will be investigated as a backup in the event the block system experiences some major development issues. This appears to be a reasonable approach for risk mitigation.

The second topic was the altitude for parachute deployment. One of the top risks identified in parachute descent was in a one-parachute-out case. In this case, considerable pendulum motion was predicted. In an effort to look at the different trades that could be made to improve that situation, one of the variables was deployment altitude. Changing the deployment altitude from 8000 feet to 6800 feet uses only some of the reserve altitude that the Program is carrying and will still ensure enough altitude to fully deploy the chutes while potentially decreasing the magnitude of pendulum swing. There appear to be good data, good trades, and a reasonable approach going forward.

With regard to the acoustic environment inside the Orion capsule, the cabin noise level during abort was predicted to be outside limits considered acceptable for unprotected hearing. However, in the planned configuration going forward, the crew will be wearing helmets, communication caps, and aircrew earplugs. Therefore, it is estimated that the data will be within the human noise exposure limits for protected hearing.

The final issue reviewed was the planning for ascent aborts. In May 2014, the Orion Program Manager authorized a study to develop a more affordable ascent abort (AA-2) option. The team came up with a range of six different options across the spectrum from "don't do one at all" to "no LAS jettison" to "LAS jettison" to "forward bay cover and chute deployment" to "EFT-1 reduced content" to having basically an all-up demonstration using the EFT-1 systems. A couple of options didn't look technically feasible and were eliminated. After considering all the pros and cons, the Program selected option 2, which takes a piece-by-piece set of particular tests to get particular data that they believe would be necessary. The downside, even though it may be faster and cheaper, is that they are not actually doing a full, end-to-end test of a very key component of the overall system. The NASA Chief Engineer, Mr. Ralph Roe, documented the logic for that decision, including airing the concerns that had been raised. The documentation included the following sentence: "The best technical approach is to conduct an end-to-end flight test to anchor our models, potentially identify unknown unknowns, and establish the requirements for a robust ground test program where we can determine our margins." That statement resonated with ASAP. Although the Program has become comfortable with the proposed reduced testing, many on the Panel are concerned about that approach and believe that a full-up test would be extremely valuable. This issue remains a Panel concern.

Dr. Donald McErlean commented that it was interesting that subsequent to that presentation, the ASAP was briefed on the current status of the investigation of the 59P failure. The Russians were confronted by an integration system problem: they had a structural failure that was caused by dynamics that were triggered by a third order response in some of their systems that they were not able to pick up in component testing. This phenomenon only exhibits itself in the integrated system. This is not a reflection on their capabilities, which are quite high. It is a comment on the way complex systems sometimes work—they have what is called "emergent behavior." Dr. McErlean opined that in a system as complicated in its dynamic effects as the LAS, if an end-to-end test is not done, there is the risk for emergent behavior that cannot be unearthed by testing all the parts in isolation.

Mr. Frost noted that NASA has wonderful simulation capabilities, an order of magnitude better than just a few years ago. However, in complex cases like this, with complex supersonic interactions between moving vehicles at close range, all the unknown unknowns cannot be fully predicted. This is one of several instances the ASAP has observed where because of schedule or budgeting, there was a need to reduce cost or speed up some of the programs. In this case, NASA needed to do both and was looking at alternatives. Mr. Frost complimented NASA personnel, remarking that they have done a wonderful job given the goal of reducing the time and cost. They have produced an excellent program to do that, but it has induced some additional risk. The question is: Is that a good tradeoff? By itself, it may be, but taken with other trades similar to it, the Panel is beginning to worry that cost and schedule may be driving the Program to a place that it should not go. Mr. Frost added that this AA-2 option was evaluated very well at the highest levels, including the NASA Chief Engineer and NASA's Chief of Safety and Mission Assurance (SMA) and was well vetted. However, the ASAP is not sure that it was well documented. The Panel has recommended that NASA adopt an individual sign-off documentation for significant risks. NASA is in the process of making that change, and the ASAP would like to see it implemented.

VADM Dyer added a general comment: the ratio of things NASA is undertaking to the dollars available to do them is impressive. The trend is negative rather than positive. This is at the same time that a mission to Mars is beginning to stand out on the horizon. Individually, the Panel observes activities such as standing down from a full-up systems test and instead embracing a modular test with modeling and simulation. The Panel sees places where that trade is very rational and acceptable at the individual program level, but the combination of things taking place across the Agency in response to cost and schedule pressure does reflect an increasing risk to safe conduct. In past Annual Reports, the Panel has recognized limited resources and the imperative of going forward

and is aboard with that. However, increased risk should be recognized and shared with the public such that there is not a perception that old safety standards are still reflected in the new ways of doing business.

Mr. Frost emphasized the criticality of the LAS. Everything on a rocket has to work, but that subsystem really must work. It is estimated to have a reliability somewhere in the range of 95 percent; it is the last hope for the crew if something goes wrong. If nothing goes wrong, it will never be tested in the life of the system. Now is the time to test it.

CAPT Jett noted that at last ASAP quarterly, the ASAP asked for an overall review of the Orion test program. At this meeting, the ASAP did get that as part of the AA-2 review. The Program went back to the 2009 baseline test program and discussed the evolution forward. The ASAP looked at the decision in the 2010-2012 timeframe to shift to "protoqual" from dedicated test articles and the issues that arose from that, some of which are still being worked off today. The Panel then looked at some of the more recent decisions on the test program, which included the AA-2. That review, and an examination in the entirety of how the test program has evolved, generates the concern voiced by VADM Dyer. Each individual decision appear to have good rationale, and NASA is doing excelling technical work to bring all the issues to bear to make a decision. However, when the ASAP looks at the entirety of the test program, it is beginning to have some concerns.

Commercial Crew Program

Mr. Frost reported on the ASAP review on the CCP. Ms. Kathy Lueders, Program Manager, provided an extensive and detailed briefing on the Program and the challenges it is facing and overcoming. The Panel divided the report on her briefing into three parts, and Mr. Frost, Dr. Pat Sanders, and Dr. Nield each talked about a section. Mr. Frost discussed the overall execution status. He first complimented the Program for an order of magnitude improvement in openness and interaction with the Panel. There is a significant flow of information that is benefiting both the Program and the ASAP.

The Panel reviewed the overall schedule. Both providers are on track for crewed launches to the ISS in 2017. The Panel also looked at the Commercial Crew Transportation Capability (CCtCap) Program, which is also on track. Ms. Lueders noted that this is the "CDR season." VADM Dyer earlier mentioned the temporal importance of hazard analyses. The ASAP has been concerned that design was preceding the hazard analyses. Hazard analyses are now flowing, and many are in process. The focus now is on improving the quality of those. The providers have not been certain or clear about what NASA expects, and NASA has been less certain or clear on what they provide, so there has been some back and forth exchange. That is normal, but it is probably a little more than what NASA traditionally sees. One possible cause of that is lack of a formal Phase 1 program. However, both providers are making substantial progress.

The ASAP also looked at the top level risks for the program. The risks are those that one would normally expect. However, at top right corner—the extreme for likelihood and severity, which is where a program does not want to be on a risk chart—the number one risk is budget uncertainty. This is out of the Program's control, but they are worried about it and are doing everything they can.

Dr. Sanders reported that the Panel had an excellent report from the CCP on the status of the work of the two providers, including progress relative to schedule and towards certification. Specific risk areas are being addressed by program management. She echoed Mr. Frost's comment regarding the ASAP's satisfaction with the openness and candor of the discussions. Dr. Sanders spoke to some of the Panel's observations on the CCP report, while respecting the need to preserve the confidentiality of competition-sensitive and proprietary information.

Overall, the Panel noted that the Program Manager is aware of the challenges the Program faces, acknowledges transparently the risks in the Program, and is actively working to retire or mitigate them. There has been substantial progress on the part of the providers in design maturation and building up their infrastructure. One item that Dr. Sanders called out from a safety perspective is the attention being paid to abort systems and their certification.

There were many areas where the Panel had positive observations. The Program Office and the commercial providers seem to be benefiting from open communications and data sharing. The CCP structure forces three engineering Centers to work together, resulting in learning from other NASA programs. The CCP is making excellent use of the assets, experience, and talents of the NASA Engineering and Safety Center. They are also leveraging their continuing engagement with Sierra Nevada and Blue Origin through the residual Commercial Crew Integrated Capability (CCiCap) efforts. The Panel noted the Program's positive exploitation of the experience of the Cargo Resupply Services (CRS) Program, including the failure analyses.

One positive observation that Dr. Sanders emphasized is the benefit being derived from having two very different providers. Not only do they bring the advantages of competition and the robustness of redundant suppliers, but the two disparate approaches are also already proving to provide innovative and cost effective design solutions.

There are some areas where the ASAP sees significant challenges and cause for caution as the Program goes forward. The Program is experiencing the artifacts of the transition from a Space Act Agreement (SAA) to an actual contract. This shows up in the level of design maturity that is lacking at CDR and even more so in the maturity of hazard reports. While the hazard reports are now flowing, there is a significant backlog of those, and their quality and immaturity is putting a huge workload on the Program Office. This is also true of requests for alternative standards. The Panel's concern is that over time, schedule or budget pressures will lead the Program office to accept more risk than desirable for safety of the crew and mission. The ASAP again cautions that individual risks not be accepted without regard for the accumulated impact. To her credit, the Program Manager did appear to be aware of the possibility of such a tipping point.

The ASAP observed another tendency or trend in working with the commercial providers—while the Program Office could derive confidence from their observations that the providers were doing the "right thing" from engineering and safety standpoints, the formality or "paperwork" aspects were frequently missing or perfunctorily accomplished. The ASAP advises that the providers need to recognize that the discipline of doing the formal aspects is as much for their benefit as the government's. Although specifics were not discussed, the ASAP noted that the appropriations outlook for the CCP does not look favorable and could add pressure on the decision process and risk posture in the next year.

Dr. Nield addressed some specific topics of Panel interest that were reviewed with the CCP Program Manager. There were two special topics on which the Panel had previously requested information: MicroMeteoroid and Orbital Debris (MMOD) and mishap planning. Mr. Justin Kerr provided a briefing on MMOD and reviewed the current situation. The Agency has a requirement to achieve a Loss of Crew (LOC) risk of no worse than 1 in 270 (1:270) for MMOD. To encourage risk mitigation, the Program has been looking at different ways to approach that. MMOD is the number one contributor to LOC risk and the primary means by which to close the gap between where the Program is and where it wants to be. The strategy that is being taken is to back off to 1:200 for the spacecraft themselves, but to require that the design and vehicle capability be the sole means to achieve that level. Any potential inspections or operational workarounds will be put aside and left for later consideration. That strategy appears to be working well. Both companies are now looking at potential changes to their vehicles to address the MMOD risks. Many of the insights on how to do that come from computational

models that JSC has to assess MMOD risk. The Panel is hopeful that this will produce some improvement. There will always be risk from MMOD, and NASA wants the providers to do as well as they can with the spacecraft design before looking at other ways to see if it can be made even safer. The first step is to ensure a good design, and that is the approach that is being taken now.

The second special topic concerned mishap response, and Mr. Rick Gavin provided a presentation on that subject. The background involves a number of different constraints and directions that the Program needs to deal with. Those include the NASA Authorization Act of 2005, the CCP contracts, NASA NPR 8621.1B, the NASA range safety NPR, and the entire process involved with Federal Aviation Administration (FAA) licensing and the National Transportation Safety Board (NTSB) laws and regulations. Another important factor is when the mishap occurs—whether it is during pre-launch, ascent, on-orbit, reentry, or after recovery; and whether there is a fatality or injury to crew members, the public, or damage to property. Depending on these factors, there are different results. The team is looking at how that will play out, and they are continuing to refine a large matrix that involves the point in the mission where the mishap occurs, whether there are fatalities or injuries or property damage, and, in each case, who would be the lead authority in any mishap response. The lead authority ranges from the contractor (where there is minimal damage occurring pre-flight or post-flight) all the way up to loss of vehicle or flight crew, in which case a Presidential Commission would be invoked (based on the NASA Authorization Act).

People are recognizing that this is a complex issue that should be thought through, agreed to, documented, and in place before the flights take place. As noted by VADM Dyer, the Panel feels very strongly that although the Presidential Commissions have done admirable jobs in the past, there are significant implications to that process—the ability to respond and continue with the program in a timely manner. The ASAP encourages NASA to continue to look at other options, such as whether a change in the law would be appropriate to provide more flexibility to achieve independent investigation while still minimizing the downtime that has in the past ranged upwards of two to two and a half years after a mishap.

Dr. Bagian agreed with Dr. Nield. In addition to the delay in operations associated with a Presidential Commission, another factor that contributes to delay is lack of transparency regarding the risk being taken. Dr. Bagian also emphasized that it is important that there be some type of independent involvement in the final investigation report. In previous Space Shuttle investigations, that independence was critical to obtain a good airing of what the various vulnerabilities were and the potential countermeasures. It is also important to recognize that in both of the Shuttle mishaps, the Presidential Commissions did not do the investigation work by themselves—they relied extensively on NASA for technical information as well as analyses. A Presidential Commission is a level of independence for "fresh eyes," but it does not do its work independent of NASA. The point is to remove as much inertia as possible in coming to a decision, but still have a level of independence.

Mr. Frost commented that when he looks at mishap planning, he observes that mishap plans are often not first priority and they do not get as much attention as they should. The statutes and laws that are currently in effect would require a Presidential Commission if the vehicle is damaged to the point that it is not reusable, even post-launch. Mr. Frost posited a scenario where there is a successful mission, the crew is recovered and on their way home, and a crane breaks when the vehicle is being lifted onto the dock, destroying the vehicle. According to present statutes and laws, there would be a Presidential Commission. Mr. Frost noted that the ASAP has members who have been involved with major mishaps and could help NASA with a plan. That plan is being written now; if the ASAP could get a draft of the plan, it could make its best input sooner, rather than waiting until the plan is finalized and signed and commenting on a de facto document.

Regarding the MMOD issue, a decision was made to reallocate the protection for MMOD, which required the providers to focus on the vehicle. Currently, this means that operational procedures must make up the difference. The good news is that the Program has identified operational changes that can do that, but those changes are not "free." NASA has estimated that those changes will cost the equivalent of $10 million per year until the end of ISS. That begs the question: Can we use other techniques to incentivize the contractors to go beyond the 1:200 requirement? The Program is hoping that the contractors would do that. Mr. Frost opined that he would look very carefully at trying to buy some more protection from the equipment.

International Space Station

Dr. McErlean reported on the ASAP review of the ISS. The new Program Manager, Mr. Kirk Shireman, briefed the Panel on the status of the Program and significant events since the last meeting. This was an interesting year for the ISS—there were three failures in resupply vehicles. However, the consumables and supplies are doing very well, and they are not hurting in that area. This is a credit to the planning and foresight of the Program. They did not expect to have a string of failures in a row, but they are getting through that fairly well. The good news is that Progress 61P arrived on time on October 1, bringing supplies to the Russian side. The booster on 61P was the old version. The newer booster version, 2.1A, was the one that recently experienced a failure. The Russians will not launch that version again until their investigation into the failure mode is completed, mitigations have been implemented, and it is fully tested on a Progress launch where humans are not at risk.

With regard to the commercial suppliers, all evidence from the Orbital-3 failure indicates that it was a failure in the turbo-machinery of the main engine, and the mishap investigation team has been working on its investigation and return-to-flight plan. NASA has now agreed with Orbital ATK on such a plan. Orbital ATK is looking forward to its first launch in October, which will be on an Atlas V instead of its Antares rocket. Orbital-4 will come up towards the end of this year or in early 2016, also on an Atlas V. Mitigations will be in place for the use of a new engine on the Antares rocket near end of 2016. That will be the first launch to ISS using that rocket.

SpaceX most recently had an anomaly on SpaceX-7, and the investigation is still ongoing. They will plan to have mitigation actions completed for SpaceX-8 towards the end of 2015 or early 2016. Although the ISS has seen a tough year with resupply vehicles, resupply is back on track, investigations are progressing, results have been confirmed by independent analysis, and mitigations are in place. Redesigns and new hardware are going into the rockets. The ISS should have a solid year in resupply in the latter part of 2015 and in 2016.

The ISS is currently undergoing several transitions. One of those is a fairly large and significant software transition as they are moving from one software load to an updated software load. This may sound trivial, but the system must be taken down and brought back up with the new software without interrupting operations. This is an involved operation and takes about a working week. There will be two U.S. ExtraVehicular Activities (EVAs) over the next six months, and those are being carefully planned. The two astronauts in the one-year-in-space study—Kornienko and Kelly—are about halfway through the research program. The ISS is getting new research investigations all the time; about 49 new investigations have been opened, and a considerable amount of crew time is being devoted to research. At the moment, status in the consumables area is excellent, and the ISS is good through end of this year and into first quarter of next year. Food and other supplies carry into the middle of 2016. As noted earlier, three supply missions are scheduled toward the end of this year.

The Program briefed the ASAP on the status of several anomalies, none of which have a significant impact on ISS operations, but all of which take effort on the part of the crew. This always shows the Panel how difficult it is to maintain living conditions 200 miles into space. Every small thing requires an immediate fix and labor. One thing of interest is the new instrument that came up on the H-II Transfer Vehicle (HTV)-5: the CALorimetric Electron Telescope (CALET). It is now being mounted to the external pallet on the ISS. CALET will monitor the high energy

universe particles that have been experienced by Hubble. These extremely high energy particles are far beyond what is normally seen, and their source is still a scientific mystery.

CAPT Jett, who reported on ISS at the last quarterly, had a couple of follow up items. He noted that it was mentioned at the last meeting that the Program was undergoing an effort to manifest the multifiltration beds on HTV-5 in August, and that it would be very tight for them to get them on board. That was successful, those beds were recently installed, and they expect to see the organic carbon counts come down. The other item discussed at the last quarterly was the two upcoming direct handovers this year, which require port relocations. They did the first one successfully without a hitch and have one more to do. CAPT Jett complimented the new JSC FOD team for making that work.

VADM Dyer noted that there have been some questions from the Hill and others regarding ASAP's assessment of NASA's participation and insight into the accidents over the past year. In summary, the ASAP is confident that both Orbital ATK and SpaceX have been very inclusive, have reached out to NASA, and NASA is intimately involved in understanding the causal factors associated with those two commercial cargo accidents. VADM Dyer added that thanks to Mr. William Gerstenmaier and others, the insight into the Russian accident has been very good as well.

VADM Dyer adjourned the meeting at 1:05 pm.