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

May 22, 2020

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

Dear Mr. Bridenstine:

The Aerospace Safety Advisory Panel (ASAP) held part two of its 2020 Second Quarterly Meeting via teleconference May 5 and May 8, 2020. This follow-on session addressed topics concerning the Commercial Crew Program (CCP), Artemis, and the Human Landing System (HLS). 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
May 15, 2020
Conference Call

Part 2: 2020 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. Donald McErlean
Dr. George Nield
Rear Admiral (Ret) Chris Murray
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 3:00 p.m. EST and welcomed everyone to part two of the ASAP's Second Quarterly Meeting of 2020. She indicated that no questions or requests had been submitted prior to the meeting, but time would be allocated at the end for public comments.

Before starting the meeting, Dr. Patricia Sanders, ASAP Chair, thanked Carol Hamilton and Lisa Hackley, ASAP Administrative Officer, for their support in arranging the multiple virtual insight meetings and discussions that constituted the Panel's Second Quarterly Meeting of 2020. Dr. Sanders indicated that this Quarterly's engagements represent a microcosm of the challenges that NASA itself faces in sustaining its mission during a challenging time and brings appreciation of the efforts all are making.

As noted at the first part of this Public Meeting discussion, the Panel was not able to complete engagements with the NASA programs on the earlier planned schedule. The insight meetings have stretched out over the course of several weeks, instead of a few days. Today, the Panel intends to complete the discussion of our assessments and advice.

A major area that was deferred to this second reporting is the Commercial Crew Program (CCP). It has been an especially dynamic period for both arms of that program—SpaceX and Boeing. I will first call on Mr. Paul Hill to speak to the Panel's view of the status of the SpaceX component.

Commercial Crew Program

Mr. Hill indicated that with Demo-2, and the first crew launching on a commercial spacecraft scheduled on May 27, this is obviously a very focused time for NASA and SpaceX. As just one qualitative indicator of where they are in the process of preparing for this launch, the Panel noted that the various risk and hazard reporting lists provided on a quarterly basis—and of course, the respective engineering for each issue—have converged, reflecting the larger team's confidence in resolving issues, closing open work, and being ready to fly. At the time of ASAP's review last week, the remaining Program-level issues were scheduled for final board review through this week.

The CCP is tracking a list of open work that must be closed before committing to launch, which is not unlike any space launch. Mr. Hill added that while this is still difficult work, and the engineering decisions must be made with due diligence, flight readiness reviews (FRRs) and launch processing are very familiar steps in the process for both NASA and SpaceX. By all appearances, they are marching deliberately through their normal process.

Mr. Hill noted that late stage operational readiness looks familiar as well. The usual range of final flight rules, mission plans, and crew and flight controller training were in work this week. The JSC Flight Operations Directorate submitted a list of exceptions to their Certification of Flight Readiness—essentially issues or concerns that require formal review or action before flight. Concerns related to flight hardware are also scheduled to be reviewed by a Program Board this week. Mr. Hill stated that this review process is in no way unprecedented. Notably, the critical point is less about the specific issues and more about the fact that the Program is tracking these exceptions, reviewing closures to issues in open forums, and reviewing each closure action separately as part of the Agency FRR *before* proceeding to launch.

The Panel also heard a summary of the Falcon-9 engine shutdown anomalies during a SpaceX launch on March 18, 2020, although this was not on a NASA mission. Fault tree analysis points to a probable cause, with ongoing work to confirm it. Due to system processing differences, the Demo-2 engines are not considered to be at risk from this probable cause. The Program is following SpaceX's ongoing work and will elevate the issue if there is an impact to the Demo-2 flight rationale.

Finally, at least for Demo-2 preparation, SpaceX has added a third supported landing site to increase landing site availability and to improve launch probability. Mr. Hill noted that this added site takes sea state, air and surface support, and trauma center locations into account, which is a great step.

In summary for Demo-2, Mr. Hill echoed the Panel's observation that it has been a complex journey for SpaceX to get the mission to this level of readiness, and they are to be commended for their efforts and success to date. As already pointed out, NASA and SpaceX are very familiar with and have strong track records in final flight readiness and launch processing, where they currently find themselves. However, as Dr. Sanders reminded NASA, now is the time to be on

alert for "Go fever." Mr. Hill said that because so much work has gone into getting this close to a launch, it can be difficult to resist the pressure to accept some risk or to trivialize some concern with less rigor in the decision making, as NASA well knows. That sentiment is compounded for Demo-2 with the additional pressure not just to launch the first commercial crew, but also to: (1) build the International Space Station (ISS) crew complement back to six; (2) relieve the constraint against U.S. Orbital Segment (USOS) extravehicular (EVA) capability; and (3) resume full ISS utilization, as discussed during ASAP's April meeting. The Panel simply urges the Agency to do what they certainly appear to be doing: follow their proven FRR process and ensure every engineering issue and risk acceptance is deliberately closed.

As the CCP Manager, Kathy Lueders, told the Panel, "We're not going to rush. We'll launch when we're ready."

The CCP also reported that all hardware and software processing is on track to be reviewed in June for SpaceX's Crew-1 mission, sometime after Demo-2. Mr. Hill indicated that the training schedule for this mission has been impacted by COVID-19, as one might expect, largely due to the various social-distancing complications. SpaceX has taken steps to increase distancing from the crew during training, including offering special housing in California and increasing remote training capability. SpaceX and the Flight Operations Directorate at NASA's Johnson Space Center have partnered on Crew-1 training plan revisions. Through this collaborative effort, other changes are being evaluated, which will have the crew ready to fly as soon as it is reasonable after Demo-2.

Mr. Hill concluded by stating that the Panel will see more concrete details on Crew-1 launch processing after Demo-2's post-flight reviews.

Dr. Sanders asked Lt Gen Susan Helms to address the Boeing component.

Since the Panel's First Quarterly Meeting of 2020 in February, a number of notable events related to Boeing's role in the CCP have taken place. First, the Joint NASA/Boeing Independent Review Team (IRT) completed its investigation of the anomalies that occurred during the flight of Orbital Test Flight-1 (OFT-1) in December 2019. Second, as a result of the investigation, a number of action plans have been developed for forward work to address the recommendations of the investigation. Third, because of the issues discovered during the conduct of OFT-1, Boeing has decided to perform a reflight of OFT-1. Finally, the CCP team has developed some additional actions to be implemented by NASA in response to the findings of the IRT.

Lt Gen Helms noted that, as discussed during the ASAP's Quarterly Meeting held in February 2020, while much was productively accomplished during the December test flight, the mission of the Starliner was significantly truncated due to a software-related in-flight anomaly; ultimately, the anomaly was determined to be caused by a coding error related to the mission elapsed timer. During on-orbit troubleshooting, a second Starliner flight software anomaly related to service module disposal was detected, but it was successfully corrected prior to de-orbit. In addition, there were notable issues with communications between the mission control teams and the Starliner, creating difficulties in sending commands to the space vehicle. Although the Starliner was successfully recovered, and much was learned, a Joint NASA-Boeing IRT was established to pursue the root cause(s) of these significant anomalies and to determine the necessary corrective actions. The team has now concluded its investigations—a total of 61

initial recommended actions were reported out to the NASA leadership. Nineteen extra recommended actions were later added based on Boeing's broader review beyond the two software anomalies. Lt Gen Helms noted that the assessments behind these recommendations were deeply comprehensive, and they included autopsies of software design, functional qualification tests, hardware/software interface testing, independent software validation and verification, environmental compatibility testing, peer reviews, and a review of the underlying requirements. At every step, the team identified not only the root cause of the problems encountered, but also when those problems could or should have been discovered during testing and other systems engineering processes.

As a result, the top priority corrective actions outlined by the Joint IRT go far beyond a software fix, or a procedural change, and they significantly improve the overall systems engineering and integration (SE&I) principles used in the Boeing software development life cycle. The corrective actions have been grouped within numerous action plans, and a process has been established to attain closure on all recommendations of the Joint IRT. Lt Gen Helms stated that NASA will have significant insight on intermediate milestones toward closure and will have significant participation in the closure processes. In addition, the identified action plans have integrated into the program's operating rhythm to ensure that recommended actions taken are mapped to the development cycle of the flight software for Crewed Flight Test-1 (CFT-1).

Unambiguously, Boeing has stated that a reflight of OFT-1, now called OFT-2, will now occur, and the Panel applauds this decision as the best approach from a safety perspective. Although not yet scheduled, the flight is likely to occur later this year. Currently, the Atlas V rocket intended for use for the CFT-1 flight, will now be repurposed for the OFT-2 flight. Lt Gen Helms indicated that although both the crew module and the service module of OFT-2 are in final assembly, certainly the corrective actions required by the Joint IRT will likely have some impact on when and how qualification and integration testing is expected to occur for both OFT-2 and CFT-1.

In response to the Joint IRT investigation and action plans, the NASA Commercial Crew Office has also initiated a series of actions intended to strengthen the oversight of the Boeing program. For example, the CCP will review hazards related to system and subsystem interfaces to ensure that they are well defined, well controlled, and properly verified. The CCP will also expand oversight through additional audits of Boeing's software independent verification and validation, and the addition of NASA software personnel with a Boeing focus. Lt Gen Helms stated that the CCP has also made substantive changes in their Boeing software certification strategy to improve and strengthen oversight. In summary, the actions taken by CCP personnel are complementary to the actions taken by the Boeing team to ensure that sound SE&I principles are supported in software development and its integration with the hardware. All of the actions taken to date—by both Boeing and NASA—are highly synchronous with the ASAP's recommendations, made during February's Quarterly Meeting, to fully explore the SE&I, testing, and verification processes that led up to the in-flight anomaly.

Dr. Sanders indicated that Dr. George Nield would be discussing the Panel's understanding of the status of the program to develop an HLS for lunar exploration. First, she expounded on the importance of NASA identifying their role in space exploration initiatives with commercial partner organizations. This HLS program, she noted, will have much to learn from the

experience of the CCP, and Dr. Nield will touch on that. But in a broader sense, the Panel strongly encourages NASA to thoughtfully consider their role going forward with complex space developments. It is critical, for both safety and mission assurance, that the right balance be struck between serving as an exacting overseer, a development partner, and a demanding customer of a service. A lot of that balance has developed, sometimes painfully, over the course of the CCP. ASAP urges NASA not to relearn these difficult lessons, but to go forward with an awareness of what is the best application of both NASA's deep experience and knowledge and the best of what the commercial sector can bring to the table.

A significant observation of the Panel concerning the CCP is that it became necessary for NASA to substantially intervene in some way to assist both providers—one using a traditional SE&I approach and one using a less traditional approach. The Panel makes this observation as a recognition that NASA continues to have deep expertise that should continue to be employed for the success of the nation's most complex and challenging space system developments and execution. The Panel has seen that greater involvement of the commercial industry can bring innovative designs and fresh approaches to the table. The Panel has also seen that NASA's long-standing experience remains valuable to the process. In addition to specialized materials, engineering, and test capabilities that NASA can bring to bear, the Panel is particularly aware of the SE&I challenges that faced both providers, which were aided by NASA's involvement. Whenever and however NASA engages—the level of insight and oversight—it is most effective if understood by all parties early in the program.

In considering the safety implications of NASA's relationship with suppliers/vendors/contractors, the Panel calls particular attention to understanding and defining the distinction between "we" and "they," both in communication and in execution. If the distinction is blurred, unintentional risks may be incurred. For example, NASA may unintentionally imply that the Agency is taking responsibility and/or action in solving an engineering problem or managing risk, when it is the contractor that remains responsible and should act.

Clarifying the role that NASA intends for the long term is also important for strategic workforce planning. Without understanding that role, the Agency could erode experience and expertise in conducting launch and flight operations to private companies that may or may not be available or able to conduct future exploration-related flight operations. Thoughtful attention to defining the key skills NASA needs to retain may prove important to the nation's overall space objectives in the future.

There are points that can be made that in a collaborative, team, or partnered environment, the distinction between "we" versus "they" is irrelevant, and the Panel offers these comments without intention to be critical or unsupportive of what NASA is doing. But the ASAP encourages transparency and deliberate and open identification of goals and discussion of management risks. The Panel will be discussing these concerns with NASA leadership in more detail going forward.

Dr. Sanders introduced Dr. Nield to speak specifically about the HLS.

Dr. Nield stated that NASA is partnering with the commercial space industry to accomplish its goal of landing the first woman and the next man on the Moon by 2024, as part of the Artemis

Program. A key component of the program is the vehicle that will take the astronauts on the last leg of that journey, a system that NASA refers to as the HLS. On April 30, 2020 NASA announced the selection of three companies to design and develop that system: Blue Origin, Dynetics, and SpaceX. The awards were for firm-fixed-price, milestone-based contracts for a 10-month Base Period that will run from May 2020 through February 2021. The combined value for all three of the contracts is $967 million.

Dr. Nield indicated that he would briefly describe each of the selected approaches and then discuss some of the ASAP's observations on the Program to date.

Blue Origin is leading what they refer to as the HLS National Team, consisting of Blue Origin, Lockheed Martin, Northrop Grumman, and Draper. The National Team will develop an Integrated Lander Vehicle (ILV) that has three stages. Lockheed Martin is responsible for the ascent stage, which includes the crew cabin, and which has significant commonality with Orion; Blue Origin is building the descent stage. Northrop Grumman will handle the transfer stage, which is largely based on its Cygnus cargo module. Draper will focus on guidance, navigation and control, avionics, and software. The ILV is designed to be launched on Blue Origin's New Glenn and United Launch Alliance's Vulcan, and it will be able to dock with either Orion or the Gateway to await arrival of the crew. A key attribute of the National Team's proposal is the significant amount of proven spaceflight heritage, given the linkages to Orion and Cygnus. The contract value for the Base Period is $579 million.

Dynetics is leading a large team with more than 25 subcontractors. Their system, known as the Dynetics Landing System, is basically equivalent to a two-stage system. It uses a single element for both ascent and descent, but there are also multiple modular propellant vehicles that are used to fuel the engines at various points in the mission and are then discarded like drop tanks. The crew cabin sits very close to the lunar surface, which should make it easier for the astronauts to enter and exit the vehicle, and to offload supplies and experiments. The system is launch vehicle-agnostic, and it can be carried on a number of commercial rockets. It can also dock with either Orion or the Gateway. The Dynetics contract value for the Base Period is $253 million.

The SpaceX proposal is based on extensive use of the Starship. There are actually three different Starship variants that will be used—the Tanker Starship, the Propellant Storage Starship, and the HLS Starship—each of which will be carried to low-Earth orbit (LEO) by the Super Heavy Booster. Once the HLS Starship is in LEO and has been fully fueled, the landing system is used as a large single stage that flies all the way to lunar orbit, down to the surface to land, and then back to lunar orbit. It is an extremely large vehicle (50 meters tall and 9 meters in diameter) with two airlocks. The entire system is fully reusable, and it can dock with either Orion or the Gateway. The SpaceX contract value for the Base Period is $135 million.

Those are the three systems. NASA plans to embed its teams with the companies to provide advice and to keep close tabs on the progress, but the companies are responsible for the designs. The goal is for the companies to be at a preliminary design review (PDR) level by the end of the Base Period. At that point NASA would like to have finalized the requirements, the trade studies that will be done, the certification plans, and the number and kinds of test flights that will be accomplished. Going forward, NASA will have lots of choices. It can select either one

or two companies to proceed toward initial demonstrations beginning in 2024 as part of Option A. NASA can also select either one or two companies for sustainability demonstration missions as part of Option B. Depending on the progress made, NASA could also choose to develop a landed services contract solicitation as early as 2027.

As the ASAP tries to wrap its arms around what NASA has done so far and where it is heading with respect to the HLS Program, some observations can be offered. Dr. Nield stated that the approach that NASA is using with industry—with a Broad Agency Announcement, firm-fixed-price contracts, and a lot of things happening in parallel—has allowed the Agency to move extremely fast. Dr. Nield commented that the progress made to date is just stunning, both on the technical design work and from the procurement perspective. It will clearly be challenging to make the 2024 goal, but so far, it looks like NASA is doing everything it can in terms of strategic planning, programmatic decisions, and contract actions to keep things on track.

Also, looking at the three teams that have been selected, NASA will be able to benefit from a tremendous amount of innovation, creativity, and diversity of design, with 1-, 2-, and 3-stage landing systems, different concepts of operations, different kinds of propellants, big companies and small companies, and both traditional aerospace contractors and entrepreneurial firms. So, a chance exists to have the companies challenge one another, both for safety and for performance, and to see what design approach works best, at least for this program.

In the ASAP 2019 Annual Report, a number of lessons learned from the CCP were identified that the Panel hoped would be applied to future programs, like HLS. Those lessons included:

- Clear and well-articulated performance-based requirements
- A well-though-out acquisition strategy
- The benefits of competition
- Early engagement with industry

It appears, Dr. Nield noted, that those lessons have been embraced and incorporated. The two lessons for which the Panel does not yet have enough information to make a judgement are:

- The importance of adequate and consistent funding
- Defining and executing to a realistic schedule

The ASAP plans to continue to watch for those, especially given the possibility that the Congress will pass a Continuing Resolution (CR), rather than regular and timely appropriations, and given the significant impacts that COVID-19 may have both on NASA and on the contractor community.

Dr. Sanders expanded on some of Dr. Nield's comments. One of the lessons from the CCP's early engagement with industry is pertinent to the Base Period with the HLS proposers. The goals that they hope to achieve during these initial 10 months will depend on that close interaction. Unfortunately, the COVID-19 restrictions will make it more challenging, at least initially, to engage effectively, but it will remain imperative to do so. Also, with three providers in the mix at this stage, NASA will have the need to ensure that they have the personnel resources—numbers, but more importantly, skill sets—to meet the demand.

Dr. Nield also mentioned the impact of timely appropriations. The ASAP has spoken of the risks of CRs multiple times, and the concerns definitely apply to the HLS development. Program managers must have the skills to adjust to whatever level of appropriation is provided by the Congress, but the uncertainties accompanying CRs are especially difficult. Given the timing of the transition from the HLS Base Period to a follow-on phase, a CR would add risk to an already aggressive development.

Dr. Sanders stated, while not explicit in the list of lessons learned that the ASAP identified in the 2019 report, an important lesson to be brought forward is the appropriate level of NASA's oversight of the execution of SE&I principles and processes.

Dr. Sanders then added some observations to the Panel's comments concerning the Artemis Program, made during Part One of the ASAP's 2020 Second Quarterly Meeting. At that time, much of the Panel's engagement with NASA on the future of the Artemis Program dealt with newly emerging information and was premature for the Panel to address. Since then, progress has been made and a path ahead is emerging. There have been a number of items contributing to the evolution. First item of note was the arrival of the newly appointed Associate Administrator for the Human Exploration and Operations Mission Directorate, Mr. Doug Loverro. Mr. Loverro's arrival brought the initiation of both a Program Status Assessment (PSA) by a group of respected independent professionals and an internal reconsideration of risk management across the Program. Both efforts appear to be resulting in actions that the Panel views as positive steps for safety and risk management.

Dr. Sanders added that the PSA provided a number of key findings, many dealing with system engineering, program organization, and schedule—all topics that the ASAP addressed from their perspective previously. The PSA findings are resulting in several actions that the Panel believes trend in a direction that has the potential to better manage risk in an aggressive development program. These noted actions include:

- Establishment of an SE&I authority responsible for orchestrating end-to-end mission analysis for Artemis with clear feedback to the programs.
- Establishment of Artemis Program Managers for all phases and the necessary support structures.
- In particular for HLS, ensuring appropriate management reserve [for HLS] to avoid future schedule erosion, focusing on requirements from the onset to preclude significant changes between PDR and critical design review, and limiting new technology development.

The internal study looked holistically across the Artemis Program with two significant results emerging. First, it recognized that there was a tension between the objective of Phase I of Artemis to reach the lunar surface with NASA astronauts by 2024 and the objective of Phase II to provide for sustained lunar operations leading to risk reduction for an eventual Mars exploration program in subsequent years. This led to a look at ways to decouple, where possible, the two efforts while recognizing that they were two parts of a whole. Secondly, the study effort looked at risk mitigation across the first three Artemis launches that constitute Phase I as a continuum.

It identified feasible adjustments to the mission profiles that would reduce or better manage risk, such as the inclusion of a demonstration of the ability to conduct rendezvous and proximity operations on Artemis II before the actual requirement for such on Artemis III. Another example of the study's results is the integration of the Gateway and the Power Propulsion Element on the ground prior to launch rather than on orbit, thus simplifying and mitigating risk and taking the Gateway off the critical path for Artemis III, and therefore, maximizing its development for sustainment operations more critical to Phase II.

Dr. Sanders repeated that the Panel views these as promising actions. The Panel still believes that the schedule for Phase I remains aggressive and will continue to caution against making decisions towards the end of achieving that schedule that lead to unwarranted impacts on safety and mission assurance. But taking prudent risk mitigation steps is a move the Panel can support.

In closing, and looking forward, the Panel has repeatedly expressed its concern with the significant and growing risk of micro-meteoroid and orbital debris. The ASAP plans to have serious discussions on this topic at the ASAP's next Quarterly Meeting and intervening insight engagements. The recognition of this threat seems to be increasing, but the Panel is concerned by the lack of action being taken to address a serious safety hazard, and you can expect the Panel to speak further on this topic at the next meeting.

Dr. Sanders opened the meeting up for public comments. One comment was made, and one question was asked.

> Anthony Intervia: "My comment is about the Lander. I think the PDR is aggressive at least for the performance period. You may want to go back to review the system design readiness. Also, the demo concept or flight concepts for the commercial crew did not have the benefit of the PDR."
>
> Richard Ward: "What sort of data handling infrastructure is planned for Artemis?"

Ms. Hamilton adjourned the meeting at 3:39 p.m. EST.

ATTACHMENT 1

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

Telecon Attendees:

Alexandra Whitze	Nature Magazine
Allen Deluna	ATDL Inc.
Amruta Muatah	JPL
Anthony Intervia	Private
Ashley Wilkens	House Science Committee
Bill Beckman	Boeing
Bill Harwood	PBS News
Brandon	ULA
Carrie Arnold	Boeing
Cat Hofacke	Aerospace America
Chris Davenport	Washington Post
Damien Mills	Boeing
David Newman	Affiliated
Deborah Circelli	Boeing
Dee Russell	The Boeing Company
Diane Rausch	NASA HQ
Dillon MacInnis	SpaceX
Dimitra Tsamis	NASA OIG
Eric Burger	ARS Technical
Erin Kennedy	GAO
Irene	No affiliation provided
James Lochner	USRA
Jamie Lentz	NASA Spaceflight
Jeff Foust	Space News
Jennifer Lewis	NASA
Jessica Landa	The Boeing Company
Joan	No affiliation provided
Joey Roulett	Reuters
Jonathan Munev	GAO
Josh Barrett	Boeing
Joshua Finch	NASA
Kenneth Chang	New York Times
Kristin Van Wychen	USGAO
Lauren Writh	GAO
Linda	No affiliation provided
Lorien Grush	The Verge
Maribeth Davis	The Boeing Company
Marsha Smith	SpacePolicyOnline.com
Marvin	No affiliation provided

Mary Gunther	Sunnex Commerce Committee
Maryann	NASA
Mat Durnn	FDACEX
Megan Secret	Space
Meghan Barpels	space.com
Michael Latidus	SpaceX
Michael Sheetz	BNBC
Mike Currie	NASA Commercial Crew Program
Miles Doran	PBS News
Mindy Buong	NASA OIG
Nick Cummins	SpaceX
Pamela Whitney	Science, Space and Technology Committee
Randy Cruz	No affiliation provided
Richard Fisher	NASA
Richard Ward	Orbits Edge
Ronald H Freeman	American Institute of Aeronautics and Astronautics Operation
Silvey Espina	European Space Agency
Stephanie Schierholz	NASA
Stephen Clark	Spaceflight Now
Theodore Miller	Law Office
Thomas Culligan	Boeing
Thomas Schwab	No affiliation provided
Tom Hammond	Health Science Committee
Vara Forzick	Astral
Walt Rice	Boeing