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

May 25, 2016

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 2016 Second Quarterly Meeting at Marshall Space Flight Center, Huntsville, Alabama, on May 10-12, 2016. 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

ASAP AEROSPACE SAFETY ADVISORY PANEL
Public Meeting
May 12, 2016
Marshall Space Flight Center
Huntsville, Alabama

2016 Second Quarterly Meeting Report

Aerospace Safety Advisory Panel (ASAP) Attendees
Dr. Patricia Sanders
Lt. Gen. (Ret) Susan Helms (telecom)
Dr. James Bagian
Dr. Donald McErlean
CAPT (Ret.) Brent Jett
Mr. John Frost
Dr. George Nield
CAPT (Ret.) Robert Conway (telecom)

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

NASA Attendees:
Jennifer Stanfeld

Telecon Attendees:

Bill Jordan	Commercial Crew Program
Carlos Sampaio	NASA/JSC
David Balajthy	NASA Office of Inspector General
Diane Rausch	NASA Headquarters
Erin Preson	CAO
Henderson	[not affiliated]
Hudson	NASA Headquarters
Jeff Foust	*Space News*
Ken Bowersox	NASA Advisory Council
Kristin Vanwychen	GAO
Linda Coration	Aerojet Rocketdyne
Lynne Loewy	NASA
Marsha Smith	spacepolicyonline.com
Nigel Simmons	nasaspaceflight.com
Stephen Clark	*Space Flight Now*

Opening Remarks
Ms. Carol Hamilton, Aerospace Safety Advisory Panel (ASAP) Executive Director, called the public meeting to order at 10:30 a.m. and welcomed attendees. She noted that no public comments were received prior to the meeting. Mr. John Frost, acting for the Chair, VADM Joseph Dyer (who was not able to attend the public meeting), led the meeting and began by thanking the MSFC Director, Mr. Todd May, and his staff for their hospitality and support. He noted that activity at MSFC is apparent, and one can readily see that programs are not dormant. The Panel had the opportunity to see some of the Space Launch System (SLS) hardware and facilities: the liquid oxygen (LOX) and liquid hydrogen (LH2) test stands, the Launch Vehicle Stage Adapter (LVSA), and the Multi-Purpose Crew Vehicle Stage Adapter (MSA), and huge pieces of hardware that have been machine and stir-welded.

NASA and the ASAP have realized two successes this week: (1) movement toward final approval of a risk acceptance authority concept and philosophy for the Agency, and (2) planning for the eventual deorbit of the International Space Station (ISS). Both of these items have been on the ASAP agenda for a number of years and are very near to completion.

Path to Mars

Mr. Frost briefly covered this topic. He noted that Mr. Bill Hill, Deputy Associate Administrator for Exploration Systems Development (ESD) in NASA's Human Exploration and Operations Mission Directorate (HEOMD), walked through the planning for the long-range trip to Mars. The first point that he made is that "exploration is very hard." However, hard things have big payoffs. This will not be an easy trip, but it will be a worthwhile one. Mr. Hill pointed out some of the things that make the trip hard and what they are doing to make it easier. The first is getting a faster mode of transportation. They are looking at multiple options, including electric propulsion and others. Another challenge is learning to work in low gravity and dust and how to collect 20 tons of oxygen to use with fuel to get from the surface of Mars back into orbit. Overall, the mission will last about three years, and NASA must learn how astronauts can live, work, and be healthy in space for that long. NASA is beginning to lay out the framework for what must be done to achieve that. Another "tall pole" in the tent is the reentry speed. The reentry vehicle will be coming back at 13.5 kilometers per second if it returns from Mars directly. No vehicle in a human space flight program has ever come back from anywhere at that speed, and NASA needs to develop that capability. These challenges are on NASA's roster to explore and develop in the coming years. For some time, the ASAP has talked about NASA getting a formal Mars plan in place for what technologies will be needed and when they will be needed. This week, NASA shared with the Panel the beginnings of "putting the meat on the bones" for the "Proving Ground"—the phase of the "Path to Mars" that is the transition from ISS to cislunar space.

Mr. Frost highlighted aspects of the initial planning. NASA has three phases for the Path to Mars. Phase 0 is what they are doing now—utilization of the ISS to develop zero gravity lessons learned for equipment and human health and effectiveness. This will continue until the end of ISS (2024). The ASAP believes that even more will be needed, but NASA will use the ISS as long as it is in operation. Phase 1 will be cislunar flight testing—beyond low-Earth orbit (LEO), near the Moon, or other orbits further away. In that phase, NASA will demonstrate the SLS launch capability and Orion operations and Mars extendable systems for longer than 20 days. Phase 2 will be cislunar validation—where all the systems are put together and systems-level integration and testing is done. They will validate the Mars-class habitats and Mars-class health and performance and will have a "shakedown" cruise that simulates going to Mars in some fashion. The ASAP looks forward to more definition and detail on these plans and encourages NASA to continue this effort.

Mr. Hill identified the many lessons that have already been learned and those are still needed to learn. Both are lengthy lists. The Nation has invested heavily, hardware has been built, and there is momentum. No one wants to lose what has already been accomplished. The Panel has mentioned several times the importance of constancy of purpose, and there is no more important time for that concept than right now. A strong base has been built and considerable resources have been invested into getting the baseline, and we don't want to lose that.

With respect to the ESD programs' progress, they have met all scheduled milestones, and there are no significant problems. The two "tall poles" for Exploration Mission (EM)-1 are getting the crew module adapter and the European Service Module ready. They are trying to move those up in schedule if possible. The EM-1 flight is now scheduled for the window of September – November 2018. That will be a full-up, uncrewed version. It will not have all of the subsystems that will ultimately be there, but it will have the major propulsion, guidance, and reentry equipment.

Orion passed its pressure tests with a 1.25 safety factor. That is the test that previously cracked Orion and caused a redesign that now works perfectly. Mr. Frost observed that this is another example of how the baseline is getting better and better.

Health and Medical Issues Associated with Voyage to Mars

Dr. James Bagian, former astronaut and an expert in medical safety for the University of Michigan, summarized what the Panel learned on health and medical issues associated with a voyage to Mars. Dr. Bagian reported on the update provided by Dr. David Liskowsky, NASA's Chief Health and Medical Officer, on the plan for implementing recommendations from the Institute of Medicine (IOM) report, "Health Standards for Long Duration and Exploration Spaceflight: Ethics Principles, Responsibilities, and Decision Framework." In 2014, the IOM (now called the National Academy of Medicine) was tasked by NASA to develop ethics considerations for various missions that could put the crew at additional risk. Radiation risk is the one that is most commonly discussed and is the "tall pole" in the tent. In fall 2014, the IOM released its report on how NASA could go about doing that. The Office of the Chief Health and Medical Officer (OCHMO) was tasked with addressing the report and producing actual policy and guidelines for implementation to enable the exploration missions. Dr. Bagian opined that they did a very good job and have codified, explicit criteria and methodology by which they assess the risk to see if it is in excess of what a crewmember would ordinarily be subjected to. They also established guidelines for deciding whether or not the additional risk is worthwhile and at what level that additional risk would be approved. They produced a three-level process. For the first level, the Administrator tasked the OCHMO to develop the criteria for decisions to allow risk to astronaut health and safety in excess of that currently permitted by health/medical standards, and that has been done. The other levels are: criteria for decisions related to a particular mission or class of missions or exposures; and criteria for decisions related to an exception for a particular crew member who may have a different risk profile, for example, the amount radiation exposure that has already been incurred. Only by exception can a mission or set of missions be approved.

The ethics-based decision framework has a number of criteria and basic principles that include: avoiding harm to the crew whenever possible, having some benefit to the program and/or the crew for taking the risk, having a favorable balance of risk and benefit, having crew autonomy to decide whether or not to take the risk, and including the principle of fairness. NASA must also ensure that there is a transparent and explicit way for informed consent by the crew members. The Panel believes that NASA did a very good job in laying out the decision framework to allow risk-based decisions if the value of taking the risk is deemed to be worthwhile. The allowance is by exception only and must be approved by the Administrator. It also protects the crew to petition for exceptions. NASA has basically operationalized the IOM report and has done a very credible job.

Mr. Frost noted that the radiation issue is important because currently, there is no technology with reasonable mass that can fully protect the astronauts. The medical Technical Authority is keeping the pressure on NASA by requiring that the exceptions are on a case-by-case basis and only if absolutely necessary. Dr. Bagian added that there is also a requirement that even when an exception has been made, the Agency must continue to pursue mitigation strategies and new technologies. NASA must engage in a continuous improvement effort to reduce the health and medical risk.

Dr. Donald McErlean noted that one of the unique parts of the radiation risk is that it probably does not pose an instantaneous risk, but presents considerable risk to the state of the astronaut's health in the future.

Update from the Office of Safety and Mission Assurance (OSMA) on Processes for Managing Risk with Clear Accountability

Dr. George Nield, head of commercial space for the Federal Aviation Administration (FAA), reported on what was learned from Dr. Homayoon Dezfuli, Technical Fellow for System Safety in OSMA, on the development of a formal process for risk acceptance. This subject has been of interest to the ASAP for a number of years. NASA is routinely engaged in expanding the envelope and pushing the state-of-the-art; therefore, identifying and managing risk is something that must be done on a regular basis. The goal is to do so using processes that are transparent and understandable to the workforce and that involve clear accountability for risk acceptance. NASA had previously documented its approach in several directives, including the NASA Policy for Safety and Mission Success (NPD 8700.1) and the NASA Directive for Risk Management (NPR 8000.4). However, the ASAP has felt that there was some room for improvement in terms of how the policies were being communicated and implemented. In particular, the ASAP had questions about the proper roles and responsibilities of Technical Authorities in dealing with dissenting opinions and in the subtle but important distinction between having a control board discuss an issue and approve a decision and having an accountable individual sign a piece of paper accepting the risk associated with that decision. It is the Panel's understanding that NASA has developed an update to those risk management policy directives that will clarify the role of Technical Authorities in the decision process and that would incorporate single-signature risk acceptance. The ASAP was pleased to hear this news and is looking forward to seeing the final document. In discussing the next steps, Mr. Robert Lightfoot, NASA Associate Administrator, pointed out that the normal Agency-wide review and approval process for management directives can take over a year. However, by issuing an "interim" directive, something can be released within the next couple of months. The ASAP believes that action would be very appropriate in this case and commends NASA for trying to quickly resolve this challenging issue.

Mr. Frost added that Mr. Lightfoot's commitment to do this in an urgent fashion speaks volumes about his understanding of the importance of this topic and his support of safety throughout the Agency.

Update on Exploration Systems Development (ESD)

CAPT Brent Jett, former astronaut, reported on what the Panel learned about three ESD topics on the second day of fact-finding. Mr. Marshall Smith, Chief Engineer for exploration systems, provided a status update on Cross Program Systems Integration (CSI). This is a topic that the ASAP discusses at every quarterly for a couple of reasons. First, systems integration is always challenging and is critical to the success of complex development programs. Second, as noted in the ASAP's last two annual reports, NASA does not have the traditional overarching program enveloping SLS, Orion, and Ground Systems Development and Operations (GSDO), which adds to the systems integration challenge.

The briefing covered program and element interdependencies, integrated product development, cross program issues and concerns, and independent assessments in progress. The Panel noted that the Cross Program System Integration Team (CPIT) continues to do a good job of resolving issues and dealing with system interdependencies. Even without an overarching program of record, the team appears to have the mindset of addressing the three individual programs as one large integrated system, which is very important. They are very focused on the upcoming test and integration phases for the hardware. Overall, the Panel will continue to follow the CPIT as they address the challenges that will inevitably arise as the hardware goes through test and is assembled for first flight.

Dr. McErlean noted that it is a known fact that complex systems integration, or what is typically known as "large scale integration (LSI)," is a difficult and time-consuming process that requires massive attention to a myriad of detail. The integrated system can demonstrate what is known in the systems integration world as "emergent behavior," which is system behavior that cannot be predicted from the simple linear addition of the

components' behaviors. In reality, this is not surprising, because integrated performance is the reason why systems are built. The difficulty is that to the extent the systems are not tested—either as subsystems or as integrated systems—the emergent behavior may not be discovered. The ASAP was pleased that the LSI program that is currently underway has taken that into account. They are building test articles that show increased amounts of integration and buildup toward the final integrated system. Although the ASAP recognized this as a positive step, it counseled that this emergent behavior potential must be kept in mind throughout the program and safeguarded against.

CAPT Jett continued with his report. The ASAP had a brief update by Mr. Jerry Cook, the SLS Deputy Program Manager, on the SLS status and current issues. The discussion was brief because some of the Panel members recently completed insight visits to both Stennis Space Center (SSC) and Michoud Assembly Facility (MAF), where they were able to see the SLS test and flight hardware that has been manufactured or is in fabrication. Thanks to a full day with the MAF team and, in particular, Mr. Steve Doering, the Panel was already cognizant of the SLS status.

Mr. John Blevins, the Lead Engineer for Aerodynamics and Acoustics, provided a detailed explanation on how computational fluid dynamics (CFD) and wind tunnel tests are used as complementary tools for understanding the SLS/Orion aerodynamics for launch and ascent. This was an excellent presentation by Mr. Blevins, who made a complex topic easy to understand. In summary, wind tunnel tests are performed where CFD is too expensive, takes too long, or cannot provide confident solutions. Also, wind tunnel tests are used to anchor CFD analysis.

For SLS and Orion, the first area where CFD cannot provide confident solutions is in unsteady aerodynamics. There are essentially two areas of unsteady aerodynamics. The first one is known as "buffet," which is the transonic, low frequency shock oscillations that the vehicle experiences. As any angle of attack comes on the vehicle, this causes bending moments that can be fairly large on the entire vehicle. On the initial runs, the analysis showed fairly high bending loads on SLS, and the team realized that they needed to look at this problem. They updated the model being used in the wind tunnel to a higher fidelity and reran the tests. The conclusion reached was that rather than changing the configuration of SLS to try to limit these bending loads due to buffet, they put an angle-on-ascent (AOA) limit on the vehicle as it goes through the transonic region. It is common for launch vehicles to have fairly tight constraints as they go through the transonic region and max-Q. The limit for SLS is four degrees (revised from six degrees), which brings the loads down to an acceptable level.

The second area of unsteady aerodynamics is referred to as aeroacoustics, which is the higher frequency turbulent boundary layer/vortex shedding phenomena, which are typically localized effects. There is some discussion on CFD advancing into this area in the future, but it cannot be done today. Therefore, aeroacoustics must be tested in the wind tunnel. The tests are run up to about Mach 2.5; at that point, the dynamic pressure during the launch phase is so low that the loads are no longer an issue.

The third area where CFD cannot provide confident solutions involves the loads that the vehicle experiences from winds during rollout, sitting at the pad, and during liftoff and transition. CFD does not do a very good job with very low velocity flows. Dr. McErlean added that given the state of the analysis and the mathematics, it is not possible to do CFD where the flow is so low. NASA did a great job using the wind tunnels to look at not only getting the vehicle to the Pad and the wind on the pad, but the initial phase of launch and ascent.

CFD takes too long and is too expensive when calculating ascent forces and moments. This is important because the guidance, navigation, and control (GNC) team needs to understand all of those throughout ascent. The center of pressure changes as the vehicle goes through the transonic region. Comparing wind tunnel tests with CFD, the team could run 17,000 flight condition in a week in the wind tunnel, but CFD could only do about 375 in

a month. CFD is more expensive and takes longer; using the wind tunnel is much more cost effective for those forces and moments coefficients.

Lastly, models are anchored by wind tunnel tests for booster separation. During booster firing, the plume is impinging back on the SLS. This is a difficult problem for CFD, and wind tunnel tests serve to anchor the model. Also, for base heating, it is important to anchor the CFD models with wind tunnel testing.

Dr. McErlean added that he was impressed with the briefing. He noted that in his past experience, he served on two panels that looked into whether or not to close the wind tunnels. Both panels concluded that it would be foolish to close them, although this was not a popular conclusion at the time. Fortunately, in both instances, the panels' conclusions prevailed, and NASA's wind tunnel capability is still viable. He also recounted a story relative to the importance of aerodynamics. In the 1960s during an AIAA meeting, there was a well-documented interview with Mikoyin, a famous Russian aircraft designer. When asked if aerodynamics would be less important in the future (because everything would be done with rockets), he replied that we live at the bottom of an ocean of air, and as long as we live here, we will probably have to figure out how to get around in it. CAPT Jett remarked that overall, the approach that ESD has taken to use CFD and wind tunnels as complementary tools instills confidence in everyone on the Panel.

The ESD Chief Safety Officer, Mr. George Gafka, provided the Panel with an early preview of two independent capabilities that are being developed by his organization. These are not the classic independent assessments – rather, they are tools to collect risk information already available and present it in a way that allows managers to better understand the aggregate risk associated with a mission and to highlight first-flight hardware. This can be actual first-flight hardware, or hardware that has flown before but is in a new configuration, or hardware that is being certified for new environments. CAPT Jett emphasized that these assessments or tools are in their preliminary phases, but the plan is to be ready for EM-1 and all subsequent missions. Collectively, the Panel sees great potential in these tools and looks forward to their maturation and eventual rollout.

International Space Station

Dr. McErlean reported on what the ASAP learned from Mr. Kirk Shireman, ISS Program Manager, on the status of the ISS and deorbit planning. The ISS is a demonstration of the prowess of NASA and the international community in space technology. One of the topics that pertains to operations and better crew efficiency is reduction in the "gap" period between the departure of a crewed Soyuz and the arrival of the next one. During this interval, the ISS is fewer in crew than it would be when fully occupied. NASA and Russia have worked to shorten that interval to provide more crew time for utilization tasks.

Orbital ATK successfully launched the Cygnus cargo vehicle on Orbital-6, using an Atlas V rocket. It is currently on Station and is due to leave in June. SpaceX-8 was fully successful in its ISS mission. In addition, SpaceX returned the first stage and successfully landed it on a barge in the ocean. SpaceX-9, currently in preparation, will carry the commercial crew adapter, which will allow the commercial crew vehicles to successfully dock with ISS. The Program has planned the necessary extravehicular activities (EVAs) to install this adapter.

To explore the potential for auxiliary missions, ISS is coordinating with Orbital ATK to launch a series of Cubesats. This coordination will help to minimize ISS debris avoidance maneuvers. Dr. Nield noted that although there was not extensive dialogue about it, the fact that NASA is expecting to have a number of these small satellite deployments in and around the Station in future years reminds us of the importance of tracking what is in orbit and being responsible in terms of protecting and sustaining the space environment. Whether or not some type of space-traffic-management philosophy can be adopted by the U.S. and the international community in the near term, this is an issue the ASAP needs to pay attention to in the future. CAPT Jett added that Cubesats are

becoming extremely popular. NASA anticipates that there will be more and more Cubesats deployed at altitudes higher than the ISS, and as those satellites degrade and pass through the same altitude as the ISS, they present a risk. Fortunately, the Cubesats are large enough to be tracked, so that if one does represent a threat, the ISS would have enough warning to do an avoidance maneuver. NASA continues to make progress and supports commercial programs that will eventually lead to higher exploitation of space and its assets as well as build a robust space industry.

Dr. McErlean highlighted some upcoming events. Orbital-5 (occurring after Orbital-6) will be the first mission use of the new Antares rocket that replaces the one involved in the Wallops Flight Facility incident. The hot fire for the full stage is scheduled for later this month. The H-II Transfer Vehicle (HTV)-6 is planned to deliver cargo in early October. The Bigelow Expandable Activity Module (BEAM) deployment is an extremely important milestone. The BEAM represents a current solution for providing habitat or storage for long duration mission flights. This will be the first use of an expandable module in NASA's space programs. In the fall, when Orbital-5 undocks from the ISS, there will be a controlled fire experiment, Saffire, inside the capsule to determine how fire behaves in a space environment. Ultimately, it is hoped that this will lead to improved fire safety and prevention programs in space transportation. In a three-year voyage to Mars, the potential risk for a small fire is much higher, and the development of a fire prevention/extinguishing system becomes more important.

The ISS has had another incident of water in a spacesuit helmet. The quantity of water in this incident was much less than in the previous incident in 2014, but it was enough to cause early termination of the EVA. NASA believes that they have tracked the cause, but they are not anywhere near the root cause of these incidents; troubleshooting continues. The ASAP will follow this issue closely.

The Panel has worked with the ISS Program for a number of years on End-Of-Life (EOL) planning for the ISS system. Preparing for the process that they will undergo when EOL occurs, or how to respond in an emergency situation (involving possible rapid de-crewing of the Station) is extremely important. Recently, there was a major milestone—NASA and Russia conducted a bilateral EOL technical interchange meeting (TIM) in Houston last month, and they have produced a joint strategy document and contingency action plan for EOL planning. These agreements were reached between NASA and Russia, but have been approved by all of the key EOL participants. The document will be updated as necessary; it is a major step forward. They have defined the key work that must occur and the EOL strategy document updates that were identified in the TIM protocol. For everyone, they will continue to refine and sign a multilateral agreement on EOL strategy. Analysts will be doing additional estimates for the footprint size, depending on the final burn delta V, as well as the optimal daily orbits to minimize any possible casualties. They will refine the total attitude control cost estimates. NASA is working very carefully to ensure that avionics will be able to operate for up to six months in a vacuum, assuming that there will not be a workable environment in the ISS. They are working on how to prevent propellant freezing in the potentially unheated cargo area of the Station. Russia has agreed to implement certain Progress and software modifications to allow the integrated burns of multiple engines, as well as the final deorbit-burn sequence from the Progress and potential Soyuz vehicles that are docked on the Station at the time of the deorbit incident. They will need to do further analysis of the dual-burn concept and to ensure that additional Progress vehicles can dock to ISS following contingency and evacuation. NASA and Roscosmos need to have final agreement before work begins, but there is no question that the TIM and the agreement reached on the strategy document is a victory for the entire Program and for the safety planning for this major system.

Mr. Frost noted that in addition, they have developed a list of actions that need to be taken with dates on each one. Getting those accomplished will be the remaining hurtle. Currently, they do not have the capability to safely bring the Station down, and, according to the plan presented, that capability will not be reached until September 2017. He remarked that every day that we do not have that capability, there is a risk of something

bad happening. The Panel encouraged NASA to keep the work going as rapidly as possible. Micro-Meteoroid and Orbital Debris (MMOD) is the number one risk to space flight. MMOD has been monitored carefully and has been growing over the years. It has consisted mainly of moderate numbers of large boosters and large satellites. However, as the number of small satellites (such as CubeSats) increases, the MMOD problem will become exponentially worse.

CAPT Jett amplified on the Panel's concerns regarding the EVA suits. He noted that the second incident was the same serial number suit as the one that experienced the first incident. The Panel is sensitive to the issue that with the end of the Space Shuttle Program, the opportunities to rotate those suits back for maintenance on the ground is more limited. The hardware is aging. In considering ISS through 2024, the Panel is interested in having more discussions with the Program on the EVA suits. Dr. Bagian added that there may be other implications—something in the process of the first incident that may have been missed. The assessments will provide a better understanding on how to look at other vulnerabilities in the future more effectively.

Commercial Crew Program (CCP) Update

Dr. Patricia Sanders reported on the dialogue with Ms. Kathy Lueders, CCP Program Manager, and her staff. Ms. Lueders discussed the execution status of the CCP in detail as well as a number of special topics of interest to the ASAP. As has become the standard, these discussions were detailed, thorough, and candid, and the Panel was impressed with the NASA professionals working the program.

It is clear that both commercial providers appear to be making substantive progress and meeting expected milestones, but they still face some notable challenges. Addressing these challenges will put schedule and cost pressures on the Program, but the NASA Program Office is aware of the potential programmatic, technical, and safety risks and, so far, is managing them effectively. There has been significant progress in closing out the adjudication of alternative standards and hazard reports, but there is still a lag in completing that body of work.

The top risks at the Program level are: (1) the potential for requirements changes with the associated cost risk, (2) the ability to close the gap in meeting the Loss of Crew (LOC) requirement, and (3) the disconnect between training hardware availability and the needs of the Search and Rescue providers. Mitigation for this latter risk is in work and resolution of that issue is expected before too long.

Ms. Lueders shared in depth the risks the Program is addressing with each of the commercial providers and highlighted topics that have been of particular interest to the Panel in past sessions. Several risk areas have been effectively mitigated and are no longer of serious concern. Others have mitigation plans well under way. A few, while being aggressively worked, remain challenging and concerning.

While some of the risk areas are of the technical nature that programs experience in any complex engineering development, there are some that are fairly unique to the nature of the commercial partnership approach in this Program. In particular, the approach encourages the commercial entities to be innovative and to use new processes that are expected to be more efficient and cost effective. However, new processes can come with an uneasiness or discomfort when they seem to violate long standing, established practices. This is forcing the community to examine the underlying rationale for the status quo to determine if, as time and technology advance, there remains a compelling reason to "do it as we always have." This examination is necessary to gain confidence to move forward, and the Panel sees it as a healthy and important step to reconsider the history of long standing practices—to either revalidate them or to understand why a fresh approach may be just as, or more, advantageous.

Dr. Sanders highlighted a few additional items from the dialogue with the Program representatives. First, a question had been raised concerning how prevalent would be the crew's dependence on touch screen actions versus physical switches. The Panel was concerned that there were certain actions where touch screen would be inadequate and cause unsafe conditions. The Panel is now reasonably confident that an appropriate mix is being implemented, and the Program Office is providing data to confirm that. Second, the Panel was pleased to see the cooperation between the CCP and SLS Program to preclude "doing the same work twice." Third, in an area of high ASAP interest, progress is being made in detailed planning for handling any potential mishaps. It is critically important to have a plan in place well before it may ever be needed. The Program Office is on track to complete the plan this year. The Panel continues to urge a reconsideration of the role of Presidential Commissions in mishap investigations. Lastly, it is encouraging to see that details are being worked to execute the certification plans for both providers. This is an area on which the Panel will continue to focus attention.

Marshal Space Flight Center Topic – Workforce for the Future

Mr. Frost wrapped up the meeting with review of a final topic—what MSFC is doing to develop its workforce for the future. The review was provided by Dr. Paul McConnaughey. Mr. Frost noted that this is another example of MSFC using people with a program management background in other positions. Dr. McConnaughey brings his program management skills to workforce development. MSFC did this previously with facilities management, and there is positive outcome from this type of cross-training and integration.

The MSFC demographics are like much of the Agency—the average age is in the 50-51 range, and every year, the average age range becomes one year older. As programs and technologies change, a different mix of skills is needed. MSFC does not have reduction-in-force (RIF) as a tool to redirect the workforce and is using attrition (about three percent) in a creative way. When a person retires, that position is not automatically filled. The Center looks at the skills needed, and that “billet” may be moved to another area. They have a formula where half of the vacancies are filled at entry level (less than GS-11), and half are filled with someone with more experience. This process is working well, and MSFC is getting people in the technologies that are needed. As part of the workforce reshaping, Dr. McConnaughey explained several programs. They are using targeted hiring, realigning, extensive training, and an analytical approach to filling future needed skills. The Agency knows what those skills will be and employees are informed so that they can obtain retraining if necessary.

The Center also does extensive Knowledge Management. Dr. McConnaughey provided several examples of how they actually do Knowledge Management, and these examples appeared to be sound. They included a number of different efforts; for example, they are developing a human space flight lessons learned course. Dr. McErlean amplified on how MSFC is using “Director’s discretionary funds” to work with universities in topics areas of interest and to encourage universities to submit proposals. There is a 50/50 share of funding, and the university executes the program. These types of programs have been extremely valuable. The latest in theoretical knowledge is gained from major universities, and undergraduate and graduate students are supported to complete their education. From NASA’s perspective, these students have primary experience in topics that are of interest to the Nation and space flight programs. Given the proper oversight, the results are usually excellent. The Panel encouraged NASA to continue these types of programs.

Dr. Nield also commended MSFC for the way it is partnering with the local community and professional societies and other groups. Rotation programs are available to gain perspectives and build partnerships. Mr. Frost added that Huntsville is a good location for sharing that kind of information.

Dr. McErlean complimented Mr. George Gafka on his presentation on independent assessments. He noted that this approach moves the safety community from being an “inspector” or “referee” into the realm of providing

additional information to help the program offices and engineering from a safety perspective. These independent assessments do not generate additional data, but they do evaluate data from many sources that are already available, consolidate the data, examine the data from a different perspective, and provide input back to the program offices to help them guide future activities. Mr. Frost observed that this approach moves safety programs from the "no, because" to the "yes, and here's how" approach.

Mr. Frost summarized that there is visible progress on SLS and Orion—drawings are done and hardware is being built and is on the ground. The CCP is working well. NASA needs to remain on course and keep up the good work. He noted that there were no written recommendations from this meeting.

There were no further comments or questions, and the meeting was adjourned at 11:45 a.m.