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

August 9, 2018

Mr. James Bridenstine
Administrator
National Aeronautics and Space Administration
Washington, DC 20546

Dear Mr. Bridenstine:

The Aerospace Safety Advisory Panel (ASAP) held its 2018 Third Quarterly Meeting at NASA Headquarters, Washington, DC, on July 24-26, 2018. 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,

Patricia Sanders

Patricia Sanders
Chair

Enclosure

AEROSPACE SAFETY ADVISORY PANEL
Public Meeting
July 26, 2018
NASA Headquarters, Washington, DC

2018 Third Quarterly Meeting Report

Aerospace Safety Advisory Panel (ASAP) Attendees
Dr. Patricia Sanders, Chair
Dr. Sandra Magnus
Lt. Gen. Susan Helms
Dr. Donald McErlean
Dr. George Nield
Mr. David West

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

NASA Attendees:
Jeanette Plante, NASA HQ, OSMA
Tracy Dillinger, NASA HQ, OSMA

Telecon Attendees – see Attachment 1

Opening Remarks
Ms. Carol Hamilton, ASAP Executive Director, called the meeting to order at 1:00 p.m. EDT and welcomed everyone to the ASAP's third quarterly meeting of 2018. She indicated that public attendees would have an opportunity later in the meeting to make comments. Prior to the meeting, the public had been invited to provide verbal or written comments in advance; none were received.

Dr. Patricia Sanders, ASAP Chair, made a few opening comments and observations. She noted that the Panel had a full and productive set of insight discussions during the week. It focused almost exclusively on the two major programs that are in critical stages of their development: the Commercial Crew Program (CCP), and Exploration Systems Development (ESD) and its elements—the Space Launch System (SLS), Orion, and the Exploration Ground Systems (EGS). Panel members delved into these programs with the program and project managers as well as the Engineering and Safety Technical Authorities. The ASAP also had a short interchange with the NASA Chief Health and Medical Officer (CHMO) about the impacts of extended time in space on astronauts. At the start of the third quarterly, Panel members bid farewell and thank you to Dr. James Bagian, who served for 12 years as a dedicated and valued member of the ASAP.

In the ASAP's discussions with respect to the CCP, Dr. Sanders reported that Panel members saw both continued progress and a large volume of work ahead. The providers have made sufficient headway to see a true "light at the end of the tunnel," and it should be possible to project a realistic time frame for at least the uncrewed test flights. This facilitates specific and detailed analysis of the interfaces with the International Space Station (ISS or Station), as well as planning for insertion into the ISS flight manifest. Depending on the results of the uncrewed flights and the resolution of some outstanding technical issues, firm dates for the crewed flight tests are still uncertain. There is still a "bow wave" of remaining effort to achieve certification for both providers. Significant testing is underway, and there is a large amount of certification products that must be delivered by each provider and adjudicated by the NASA Program Office. These certification products are critical, as they represent the validation that the vehicles meet the design requirements and provide confidence that they will perform their mission as expected. Having realistic schedules in hand also means that pending decisions must come to closure, especially where they involve addressing residual risk issues.

Dr. Sanders introduced Dr. Sandra Magnus, who initiated the discussions on the CCP.

Commercial Crew Program

The Panel had extensive interaction with the CCP—a report on the overall status of the Program and discussion of technical and safety risk areas. The Panel also had discussions about the path to certification. The upcoming months will be busy for NASA and the providers in preparation for the uncrewed demo flights. After many years with the demo flight dates always being "distantly in the future," the Program is rapidly approaching launch. From this point forward, the momentum of activities will continue to build, and there is much work yet to accomplish. Dr. Magnus noted that having the hardware on hand and ready to go is exciting, but much needs to be done to understand the risk posture and certify the systems. Nonetheless, the uncrewed demos are an important milestone for the Program, and it will be rewarding for the community and a good morale boost for everyone. Dr. Magnus indicated that today, the Panel members would like to comment on some of the open items, certification, and a few other miscellaneous topics.

Dr. Donald McErlean followed up with a discussion on the certification products. He commented that all the external stakeholders need to realize that while the concluding aspects of certification have sometimes been described as a "paper process," that is merely a shorthand expression; it could not be further from the truth. He explained that in a certified design, the design agent (the partner, in this case) performs the design. In the certification plan, the design agent and the certification agency (NASA, in this case) agree on the submittal of certification evidence, which could be measurements, test data, and analysis. Almost always, it involves the submittal of detailed technical data, not simply paper descriptions or forms. Sometimes it involves witnessed testing or physical inspection. In any case, it wraps around important technical submittals. NASA reviews and analyzes that data to validate the design meets the stated requirement with the expected margins. This validation activity extends to many aspects of design and operation of the integrated mechanism, or the entire system in this case. Once NASA agrees that these validations are correct and acceptable, it certifies design and moves toward the conclusion of the certification process. This technical review of certification data and technical products constitutes the work required to conclude the certification process and if successful, results in the Agency certifying the design. Everyone should realize that this is not a paper sign-off process; it involves considerable detailed technical activity by both NASA and the partners. Also, as part of the process, the design is certified for a given range of operations. Should this range of operations be significantly exceeded, the data would have to be reexamined and reevaluated to determine if the design was adequate for the new regime. However, this does not appear to be the case in the present vision. A considerable amount of detailed, technical review process is in front of NASA and both partners. The data, backing up the design itself, will be reviewed and assessed against the certification criteria. Once that process is complete, the design is eligible for certification by NASA.

Dr. George Nield made a few other comments about the work and the calendar. It is important to note that the ASAP has not seen any evidence of negative safety impacts based on schedule pressure. The Panel was pleased to hear from the Program teams and the Safety and Mission Assurance (SMA) Technical Authorities that schedule pressure is specifically something on which they are focusing as they consider the workload, danger of "burnout," and getting all the steps completed before the targeted launch dates. They are also looking at intangible, subjective aspects, such as how communications are conducted, frustrations in interactions, tempers, etc. The team is sensitive to dangers and will be alert to increased pressures that could endanger safety.

Mr. David West followed on to the discussion regarding the work required in certification. He noted that one of the things discussed this week involved the timing and sequencing of some of the certification activities. The Panel was told that an option under consideration to help alleviate some of the demands is the possibility of dividing Design Certification Reviews (DCRs), particularly for the crewed missions, into two parts. While the

ASAP acknowledged and discussed the potential benefit of this approach, it advised caution. Mr. West explained that when such a milestone is split into two parts, there can be a tendency to defer many certification activities to the second part. This could create a bow wave of work and make it very difficult to accomplish part two.

Dr. Magnus added that in the context of what Dr. McErlean mentioned about the mass of data for the certification process, the Panel was excited to learn about a tool SpaceX has developed. Internally, it can track design and production to ensure that configuration control is being done appropriately. The tool is very impressive and comprehensive and, if used appropriately and widely across the company, will provide a necessary (but not sufficient) condition for certification. It will facilitate a comprehensive, well-connected collection and examination of data to move efficiently through the certification process. NASA is engaged with this tool and has instituted audits of the SpaceX process to ensure the tool is widely and comprehensively used.

Lt Gen Susan Helms related the previous discussion to the Panel's standing recommendation for NASA to obtain evidence from the CCP providers that they are successfully incorporating systems engineering and integration (SE&I) principles in a disciplined and rigorous manner. At the Panel's last meeting, there was extensive discussion about the NASA Engineering and Safety Center (NESC) report. Since discussing that report with the NESC and the CCP, the Panel has seen progress on some of its concerns. The ASAP will continue to have in-depth discussions with NASA on its strategies and approaches for meeting the intent of the SE&I recommendation. Lt Gen Helms explained that "SE&I principles" means understanding the margins of the integrated system design, verifying those margins through test and analysis, and controlling both the configuration and the operation of the system to ensure those margins exist when flown. These principles are essential, in both culture and practice, to achieve the best possible outcomes for human space flight safety.

At the last meeting, as noted by Lt Gen Helms, the Panel specifically focused on NASA's internal NESC report on SpaceX's SE&I. While SpaceX has incredible strengths in agility and innovation, the recent process escapes had raised the question of whether the fundamental SE&I principles had been effectively incorporated into the culture. At that meeting, the Panel had considerable interaction regarding the NESC report and some follow-on discussion about how the outcomes of that report interleave with how the CCP is addressing the challenge of working with SpaceX and its highly innovative and agile approach. The Panel needs to have confidence that SpaceX is evolving its own SE&I culture to an appropriate level for human space flight risk management. While SpaceX has substantial experience with non-human flights, and that experience base is a large asset, there still needs to be a suitable level of risk management for human space flight. This is the extra "tactical mile" the Panel is watching for in the SE&I processes and how SpaceX manages the human space flight risk.

In this session, as Dr. Magnus mentioned, the Panel was able to have a more in-depth discussion on SpaceX's tools, which were impressive. Some attributes of the tools include traceability from component design drawings and their design notes all the way through to production procedures, automation of promulgating design changes through other appropriate products, and use of the tools to automatically catch important deviations such as human error in data entry and anomalous qualification testing outcomes. If used comprehensively and broadly across their culture, their tool set is very encouraging and could evolve into an admirable advantage for SpaceX's industry innovation. In fact, a NASA team member who was in the room when these tools were briefed mentioned that he wished NASA had had such tools for the Space Shuttle Program. As mentioned, it is important to be confident that the entire SpaceX workforce is leveraging these tools to enhance their SE&I culture. To SpaceX's credit, they have been extremely transparent with the Program Office on all their data, including how the tools help them with risk management. If the Program continues to have confidence that SpaceX's SE&I principles are innovatively evolving, that will be a good step toward meeting the intent of the ASAP's recommendation. However, the CCP will still have a bow wave of work as both providers provide large amounts of necessary information to the Program as they approach certification milestones. NASA will still need

to be assured that the component hardware design will be ready for certification and the overall integrated risk of the human space flight mission can be effectively managed through both the hardware design and the operational practices of the hardware use.

One of the areas the Panel probed during this meeting was how, procedurally, the CCP approaches risk acceptance leading up to design certification. Dr. McErlean described what an appropriate certification process would be. Coming into this meeting, the Panel had the question: How well is NASA doing on adherence to an appropriate design certification process? The Panel learned that the transparency and access into the work of both providers has been a major asset in helping the Program with the steps leading to the DCR. It allows the engineering communities to be a part of the provider teams; they can follow the work on subsystem design, analysis, qualification, and controls. Issues appear to be getting worked well ahead of provider deliverables on contract, and NASA management appears to be tightly engaged on possible issues that might relate to certification risk. Ahead of the DCR, the CCP and the Engineering and Safety communities intend to ensure that both providers meet the intent of ensuring their integrated designs and their operational margins are well understood and qualified, are adequately controlled, and meet the intent of NASA's design reference mission set. From the Panel's discussions, it appears that NASA leadership will be confident that both providers will produce what they require prior to DCR.

At DCR, it is expected that there will likely be some residual risk still carried in both vehicles, a situation that is not at all unusual for any spacecraft or rocket. It is inherently risky business. The important point is that NASA understand the sources of those risks, and has a clear, transparent, and unambiguous rationale for how those risks will be accepted prior to certification. Based on what the ASAP has seen to date, it appears that NASA has that well in hand.

Dr. McErlean noted one of the key critical points regarding certification and operating a certified design: after completing the design and the design certification, NASA will want to be certain that the provider can continue to produce the design in accordance with the drawings. One of the great strengths of the SpaceX tool is its tracking capability to help to ensure changes are compatible. In the SpaceX system, if an engineer in Structures, for example, makes a change, even though the change may be an improvement, the system automatically gives that engineer a list of the drawings that are affected because of the interfaces. It doesn't allow that change permanently into the configuration until the other changes have been corrected. This is a powerful benefit and advantage in ensuring integration is at the forefront as the design comes together.

Dr. Magnus reviewed a few technical issues that the Panel wanted to address. An issue has arisen related to the increased demand for Reef Line Cutters (RLCs) from numerous parachute systems under development, both within the CCP and ESD. Only one supplier, to date, has gone through the qualification program necessary to supply these cutters. A combination of the increased demand, the size of the of the company involved, its ability to increase throughput, and the retention of critical knowledge creates quality and supply challenges for both programs. Another vendor, currently going through RLC qualification, is expected to be successful in the future. In the interim, discussions are underway about the transition from a known system to a new system. For example, at SpaceX, the Demo-1 mission is currently configured with the RLCs from the traditional vendor, and the program must determine the optimum time to introduce the new RLCs from the second vendor. Retrofit Demo-1? Introduce the new system on the first crewed mission? There are several options and the risk postures for each must be understood.

The Panel also participated in discussions on the Boeing hot fire test, the SpaceX Composite Overwrapped Pressure Vessels (COPVs), and the SpaceX engine turbine blades.

Mr. West reported that the Panel learned about a detailed and structured approach for certification of the COPVs used in the SpaceX design. There has been a considerable amount of testing and follow-up investigations to try to understand the physics of what could cause a potential ignition mechanism or other failure mechanism. The Panel commends the "deep dive" being done but still recognizes the substantial amount of work yet to do. The ASAP looks forward to results on the final characterization of the risk, whether that risk will be acceptable, and if not, what further risk mitigation measures might be necessary.

Dr. Nield noted that Boeing recently conducted the hot-fire test for its low-altitude abort milestone for CST-100. There was an anomaly on that test that requires a better understanding of the potential impacts on design, operations, and schedule. There is considerable interest in this issue, and Boeing has requested some additional time to more fully understand the anomaly. The Program expects some uncertainty in Boeing's near-term schedule while it goes through that process. At the end of the process, the CCP should have a much better sense of Boeing's orbital flight test and crew flight test.

In terms of continuing development, Dr. McErlean highlighted one of the things that has been complementary to the transparency between SpaceX and the Program Office: their partnership on the problem with the new configuration of the SpaceX Merlin engine, generally designated as the Merlin M1-D. The first two engines began to go through the qualification procedure; upon teardown, the team observed some anomalies in the hardware that were considered undesirable and potentially dangerous. A program was undertaken to modify the design and correct these anomalies. SpaceX and NASA agreed on the requalification plan: six engines—two in ground test configuration, one in flight test configuration. Working through the mitigation plan required development of several courses of action, some of which have been eliminated. They now have two courses of action in the short term and two others that would require additional modification. The Program has determined that the risk is low enough with the two short-term engine modifications to use them for powering the uncrewed test. The decision on powering the crewed test will come later. In all cases, SpaceX is working with the Program to go through the courses of action and determine the final way forward. The Panel is optimistic that the action will result in a satisfactory conclusion.

Dr. Sanders noted that as NASA moves nearer to realizing the CCP objectives, the business model used in working with the commercial partners and the shared accountability for development and risk management has provided both opportunities and challenges. The future portends even more arrangements with commercial partners as well as international partners. The ASAP exhorts NASA to be attentive to the lessons learned from this experience and apply those to the future way forward.

Dr. Sanders moved on to the discussions on Exploration Systems, a program that continues to make significant progress and has many critical activities on the threshold. While some items on the critical path are nearing completion, there is still sufficient work ahead that the schedule risk remains significant. She noted that the Panel remains encouraged that there is schedule awareness but not schedule pressure causing decisions with adverse impact on safety. Reaching a realistic schedule will be key. When the schedule is perceived as too relaxed, the team could lose focus, and potential schedule margin might be wasted. If the schedule is unrealistically aggressive, mistakes can be made or shortcuts taken such that safety is impacted by the schedule decisions.

Exploration Systems Development

Dr. George Nield led the discussions on Exploration Systems. He observed that this is a time of transition for the Program, from initial hardware design and development to integration, assembly, and system-level testing. There has been a lot of progress; at the same time, while some of the long-standing challenges are being

addressed, the team is at a point in the schedule where the Panel can expect to see new issues pop up, and they have. Dr. Nield first highlighted some notable areas of progress.

Parachute Testing: Qualification Drop Test 7 (of 8) was successfully completed, with a 35,000-foot extraction altitude and a high dynamic pressure on the drogues, pilot chutes, and mains.

Ascent Abort Test 2 (AA-2): After 4 months of integration and installation of 11 miles of wiring, the Orion module for the AA-2 test completed its initial power-on milestone on July 12, 2018. The flight computer booted up successfully and displayed nominal data. Verification activities will be continuing over the next month.

Recent programmatic decision to use the Interim Cryogenic Propulsion Stage (ICPS) on EM-2: The Program has issued a Decision Memorandum stating that the first crewed SLS/Orion mission, EM-2, will use the SLS Block 1 configuration and the current Block 1 Mobile Launch Platform (MLP). That decision was made possible when Congress provided funding for construction of a second MLP. Therefore, NASA will now be using the ICPS rather than the Exploration Upper Stage (EUS) on the first crewed mission. That has several implications, including some advantages in terms of how quickly EM-2 can launch.

Micro Meteoroid and Orbital Debris (MMOD): Dr. Magnus noted that MMOD has been a challenge across all the human space flight programs and has been driving much of the anticipated risk. With the change to ICPS for EM-2, the Program needed to gain further understanding on the ICPS vulnerabilities and what it would take to human rate it. The Program has looked at the tank exposures, specifically the helium tanks on ICPS, because there were some uncertainties about the level of risk from MMOD damage. High-velocity impact tests were performed on both pressurized and unpressurized tanks to determine their robustness. The Panel was pleased to see the helium tanks are much more robust than previously thought. Consequently, the MMOD risk from those tanks was assigned a much lower value. The question now is how to gain similar insight into the liquid oxygen and liquid hydrogen tanks, which are much more difficult to test and gain a measure of confidence. The Panel acknowledged an important step forward with the helium tanks in understanding the risk and looks forward to further developments with the remainder of the tanks.

Dr. Nield cited another important area of progress relating to the SLS engine sections, specifically the tubes in those sections. Boeing recently found that there was some significant internal contamination of the tubing in the core stage of the SLS engine section. Boeing formed a team to investigate supplier sites, identify the root cause, and develop a corrective action plan. That work has now been completed. A new cleaning process was established and is being implemented based on a triage approach on the hardware. There were about 900 affected tubes; 300 have been cleaned using the new process and 600 have been assessed as being acceptable to use as is. As a result, this is no longer the pacing schedule item for the SLS engine section.

Dr. Nield next highlighted some technical issues the Panel is interested in tracking.

Booster Engine Throat Plug: Dr. McErlean described the booster engine throat plug and its purpose. It is installed prior to the first firing of the engine to protect the engine on the pad from contaminants and miscellaneous debris. When the engine is fired, the huge velocity of the outgoing gas shoots this plug out of the nozzle. These plugs were use in the Shuttle, but in those cases, the engine plane was higher from the ground plane of the launch platform. On the SLS pad, in addition to a concrete surface, there is a huge water surface. Water is dumped under the engines at high volume to prevent damage to the launch platform. When the plug strikes the water surface, it can rebound from the surface and, under some circumstances, bounce high enough to possibly strike an engine bell. This has been a recent concern, and the Program is performing computational fluid dynamics (CFD) analyses to determine the bounce parameters. The Program has decided to redesign the throat

plug with a more frangible design that would break up when striking the water surface, reducing the recoil. The Panel is encouraged to see the teams are working diligently to identify and solve everything that could impact operations, and the ASAP looks forward to hearing more about the solution.

Parachute RLCs: Dr. Nield noted that this issue was discussed earlier by Dr. Magnus relative to the CCP. Orion has the same RLC supplier. In this case, the Program believes it has an adequate inventory of the traditional RLC systems to support the near-term ESD activities. However, this is something the Program will want to watch closely.

European Service Module (ESM) delivery schedule: The ESM is a very important part of the overall program. NASA is closely monitoring the progress and assessing schedule implications of ESM issues. Acceptance testing of the ESM Propulsion Qualification Module (PQM) began in early June, and the first hot fire is expected in August. NASA and ESA are evaluating which PQM tests are prerequisites to ESM-1 shipment.

MLP stress: There are four areas of concern for the MLP base; two of those will require MLP modification. The team is proceeding with the modifications, with construction expected to be complete in September. The current plan involves proceeding at risk, since the updated vehicle loads analyses will not be complete by the planned installation time.

Flight Termination System (FTS) access: Launch opportunities could be limited based on the need for pad access to inspect and service the FTS. There is not an easy way to do this in the current configuration. The SLS Program is working with the Range to see if there is some flexibility in the near-term. For the longer term, the Program will be examining ways to enable easier access to the FTS in follow-on SLS configurations.

Tail Service Mast Umbilical Leak: The SLS core stage tail service mast umbilical has a hydrogen leak that is above allowable safety limits, something that was observed during some recent launch equipment testing. Additional testing is planned to better understand the issue.

Dr. Sanders noted that the ASAP had previously stated a concern with the length of time between EM-1 and EM-2 and the safety implications of a long gap. The Program is proactively taking actions to shorten the time between EM-1 and EM-2, some of which Dr. Nield mentioned. The Panel also noted that NASA has wisely chosen a path for Exploration Systems, including planning for the Gateway, that puts in place the building blocks of the Exploration infrastructure, which will serve NASA well for lunar, Mars, or other future deep space exploration. Dr. Sanders indicated that the ASAP strongly supports this approach. Not only does it pave the way for NASA leadership in future commercial and international collaborations, it also promotes risk reduction for excursions into the exciting but hostile environment of deep space.

Mr. West reported on the Panel's interchange with the CHMO, Dr. James Polk. As noted earlier by Dr. Sanders, the Panel had an enlightening and informative discussion with Dr. Polk on some space flight health and medical issues. These concerned some of the medical effects on astronauts who have experienced long-duration space flight missions. NASA has known about space flight effects such as bone loss and cancer risks from radiation for quite some time. It is gaining a better understanding of mechanisms such as fluid redistribution within the body due to weightlessness for long time periods and how mechanisms can affect things such as vision impairment. There is considerable ongoing work in this area, and the Panel will be monitoring the results of studies conducted to better understand these risks and what can or may need to be considered to mitigate them.

Dr. McErlean commented that it was interesting that Dr. Polk noted some of these medical effects were not observed in Apollo or Shuttle. He explained that NASA is seeing these effects now as a byproduct of much longer durations in space (six months to a year). These types of medical effects could impact a one-year Mars mission.

Dr. Magnus added that NASA now has data on what happens in microgravity; there is evidence of how the shape of the eye changes and impacts on the optic nerve. However, the Program does not yet have a good understanding for what fractional gravity (g) level might mitigate those effects. In the medical toolbox, there is a lack of knowledge about the gradient between 0 g and 1 g. Understanding the long-term effects on the human body is coupled with understanding how fractions of g can affect some of these phenomena.

Dr. McErlean observed that even if positive results are seen after a 3- or 6-month exposure, it is not known whether the problem has been mitigated or merely pushed further downstream. This is a medical "mystery" that requires additional research.

Lt Gen Helms emphasized the importance of this topic. The ISS has been flying for over 15 years, but some of the mysteries of how the human body responds to long-term space flight are only beginning to be revealed because of the growing sample size of humans on long-term missions. It is important to note that the discovery of some of these issues relies heavily on having the ISS available to continue the research. Lt Gen Helms indicated that she would like to see the Station continue as a National Laboratory that provides the one and only place these issues can be studied. It is very important to think through the human science requirements of exploration and continue to develop a long-duration National Lab Space Station Program to keep sample sizes growing and to provide the time for issues to reveal themselves.

Dr. Magnus added that it is not just sample sizes, but some of the data they have recently been able to get from in situ measurements and tools put on Station to understand the physical changes in the eyes that form the current medical opinions. Having the right tool set is just as important as having the right sample size. Lt Gen Helms agreed that we are only at the beginning of what could be learned on the Station. It is a very important research and risk-reduction platform.

Dr. McErlean noted that it is worthwhile to remember that even while different spacefaring nations may have different hardware architectures, we all share the same human body architecture. The Panel believes these investigations are extremely important to understand the risks of humans spending considerable time in space, exploring the outer planets, or even going to the Moon and staying there for an extended period.

Dr. Sanders opened the floor for public comments. There were none. Before she adjourned the meeting, Dr. Sanders indicated that Dr. Nield had another comment about MMOD.

Dr. Nield noted that in the Panel's most recent annual report (2017), MMOD was recognized as the dominant contributor to loss of crew (LOC) assessments for both CCP and Orion. MMOD was also involved in two of the top three safety risks for ISS. In the annual report, the Panel stated that the National Space Council (NSpC) should assign a lead agency to spearhead and coordinate efforts to prevent the generation of new debris and reduce hazards posed by existing debris. The ASAP is pleased to see the President and the NSpC have now done that in Space Policy Directive #3, with the Department of Commerce as the focal point. Clearly, this will be a governmental effort involving several departments and agencies. The Panel is interested to see how NASA will participate in that effort and what the country can do to ensure retention of its leadership.

The ASAP third quarterly meeting was adjourned at 1:58 pm.

ATTACHMENT 1 – TELECON ATTENDEES

Alison Sheridan	Boeing
Anthony DiVenti	NASA OSMA
Ava Baron	SpaceX
Carrie Arnold	Boeing Communications
Daniel Beck	Boeing
Daniel Lentz	[not affiliated]
Diane Rausch	NASA
Dina Weiss	Federal Government
Eric Berger	*ARS Technica*
Eric Ralph	Casperotti
Isao Kotani	NASA
James Dean	*Florida Today*
Jeff Foust	*Space News*
Jeffrey Sugar	NASA JSC
Kelly Kabiri	NASA OSMA
Lynne Loewy	NASA HQ
Lovey Pettit	NASA
Marie Lewis	NASA
Mary Hovater	NASA
Mat Dunn	SpaceX
Michael Lapidus	SpaceX
Michelle Green	NASA
Patricia Soloveichik	Boeing
Rebecca Regan	Boeing
Rick Irving	NASA
Rob Marchin	[not affiliated]
Ronald Freeman	American Institute of Astronauts
Stephen Clark	*Space Flight Now*