

NASA AEROSPACE SAFETY ADVISORY PANEL
National Aeronautics and Space Administration
Washington, DC 20546
Dr. Patricia Sanders, Chair

May 6, 2021

Senator Bill Nelson
Administrator
National Aeronautics and Space Administration
Washington, DC 20546

Dear Sen. Nelson:

The Aerospace Safety Advisory Panel (ASAP) held its 2021 Second Quarterly Meeting via teleconference May 4-6, 2021. We greatly appreciate the participation and support that were received from NASA leadership, the subject matter experts, and the support staff.

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

Sincerely,

A handwritten signature in cursive script that reads "Patricia Sanders".

Patricia Sanders
Chair

Enclosure

AEROSPACE SAFETY ADVISORY PANEL

Public Meeting
May 6, 2021
Conference Call

2021 Second Quarterly Meeting Report

Aerospace Safety Advisory Panel (ASAP)

Attendees:

Dr. Patricia Sanders, Chair
Lt Gen (Ret) Susan Helms
Mr. Paul Sean Hill
Dr. Sandra Magnus
Dr. Amy Donahue
Mr. William Bray
Dr. George Nield
Mr. David West
Dr. Richard Williams

ASAP Staff and Support Personnel

Attendees:

Ms. Carol Hamilton, NASA ASAP Executive Director
Ms. Lisa Hackley, NASA ASAP Administrative Officer
Ms. Kerry Leeman, Technical Writer/Editor

Telecon Attendees:

See Attachment 1

Opening Remarks

Ms. Carol Hamilton, ASAP Executive Director, called the meeting to order at 2:00 p.m. ET and welcomed everyone to the ASAP’s Second Quarterly Meeting of 2021. She indicated that no comments or statements had been submitted prior to the meeting, but time would be allocated at the end for public comments.

Dr. Patricia Sanders, ASAP Chair, opened the meeting by noting that the quarter since the ASAP’s last meeting—indeed the entire past year—has seen a period of high activity and achievement for NASA. In this time, there have been multiple Commercial Crew launches and crew missions, significant, complex tests accomplished in Exploration Systems Development (ESD), including the Green Run, and a great deal of important work on the International Space Station (ISS), not to mention some incredible robotic accomplishments in the Mars campaign and significant progress toward the launch of the James Webb Space Telescope. All of this is especially remarkable when considering the limitations imposed by the ongoing pandemic. The Panel received updates and discussions surrounding the ongoing activities in the human space flight areas during their fact-finding meetings held over the course of the week. Dr. Sanders indicated that Panel members would be discussing their observations, assessments, and advice. But, she added, the Panel intends to retain its focus on the evolution of NASA—its roles,

responsibilities, and mission going forward—and the critical strategic deliberations and decisions that face the Agency.

Dr. Sanders remarked that the Agency is not the same as it was 10 years ago, and most assuredly it will not be the same as it is 10 years or even 5 years from now. The commercial space industry continues to grow rapidly, and global interest continues to increase. This environment in which NASA operates will not walk itself back, she noted, and these developments have tremendous upside potential—and are accompanied by equally tremendous challenges for managing the risk of human space exploration. Concurrently, the human exploration endeavors NASA is leading are becoming ever more complex, and with more risk, from the lunar exploration to eventual excursions to Mars and beyond.

In light of the dynamic and evolving nature of the commercial and international space communities and their expanding activities, Dr. Sanders observed that the Agency needs to determine its future role and how it plans to transition going forward while managing the risks that will still be associated with its human space exploration mission.

How the Agency plans to evolve and transition to an organization that more frequently procures human space flight capabilities as services, while managing a wholly new human exploration campaign, is a key strategic question that has the Panel's attention. Dr. Sanders noted that the Commercial Resupply Service (CRS) and the Commercial Crew Program (CCP) were forays into the commercial environment, that have seen great success, but these programs are based on a broad, strong foundation of understanding of launch and low-Earth orbit (LEO) operations across the space sector derived from 50 years of NASA activities. The emerging challenges for NASA, especially as they manage the lunar campaign, include the melding of traditional and innovative program approaches, including the acquisition, integration, and certification of commercial human spaceflight capabilities that carry high levels of risk. As this Panel stated in the ASAP 2020 Annual Report, there are clear advantages to leveraging the industry innovators for this campaign, but NASA must still manage the overall risks, even when they do not control nor dictate the material solutions for some of the Artemis campaign components and services, such as the Human Landing System (HLS). How NASA plans to manage integrated risk under this context, including the contractual risk management requirements and vendor relationships, remains unclear, Dr. Sanders said. She then asked Mr. William Bray for his professional insights from his experience with the Department of Defense (DoD).

Mr. Bray stated that twenty-five years ago, as a result of the peace dividend, the DoD entered a period of heavy reliance on industry to deliver weapon systems and platforms and technical expertise, minimizing the amount of engineering and technical development occurring inside the DoD. As a result, over the subsequent two decades, much of the DoD's inherent technical capabilities eroded across most of the services. As a consequence, Mr. Bray indicated, the ability for the DoD to make effective programmatic and technical decisions significantly eroded and had to be rebuilt. NASA is currently facing many of the same strategic decisions that the DoD did 25 years ago, he noted. As the Agency looks to the future and its strategy on how to engage with the commercial sector, Mr. Bray emphasized that it is critical to understand those

implications that the DoD is still living with today and absorb any lessons learned as NASA thinks through its workforce, infrastructure, and inherently governmental capability needs in the coming decades.

Dr. Sanders thanked Mr. Bray for his observations and noted that achieving the right balance is difficult. The ASAP is concerned about the implications for the safety of the nation's astronauts and the risks attendant with mission assurance that result based on how the right balance is defined and managed. For example, Dr. Sanders explained, NASA needs to figure out how to exercise appropriate accountability—or hold its vendors accountable—for the successful accomplishment of its mission across the full spectrum of acquisition and development approaches.

NASA Evolution and Workforce

She added that NASA's approach is complicated by the nation's current lack of a comprehensive regulatory framework for human commercial spaceflight. Currently, NASA retains full accountability, but there exists no external government regulations or rules that help the Agency manage risk or even set a baseline level of expectation for the providers related to human occupant safety. In some ways, Dr. Sanders opined, NASA is working in a vacuum: being asked to delegate vehicle design and development to contractors but in an environment where there are no other "rules" to drive outcomes for the safety of NASA's people. A regulatory framework that addresses occupant safety would at least provide NASA with some foundational support for driving risk mitigation, even if that baseline is not up to what NASA might consider "its standards," she stated, and added that NASA has been at this point before for different regimes as many of the Panel members have noted in their discussions.

Mr. Paul Hill compared the evolution of NASA's regulatory framework with the creation of the nation's airmail service in the early 1900s, and the advent of commercial aviation more broadly. For more than a decade, NASA has made this comparison to its commercial cargo and commercial crew procurement approach. There are two facets to this comparison that have come up in Panel discussions. First is the reminder that early in airmail development there was an alarming growth in aircraft accidents that then fostered the need for what would become the Federal Aviation Authority (FAA) and its regulatory environment, as Dr. Sanders mentioned earlier. This is not to suggest that there are necessarily going to be a growing number of accidents stemming from this burgeoning commercial space industry, but it is a reminder that there are still very real risks involved in flying people in space, just as there were in the early days of aviation. In fact, compared to air travel, there are significantly higher risks involved with space flight to include the ground crews, passengers and crew on board, and the general public. Much of human space flight—commercial and governmental—is still operating without the same comprehensive regulatory environment.

Secondly, even after the advent of airmail and commercial aviation, there were and still are valid roles for government aviation, most notably but not exclusively by the military. NASA and its stakeholders should carefully consider the similar continuing NASA roles both in development and operations while increasing its reliance on these commercial services contracts. Both serve

valid goals, but it has to be very well-thought-out with a clear understanding of what the Agency will continue to execute and why, which operations it will purchase as services and why, and how NASA will manage risk in both settings.

Mr. Dave West shared another relevant historical example of governmental roles in regulation. About 75 years ago, after the end of World War II, the Atomic Energy Commission (AEC) was established. Initially, it was charged with not only advocating and promoting but also supporting the development of nuclear power. After some time, it became clear that this emerging technology carried with it inherent risks to workers and the public, much like space travel. It became clear that nuclear power had to be regulated to control those hazards. As an agency, the AEC was charged with advocating and promoting nuclear power, so it was not appropriate for it to regulate it. Eventually, the AEC was split and reorganized into both the Nuclear Regulatory Commission, that today carries with it the regulation piece, and eventually what has become the Department of Energy.

Dr. George Nield added to the governmental regulatory discussion. He noted that the U.S. actually does have a regulatory framework, even though it is not exactly of the form that the Panel has been talking about. At the very highest level is the Outer Space Treaty, which has been ratified by the United States and over 100 other nations. Article 6 requires that the activities of non-governmental entities in outer space be authorized and continuously supervised by the appropriate state party to the treaty. Exactly how this is done is up to the national government affected. Article 7 of the treaty says that the signatories are internationally liable for any damage that might be caused to other spacecraft. In the United States, there are several different organizations that have responsibilities. The FAA is responsible for licensing commercial launches and reentries, with a specific focus on the safety of the uninjured public on the ground. The Federal Communications Commission is responsible for licensing radio broadcasts from space. The National Oceanic and Atmospheric Administration is responsible for licensing remote sensing operations, such as taking pictures of the Earth. NASA and the DoD are key players in space, but they are not regulatory agencies. That leaves us with a gap in authority. Given the importance of space to national security and technological leadership and international competitiveness, the Panel believes that it is vital for the United States to act now to preserve the safety of space operations and the safety of the environment. As mentioned in the ASAP 2020 Annual Report, the next step is to designate a civil agency to oversee space traffic management.

Dr. Sandra Magnus added to the discussion. The Panel has looked at NASA's challenge in managing risk in the lunar campaign going forward, and in a general era of acquiring lunar services. There is a lack of any external guidelines for these companies. And as these companies engage in other activities outside of NASA, what lessons are they learning? How are they folding those lessons into NASA's risk posture? Whether these entities are learning good lessons or bad lessons, there is no baseline that people are working from in terms of regulations that Dr. Nield discussed and what Mr. Hill and Mr. West drew parallels upon. This issue is a ball of yarn that is knotted together, and these things cannot be looked at independently. As noted, under the Outer Space Treaty, the United States is responsible for non-governmental orbital activities of

its citizens. Now we have commercial orbital activities, but we have zero framework there for any kind of baseline or rules of the road. This is why the Panel is bringing up these kinds of issues.

Dr. Sanders thanked Panel members for their input. She then indicated that while the evolution is going to require some activity outside of NASA itself, the ASAP strongly continues to recommend that NASA tackle its future—top down from the senior leadership—strategically and aggressively. The ASAP continues to pose the following key questions:

- What role does NASA intend to perform going forward and why?
- How will the Agency interact with commercial and international partners?
- How will the Agency address shared risks?
- What management practices will be employed?
- How will expectations be communicated to partners and the workforce?
- How will effective Systems Engineering and Integration (SE&I) be accomplished?
- What will the NASA workforce of the future look like and how will it be achieved?

NASA has consistently reacted and adapted to the changing environment and must continue to do so, advised Dr. Sanders. The strength of NASA, as a government agency, is its ability to continue to push boundaries in exploration and technology in ways that the commercial sector cannot and in ways that benefit the whole of the country—not a minimal set of companies. Much of the discussions of this week and preceding meetings demonstrate that, Dr. Sanders stated. Kennedy Space Center has transformed itself from the traditional NASA Center to an increasingly commercially used spaceport. Dr. Sanders indicated that CRS and CCP have provided important lessons that chart the path to the future, which are being leveraged in the HLS program. Among the Panel's discussion topics this week were the NASA efforts into LEO commercialization and the potential for Private Astronaut Missions (PAMs). Dr. Sanders finds that these are positive steps forward, but they are not yet a holistic or fully strategic evolution. The Panel engaged with NASA on efforts for human capital planning, but these efforts also are not yet reflective of a holistic comprehensive Agency strategy, added Dr. Sanders.

She echoed the Panel's collective sentiment stating that now is the time for NASA to spend the time and energy to think strategically about its future and define clearly—as the industry and the Agency continue along the evolutionary path they are traveling—the impacts on risk management and mission assurance, including astronaut safety. The Panel intends to devote the third quarterly series of meetings in July largely toward engaging with NASA further on this topic.

Meanwhile, the ASAP engaged with NASA on a number of important topics this week. One that is always of high interest to the Panel is overall integration of the human exploration mission. Dr. Sanders invited Mr. Bray to start the discussion on that topic.

Human Exploration and Operations

In regard to the Human Exploration and Operations (HEO) role, the Panel continues to see the importance and criticality of their mission architecture definition and mission engineering and integration efforts. These activities, Mr. Bray reflected, will establish the baseline mission architecture, the overall mission-level requirements, and define critical mission gaps and set investment priorities for the Agency to resolve these gaps. Nevertheless, the Panel views these crucial activities and efforts as mission engineering and integration rather than a traditional SE&I function that is being executed at the design and development level within the Advanced Exploration Systems (AES) and ESD organizations. It is good to see how the Agency has tightly coupled and integrated these functions; however, the Panel believes continued referral to the HEO efforts as an SE&I function rather than a mission engineering and integration function will continue to create confusion.

Given the complexity of the Artemis project, supporting processes, and the sometimes imprecise application of terminology such SE&I, Mr. Bray advised that the Agency needs a concerted effort at clearly communicating to the workforce and engineering community the roles and responsibilities of the various organizations, systems engineering processes and boards, and the supporting engineering tools in use so that the entire NASA team understands the concept of operations, and most importantly, who is accountable for the risk acceptance and final decisions. NASA has initiated efforts to communicate these ideas through “all hands” meetings and workshops. The Panel applauds this initiative and highly recommends that it continue as the engineering processes and associated organizations and boards mature. In addition, Mr. Bray stated, finalization and publication of key engineering and implementation documentation and artifacts delineating these roles and responsibilities, process definitions, and decision-making authorities will be important as authoritative and foundational documentation and references. He encouraged continued communication to the workforce—circle back and check and re-check as to whether the engineering directors and those in the trenches really understand the engineering processes and boards and operate as expected—will be critical to the Agency’s success with the Artemis mission set.

Finally, with the strong reliance and partnership with the commercial sector for the success of the Artemis mission set, it is highly encouraged that the Agency regularly engage the commercial sector through communities of practice and standardization boards to ensure definition and alignment of key technical standards to enable future designs and facilitate commercial activities that could evolve independent of government mission needs, advised Mr. Bray. By working proactively with industry, he continued, NASA will create a modular and open system design, which can be leveraged for the future larger set of Artemis missions and associated design requirements. This strategic engagement now rather than later will enable discussion and insight on some of the more longer-term technical challenges critical to the mission to Mars. Mr. Bray concluded that a strategic framework will also provide NASA an early opportunity to engage with industry to lay the groundwork for establishing the necessary infrastructure that will enhance private non-governmental enterprise on the Moon when NASA decides to extend its activities to Mars.

Dr. Sanders thanked Mr. Bray for his articulations, and noted that the Panel spent time engaging more deeply into the overall Artemis campaigns. Dr. Nield was then introduced to lead off on that topic.

Artemis

Dr. Nield stated that the Panel looked at a number of different aspects of the Artemis Program over the course of the week. He invited Dr. Magnus to start off the Panel's report with the status of the hardware, the organizational structure, and some comments about the communication of technical issues.

Dr. Magnus affirmed that NASA has made a lot of progress lately on the Artemis Program. The Panel congratulates the government/industry team on the recent successful Green Run test, and most importantly, on the fortitude and foresight to establish the requirements for the test and then complete it, achieving all objectives. This test served as an important risk mitigation step, not only for Artemis-I, but for subsequent crewed launches. The Space Launch System (SLS) core stage recently arrived in Florida, a notable and long-awaited milestone along the path towards the Artemis-I launch. With the processing plan in place, Dr. Magnus acknowledged that NASA will now start executing the steps needed to prepare the SLS and Orion systems for launch. The processing flow later this year will be the first time the complete end-to-end software and hardware elements will be assembled and integrated. The Panel is looking forward to hearing about the results of the Integrated Verification Test that provides the assurance that the full stack is ready for launch.

One of the topics the Panel has been following is the evolution and formulation of how NASA will manage the complex SE&I functions needed to understand and mitigate risk for the lunar campaign. As mentioned in the ASAP 2020 Annual Report, there are numerous different program elements at different stages of maturity that encompass sending humans back to the Moon. Making the matter more complicated, Dr. Magnus stated, is NASA's use of different acquisition strategies for the various elements. This week the Panel received an update on the approach that NASA will put in place, and they were pleased to see quite a lot of progress since last fall. First and foremost, the Panel expressed thanks to Ms. Erika Alvarez and Mr. Wayne Jermstad for an excellent, well-articulated presentation on a very complex subject. Ms. Alvarez explained the organizational structure of the SE&I function as well as the program board structure that NASA is implementing—a structure that is well understood by the Agency—having been used in previous programs. NASA is instituting two levels of joint boards to manage integrated decision-making across the programs in the AES division, and as well between AES and the ESD. Dr. Magnus shared that the team has also started to produce the necessary governance and technical guidance documents for access by the teams across the whole enterprise. Most importantly, she noted, is that the whole team will be relying on an enterprise-wide requirements/configuration management tool to track open issues and the flow down of requirements across the different programs.

The Panel also noted that Ralph Roe, NASA's Chief Engineer, is maintaining an independent status of the technical issues being worked across the lunar campaign enterprise in a weekly forum that includes the Engineering Directors from the relevant NASA field centers, as well as all of the program element Chief Engineers. Dr. Magnus added that this group, while not the primary organizational unit to formally resolve issues, does serve as an additional communication channel to ensure that important topics and concerns are clearly communicated across the broad landscape of the lunar program activities.

Dr. Nield then asked Mr. Hill to discuss some of the Panel's observations related to risk management processes for Artemis, the acquisition approaches being used for the HLS, and the tools NASA plans to apply to ensure that its safety requirements are met.

As the lunar campaign activities continue to mature, the Panel will be interested in learning more about the risk management process that NASA will employ. The transition from "NASA-centric" programs to "commercial programs" that was discussed in the ASAP 2020 Annual Report has a profound effect on how the Agency manages risk. For example, Mr. Hill stated, in the traditional NASA-centric methodology, NASA has both the accountability for and the authority to make decisions about risk, being able to direct contractor decisions that relate to risk. In a purely commercial model, the contractor has the accountability for and the authority to make decisions affecting risk and the customer can choose to buy the product or not. However, NASA's move to "commercial space" has not yet reached the maturity of a purely commercial model, reflected Mr. Hill. Consequently, during this transition, NASA has the accountability for safety but, depending on the acquisition model deployed, does not necessarily have the authority to direct contractor decisions that affect risk posture. He indicated that this dichotomy, along with the need to strategically define what the Agency's future work force should look like, is forcing the Agency to adopt new approaches to influence contractors in order to drive decisions for risk mitigation.

In the case of the HLS, which NASA is pursuing under a "commercial services" acquisition model similar to the CCP, it is applying many of the lessons learned from CCP concerning how to drive the desired behavior in the contractors during the design and development phase. For example, Mr. Hill elaborated, NASA was able to gain agreement early on the standards that will be used, and NASA has engaged its technical experts with the providers right from the start of the program. NASA is encouraging a collaborative team approach with industry, under which its engineers are able to provide technical advice and assistance when requested, while benefiting from hands-on experience through working with real hardware. Although this approach appears to have a number of advantages, Mr. Hill indicated that one challenge will be to ensure that there is no blurring of the lines of accountability: NASA is responsible for establishing its mission and safety requirements, while the provider is responsible for system design and for ensuring that it satisfies the government's requirements.

NASA does believe it has the management control it needs, primarily through two levers; it has the ability to withhold milestone payments under the fixed-price contract, and it gets to decide whether or not to certify the systems that have been developed. Developing the certification

process has required a lot of work up front to define the requirements that the providers must meet. Outside of these two levers, NASA plans to establish and maintain relationships with the providers at the technical level, and to use these relationships to retain enough insight into the system design that the Agency can address risk-related issues early. Whether this approach will be sufficient remains to be seen, stated Mr. Hill. The Panel continues to be concerned about the blurring between authority and accountability in the context of risk-related decisions, from design to operations. Clarity of roles and responsibilities between industry's technical workforce and the NASA technical workforce is vital, even with the collaborative model that NASA has chosen to implement.

Mr. Hill emphasized that these are complex issues, but they are representative of the challenges that NASA will face in its future human spaceflight programs, and should be carefully considered as NASA develops its strategic plan for the kind of workforce it will need in future years.

Dr. Sanders called upon Mr. West to initiate a summary of discussions with the CCP.

Commercial Crew Program

As Dr. Sanders noted in her opening comments, there has been a great deal of activity recently across many of NASA's programs. This is certainly true of the CCP, which has been logging some significant accomplishments, said Mr. West. As it transitions into a steady state operation, the CCP is proving the effectiveness of—and serving as the model for—new acquisition strategies for commercial space transportation services. The successes of the CCP are helping to secure and sustain NASA's position as the world leader in space program development and execution. As one of the two CCP providers, SpaceX is past the development and demonstration phase and is now flying crew rotation missions to the ISS. The Crew-1 mission spent 168 days in orbit and now holds the record for the longest mission duration of a crewed U.S. spacecraft. NASA is working with SpaceX on a variety of spacecraft engineering efforts—in some cases, pursuing design improvements, and in other cases, upgrades. From vehicle processing to in-flight decision making, the combined NASA-SpaceX team is gaining experience and learning lessons, noted Mr. West.

Boeing is making progress toward its second orbital flight test (OFT-2). NASA has just released a target date of July 30, 2021, for the launch of OFT-2. This test flight is intended to pave the way to Boeing's first crewed test flight, to be followed by ISS crew rotation services. Boeing is working through some engineering fixes, and there is good confidence within NASA as Boeing approaches readiness for OFT-2. There are several open items that will require resolution prior to the crewed flight test (CFT), but the current focus is on preparing for the OFT-2 flight. The Panel will continue to follow the team's efforts as they prepare for the crewed mission.

The new ground being plowed by CCP is impressive, observed Mr. West, but it also highlights some of the important questions raised earlier in this meeting and discussed in the ASAP 2020 Annual Report—questions about the evolving role of NASA and its long-term approach to accountability and risk management, and how expectations will be communicated to its partners as it transitions to that role. As more time passes since NASA was directly involved in

continuing space launch, flight, entry, and landing operations, the Agency will have less experience-based expertise among its managers and senior leaders—those who will make decisions and accept risks, both preflight and during each mission. Maintaining that expertise will require a different approach going forward than has been used throughout NASA’s history, and the Panel encourages the Agency to deliberately step up to the challenge.

Between now and the Panel’s next quarterly meeting, members will be closely monitoring the CCP, not only for activities and achievements, but also for signs that NASA and its providers understand and meet the challenges the Panel has been pointing out with respect to new roles and responsibilities, workforce shifts, loss of organic expertise, and the need for effective communication and resources. The Panel will also be watchful to ensure that the program does not succumb to complacency in the wake of its recent successes. Safety culture is at the heart of mission success in the CCP. Dr. Amy Donahue was invited to elaborate on NASA’s current efforts in this regard.

NASA’s Safety Culture

One of the Panel’s most central concerns is NASA management and culture issues related to safety. Dr. Donahue noted that NASA agrees about the importance of this focus. The Agency has explicitly stated their view that a workforce with a strong safety culture is vital to achieving mission success. The Panel has previously made the recommendation that NASA’s Office of Safety and Mission Assurance (OSMA) have processes to verify effective safety culture, and NASA has taken this to heart, having engaged in several safety culture outreach and training activities in the past several years. This includes 14 intensive Organizational Safety Assessments (OSAs). Thirteen of these have been internal, and one was with its partner, SpaceX, a couple of years ago.

The goal of the OSAs is to gain foresight about organizational dynamics that might be problematic and contribute to mishaps. Dr. Donahue stated that experience shows these kinds of assessments are an important way to help assure a focus on safety is driving behavior in meaningful ways. Apparently, she continued, evidence from years of similar examples in the DoD shows that operational organizations that engage in OSAs experience a reduction in mishaps.

At NASA, the assessments typically involve interviews with many dozens of people at various levels, from senior managers to frontline technical workers. The interviews are conducted by a team with experts from engineering, life sciences, medical, and sometimes the relevant program. These assessments are led by Dr. Tracy Dillinger, who is a deeply experienced expert in designing and conducting them. Importantly, Dr. Dillinger made very clear to the Panel that these assessments are *not* technical reviews, inspections, or “audits,” a term that is sometimes used (imprecisely) to describe these activities, said Dr. Donahue. While these other sorts of activities are important compliance-oriented efforts, OSAs have a different purpose and approach. They examine organizational structures, processes, dynamics, and communications through a safety lens, grounded in the perceptions of the people engaged in technical and operational work at various levels in the organization. The results of the assessment are then

shared with the Agency's leadership to precipitate close and candid conversations about understanding and behavior that could be changed to improve safety, mitigate risk, and ultimately protect the lives of astronauts.

In short, Dr. Donahue explained, OSAs can be powerful tools for gaining insight and perspective. To be productive, though, this greater self-awareness must then be operationalized in the form of corrective action plans. As a case in point, the Panel understand that recently NASA and SpaceX have been able to use what they learned from their joint OSA to make specific safety-related improvements in procedures.

At the Panel's last quarterly meeting, after members heard about Boeing's response to the OFT-1 anomalies and subsequent preparations for OFT-2, it was noted that the Panel was still waiting for NASA to take action on a safety culture assessment that had recently been planned and was to have been conducted by then. The Panel observed then, and they continue to believe, that safety culture assessments must be performed soon to ensure that any lingering systemic issues related to risk management, quality, and safety are identified and corrected—certainly before CFT takes place, but now even before OFT-2. The Panel understands that NASA and Boeing have recently agreed on a plan to proceed with an OSA conducted by a joint NASA-Boeing team led by Dr. Dillinger very soon. The Panel has great confidence in Dr. Dillinger's expertise in designing and executing these processes, and expect the joint NASA-Boeing OSA to yield findings and insights that can productively inform leaders at both NASA and Boeing. Importantly, Dr. Donahue stated, the Panel is hopeful that the OSA can offer insights that would help NASA and Boeing guard against future mistakes and also enhance their ability to catch those mistakes that do occur. The Panel will be very interested to hear how the process went at the next meeting in July.

Dr. Sanders thanked Dr. Donahue for her insights regarding NASA's safety culture. Dr. Sanders then stated that the Panel received an update and discussion on NASA's efforts with respect to commercial activities in LEO. She returned to Dr. Nield to say a few words about that topic.

Although NASA has completed a number of studies to determine whether the lifetime of the ISS can be extended, at some point it will no longer be able to be operated safely, Dr. Nield stated. In order to allow NASA to devote its attention (and its funding) to returning to the Moon and to sending astronauts to Mars, Dr. Nield explained that it is unlikely that the government will decide to design, build, and operate a replacement station. However, he added, there is a clear need for the United States to maintain a presence in LEO, for research and other purposes. To meet this need, NASA has announced the initiation of a Commercial LEO Destinations project, with the goal of allowing NASA to be one of many customers for commercially developed and operated platforms.

Under Phase 1 of the project, NASA will pursue multiple funded Space Act Agreements for early concept development of a commercial destination. This will be a full and open competition among United States domestic entities. NASA anticipates making two to four awards, with an

approximate total budget of \$300M to \$400M. The selected partners would be responsible for funding the actual development of the platforms.

In Phase 2, it would be NASA's intent to purchase destination services under fixed-price contracts when such services become available, based on NASA's needs.

The announcement for proposals is expected to be released in June 2021, with funded Space Act Agreements awarded in the first quarter of FY22, Phase 1 execution in FY22-25, and Phase 2 procurement planned for NET FY25.

Although Congress has previously not provided the funding that NASA has requested for its commercial LEO program, NASA believes that it now has a solid rationale and a well-thought-out approach. The Panel notes that maintaining the capability to perform human spaceflight research in LEO will be an important risk-reduction strategy in preparing for long-duration exploration missions. Dr. Nield noted that in order to avoid a "capabilities gap," such as what the United States experienced between retirement of the Space Shuttle and the availability of commercial crew transportation services, development of whatever systems will come after ISS needs to be started now.

Dr. Sanders then thanked Dr. Nield for his discussion and stated that the Panel's interactions with the ISS program over the previous week were focused on a few topics of interest to the ASAP. Lt Gen Susan Helms was introduced to speak on the Panel's discussions with respect to the ISS.

International Space Station

As is our usual pattern, Lt Gen Helms stated, the Panel reviewed a top-level overview of the ISS transportation plan and major operational milestones. In addition, the Panel requested and received an update on the ISS leaks. The ISS program appears very engaged on the leak situation and very comprehensive on its approach to diagnosis for discovering underlying cause, Lt Gen Helms observed. Roscosmos established a commission to address the ISS leaks, and joint forums have been set up between NASA and their Russian partners to collaborate on determining cause and potential mitigations. The leaks have been isolated to the hull of the Service Module (SM) transfer tunnel. Two small cracks have been repaired, and several other areas of interest have been addressed with sealant applications. However, she added, at this point, the leakage has not been completely mitigated and the underlying cause for the leaks remains elusive. NASA is preparing strain gauges to be delivered on SpaceX-22, which will be installed in the area of concern to aid in anomaly resolution. The leakage is being managed by appropriate operational workarounds (i.e., hatch closure and occasional pressure equalization), said Lt Gen Helms. Based on understanding of the structural stresses and the cracks themselves, programmatic teams do not believe there is an immediate safety concern. According to Lt Gen Helms, at the current time, assuming the leaks remain stable, and the situation does not deteriorate, risk to the crew is minimal. She added that there is of course a docking port at the end of the SM transfer tunnel, but the ISS has the flexibility to utilize alternate Russian docking ports, as required.

The Panel had the opportunity to review the current strategy and planning for PAMs to the ISS, the first of which is expected to fly in January of 2022. The ISS program has adapted current flight crew worthiness and certification practices, along with previous experiences with space tourism, to approach risk management with the Axiom-1 (AX-1) mission of four tourists during their eight-day stay on the ISS. The framework for certifying the AX-1 crewmembers includes ISS vehicle training appropriate for safety, medical qualification for flight, and contractual requirements to define performance and bound behaviors appropriate to the space environment. Since the contractual requirements provide key elements of risk management, the Panel has been particularly interested in understanding NASA's execution of the chain of accountability for contractual violations, as the contracts stipulate a range of potential consequences for non-compliance with policies, requirements, and constraints. NASA assessments for conduct of PAM U.S. segment extravehicular activities (EVAs) was recently completed with the recommendation that no PAM EVAs be generically offered, and at this time no PAM EVAs are being pursued, stated Lt Gen Helms.

Finally, it has long been the Panel's position that risks of ISS operations and the accomplishment of critical science is greatly mitigated when redundant crew transportation systems are available to reliably deploy crewmembers to the ISS on a continuous basis. Now that SpaceX is providing crew transportation, a sustainable strategy to cover both U.S. and Russian critical tasks is to utilize both the Soyuz and Dragon vehicles to transport U.S. Orbital Segment and Russian crewmembers. By doing so, the ISS programmatic risks and operational drivers would be better managed, she noted, should there be a break in service of one transportation vehicle due to unforeseen circumstances. The Panel supports the option for all partners to be able to use both Soyuz and SpaceX transportation systems for ISS access.

Dr. Sanders thanked Lt Gen Helms for her observations on the ISS, and asked her to talk about the updates the Panel received on enterprise protection and progress in the always important cybersecurity arena.

Enterprise Protection

The Panel reviewed an update on cybersecurity and enterprise protection, the first in about a year. Lt Gen Helms indicated that there were some good takeaways from the updates.

First, Mr. Mike Witt and Mr. Jeff Seaton have been working productively on NASA cybersecurity policy, with an eye on addressing cybersecurity risks. The collaboration across the Agency continues to improve, Lt Gen Helms stated, and there was recognition of the need to adapt current policies to address evolving risks, such as raising the level of risk acceptance approval authorities, and the ongoing selection of enterprise-wide information technology solutions.

Second, the Panel had the opportunity to engage with the new Principal Advisor for Enterprise Protection, Mr. David Adams, who comes to NASA with a wealth of national security experience, said Lt Gen Helms. In taking over his new role, Mr. Adams conducted a 2021 Zero Base Review of enterprise protection and formulated one-year and three-year plans for advancing new and improved policies and actions intended to reduce risks and mitigate vulnerabilities. The Panel

was impressed with his strategic approach, and his action plans in a number of critical areas, and looks forward to progress reports in the future.

Third, Lt Gen Helms noted that across the board, a lot of appropriate activity is happening, and thanks to the efforts of the cybersecurity and enterprise protection teams, the awareness of the risks continues to grow across the NASA enterprise. However, although evolving policies and material improvements are evident, the Panel still has questions about how the risks are managed when it comes to decision-making in this area, who is accountable for those decisions, and whether those decisions actually improve NASA's overall posture in the face of threats and vulnerabilities. This includes specific decisions regarding the implementation of the requirement for security clearances and other defined security and protection policies. This continues to be a focus of the Panel in the coming months.

Lt Gen Helms returned the discussion back to Dr. Sanders, who indicated that before leaving the meeting, the Panel would like to return to a topic of vital interest, which remains unresolved. Last year, the ASAP made two formal recommendations related to space traffic management. One recommendation was directed to Congress to designate a Lead Federal Agency for Civil Space Traffic Management, providing that agency with the requisite authority, immunity from lawsuits, and resources. The need remains urgent, yet the necessary action has not yet been taken.

Dr. Sanders asserted that the Panel made a companion recommendation to NASA to support the Lead Federal Agency for Civil Space Traffic Management, once designated, and to take some specific actions in the interim period. Obviously, she noted, the first part of that recommendation cannot be implemented, but NASA has made good progress on the actions within their purview.

Dr. Sanders then asked that the lines be opened for a few minutes for public comments. No comments were received.

Ms. Hamilton adjourned the meeting at 3:00 p.m. ET.

ATTACHMENT 1

Note: The names and affiliations are as given by the attendees, and/or as recorded by the telecon operator.

PARTICIPANTS

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Debra Percelle	Boeing
Deirdre Healey	NASA
Dee Russell	Boeing
Dillon Macinnis	SpaceX
Erin Kennedy	BAO
Frank Groen	NASA OSMA
Jackie Wattles	CNN
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Joan Higginbotham	Collins Aerospace
Joey Roulette	The Verge
Josh Finch	NASA
Laura Forczyk	Astralytical
Lenny Lentz	NASA Space Flight
Lewis Groswald	Lockheed Martin
Linda Karanian	Karanian Aerospace Consulting
Linder Metts	NASA Marshall Space Select Center
Marcia Smith	Space Policy Online.com
Maribeth Davis	Boeing
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