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

May 1, 2020

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

Dear Mr. Bridenstine:

Due to restrictions imposed by the COVID-19 pandemic, the Aerospace Safety Advisory Panel (ASAP) held its 2020 Second Quarterly Meeting via teleconference April 21-23, 2020. Although this was an unprecedented forum for our engagement, we greatly appreciate the participation and support that was received from the subject matter experts and support staff. Because not all topics could be addressed on the planned date, a second session of the Second Quarterly will be held in a few weeks.

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
April 23, 2020
Conference Call

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
RADM (Ret.) Chris Murray
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 12:00 p.m. and welcomed everyone to the ASAP's second quarterly meeting of 2020. Prior to the meeting, the public had been invited to provide verbal or written statements. None were received.

Dr. Patricia Sanders opened the meeting by stating that the Panel's second quarterly meeting of 2020 was not conducted with the usual face-to-face engagement with NASA personnel. All members participated remotely from home locations due to restrictions imposed by the COVID-19 pandemic. She expressed her gratitude to all the IT experts who make virtual work possible.

The novel coronavirus has certainly added both complexity and simplicity to our lives, reflected Dr. Sanders, noting that the pandemic has definitely impacted NASA efforts. The Panel spent time at this meeting reviewing the steps that NASA is taking to ensure the safety of both personnel and continuity of essential actions.

Dr. Sanders remarked that NASA initiated mitigation efforts early and aggressively. They have a well-structured, four-tier level of response that allowed for a phased approach in introducing telework and identification and managing of essential tasks. Non-essential tasks were put on hold in a manner that secured critical hardware and facilities. A substantial amount of work was amenable to telework and is ongoing. Essential development and operational work–support of the International Space Station (ISS), mission control, astronaut training, critical launch, and hardware development–is being conducted with appropriate safety precautions including personnel distancing, use of personal protective gear, extensive cleaning, and separation between shift changes. Only in very limited circumstances is travel approved and mainly on NASA's own aircraft. The Panel commends NASA for the thoroughness of the mitigation steps in force.

The response does, however, have costs, noted Dr. Sanders. While telework is being effectively used, many activities are less efficient and take longer, placing additional stress on an already heavily burdened workforce. The Panel has some concern that critical reviews conducted through virtual meetings may suffer from the less intense engagement and non-verbal communications of face-to-face engagement. There will be schedule impacts. The "stop work" on the Space Launch System (SLS) core stage Green Run, as an example, will have an impact, although the extent is not yet known. And there will be definite financial costs incurred whose full scope is not yet known. There is a possibility that some critical small vendors will not survive the economic impact.

NASA has also initiated planning for a "slow start process" in order to efficiently and safely resume activity when the conditions permit. This is a prudent management process, which we also view positively, affirmed Dr. Sanders.

Meanwhile, the Panel's engagement this week was incomplete–partially due to the difficulties in arranging logistics for some of the NASA participants in the current environment, and partially for timing relative to various decision and acquisition schedules. Dr. Sanders indicated that the Panel was unable to meet with the Commercial Crew Program (CCP). Additionally, some insights into the Human Lunar Exploration (HLE) Program were limited until completion of ongoing source selection activities and associated studies. The Panel will therefore be conducting a part two of this Quarterly meeting in early May, Dr. Sanders stated, with a subsequent second follow-on session of this Public Meeting at a date to be announced soon.

As noted, the ASAP did not engage with the CCP during this Quarterly meeting due to a number of scheduling issues. The Panel, however, has been apprised over the past weeks of ongoing Program activities, and a thorough insight meeting with CCP personnel is anticipated in the near future.

As is publicly known, a projected date of 27 May 2020 is scheduled for the crewed flight test–Demo 2–of the SpaceX variant of the CCP. Dr. Sanders remarked that the Panel is aware of a few technical items that remain to be more fully understood before that event occurs, but the path forward appears feasible. Clearly, Dr. Sanders indicated, the decision on when to launch and on the duration of the test mission will be one that balances any residual risks with the vehicle design and implementation, with hazards of the current pandemic environment, and with the risk of insufficient manning of the International Space Station (ISS). This is a risk decision of which NASA is well aware and prepared to address and which the Panel will follow over the next weeks.

With respect to the other vehicle provider, Boeing, much remains to be resolved before they will be certified for human space flight. The Boeing decision to fly a second uncrewed test flight was welcomed by the Panel for the opportunity to demonstrate those test objectives not satisfactorily achieved on the first test attempt. However, Dr. Sanders cautioned that this is not sufficient to address the concerns that have arisen following the Operational Flight Test (OFT). The Panel continues to strongly advise NASA to ensure that the underlying technical *and* cultural/organizational shortcomings–uncovered during the investigation of the mishap and in subsequent reviews–are fully addressed and mitigated before any attempt to launch astronauts on the vehicle. The Panel believes NASA leadership intends to do so, but they remain steadfast in emphasizing this in their advice to them.

Dr. Sanders introduced Dr. George Nield to discuss the Panel's interactions with the Exploration Systems Development (ESD) Program personnel.

Exploration Systems Development

The Panel had a chance to hear from several presenters from the ESD Division, including the Acting Deputy Associate Administrator for ESD, Mr. Tom Whitmeyer. Mr. Whitmeyer reviewed the overall status of ESD programs and schedules, including some of the impacts from the coronavirus. Dr. Nield stated that although work has been halted on many ESD activities, such as the Green Run engine testing at Stennis, NASA has already started looking at the conditions under which they could implement a slow and deliberate re-start to the work. However, it's clear that some significant delays may be seen, depending on the duration of COVID-19 restrictions.

Dr. Nield noted that Rafael Garcia gave the Panel a rundown on the Artemis 1 environmental testing that was recently completed at Plum Brook Station. An extensive series of tests on the Orion spacecraft was accomplished for various thermal vacuum and thermal balance conditions, as well as for electromagnetic compatibility and electromagnetic interference; all tests were completed successfully and with no damage to the hardware. Also worthy of note were the challenging logistics associated with transporting the spacecraft to the test facility, and then on to KSC, using the Super Guppy aircraft. Dr. Nield remarked that the NASA and contractor teams clearly did a great job on all of that, and they are certainly deserving of the Panel's congratulations for their efforts.

The Panel had an opportunity to discuss several areas that they had questions about previously, including systems engineering practices in ESD, the testing being done on the Orion parachute system, and what the abort capabilities are going to be during launches for the Artemis Program.

Systems engineering has long been an interest area for the ASAP, and members have previously noted some of the challenges that NASA has faced in overseeing and integrating the various ESD projects, including the SLS, Orion, and the ground systems. Dr. Nield noted that Wayne Jermsted provided a thorough description of how ESD is applying accepted systems engineering and integration principles and putting them into practice. The Panel also understands that Doug Loverro, NASA's Associate Administrator for the Human Exploration and Operations (HEO) Mission Directorate, commissioned an HEO Program Status Assessment, and the results of that evaluation, along with the benchmarking of integration functions against past programs and past assessments by the NASA Engineering & Safety Center, have all indicated that ESD's systems engineering activities were very much on track. So that is certainly very encouraging, commented Dr. Nield.

Dr. Nield turned to Dr. Don McErlean, who presented the Panel's discussions related to the Orion parachute system.

In response to a Panel inquiry, the Artemis Program provided a review of the Orion parachute system. The topics covered included a short background, a status review, and a technical discussion regarding asymmetry in the loads applied to the riser lines, a phenomenon that had been observed in testing for the CCP. Dr. McErlean stated that although the Orion parachute system has not exhibited any difficulties in any testing to this point, given that the asymmetry problem has been observed on other programs, the Panel requested that the Artemis Program review this situation regarding the Orion system.

It was discussed that the actual acceptance of the parachute system as being certified for human flight had been accomplished during September 2019, with the exception that the chutes had not been packed in their mortars at that time. Hence, the final acceptance had to await one final test point, which was completed recently. All tests proved satisfactory, and the final U.S. government certification for human use is expected to be complete in May 2020.

As of this time, the chutes for the Artemis 1 test have been packed and installed in their mortars and are installed on the system. The chutes for Artemis 2 have been fabricated and the packing process is underway. The fabric for the parachutes for Artemis 3 is now available, and their fabrication has been started. Given this status, the Panel agrees that it is unlikely that the chutes will delay any testing if their operation continues to be satisfactory.

Dr. McErlean explained that when a parachute inflates, the inflation pressure places a load on the risers, which are the lines connected to the payload. In this case it would be the Orion capsule. In prior models up until very recently, these loads were considered to be symmetric, i.e., evenly applied to all risers. A factor of safety was assumed for the load, typically called "s," and it was assumed to be 1.1 for the calculated loads. Thus, each riser would have been capable of handling 1.1 times the calculated load and that load would have been assumed to be evenly split for all the risers.

Testing in other NASA programs, Dr. McErlean noted, has measured the load splits in an asymmetric fashion with some risers seeing an s-factor as high as 1.2 or even slightly higher. While most risers are designed to have margin, as the s-factor increases, that margin shrinks towards the failure load, and this is a cause for safety concern. Therefore, the Panel requested that the Artemis Program investigate their situation and report findings.

The Orion Program has investigated the impact of higher asymmetry on the margin for their risers and has determined that their margins are considerably above the 1.1 factor, and thus, are able to handle larger asymmetry. It turned out that when the models being used by the Orion Program to design their parachute were compared with the actual loads measured in test, the results showed the model to be considerably conservative, said Dr. McErlean. In addition, the mission profiles for the Orion are less stressing than the design missions used in the original design. While the driving requirement on the riser loads is the launch abort case, measurement of those loads still shows a positive margin with s factors up to 1.7. In fact, explained Dr. McErlean, for the nominal case of landing, the acceptable s-factor for the Orion parachute risers is 2.2, well over the recommended margin and well into the safe zone. The Panel was glad to note that this problem of asymmetric loading of the parachute risers does not seem to be a problem for the Orion system. The Program has investigated how they might improve their model and may indeed undertake such modifications in the future. However, at the moment, Dr. McErlean stated, since the model—upon which the Program based their design—is conservative when compared with measured test loads, this is not a significant concern.

The Panel noted to the Program that the parachute industry and the technical population, in both the government sector and in private industry, with high competence in the design of parachutes, are quite small. This gives rise to small companies with exceptional expertise, but vulnerable to leaving the industry when their (often family-owned) leadership and engineering team retires or otherwise leaves the business. The Panel inquired of the Orion Program if they had experienced that phenomena. Orion Program staff reported that they had; in fact, their leading expert in the government sector had been resident at Naval Air Weapons Center, China Lake, and had recently retired. Luckily, she continued to be available to the team for consultation and had taken on the task of passing her knowledge to a younger engineer at China Lake. The Orion Program also reported that the situation at their parachute supplier was similar. Although the company was modest in size, actions were taken to ensure that their experienced designers and engineers were bringing up younger folks to continue with the business. The Panel was certainly pleased to hear this report.

Dr. Nield added a comment on parachutes, which he noted also applies to several other highly specialized segments of the aerospace community. He encourages NASA to continue to closely monitor the health of the industry and to look for opportunities to support the development of relationships with multiple suppliers and sources for needed products and services to avoid the potential consequences associated with the loss of a sole provider.

The final ESD topic the Panel had a chance to review pertained to abort capabilities on the Artemis Program. Mike Sarafin, the Artemis Mission Manager for ESD, talked with the Panel about that subject, and according to Dr. Nield, did an excellent job describing current plans. Five different abort types were assessed. Mode 1 uses the Launch Abort System (LAS), and may occur any time after the LAS is armed on the launch pad until it is jettisoned at about 110 seconds after launch. Mode 2 is the Untargeted Abort Splashdown (UAS), which may occur in powered ascent after LAS jettison. It is only certified for splashdowns in the Atlantic using a 25-nautical mile standoff distance from the African landmass. Mode 3, Retrograde Targeted Abort Landing, is not currently baselined for Orion missions. Mode 4, Abort Once Around and Abort to Orbit, would occur during the first revolution of the Earth, with splashdown most likely occurring between Hawaii and Mexico/California. Finally, Early Interim Cryogenic Propulsion Stage (ICPS) Separation could occur between core stage main engine cut-off and the trans-lunar injection burn.

The Panel also discussed how an abort could be triggered. Dr. Nield noted the five different sources (per Mr. Sarafin's briefing): triggers from the SLS, from Orion, from the ICPS, from a

Range Safety Flight Termination System command, or from a manual command—either by the crew or from the ground. It was reported that under the current plan, Range Safety Flight Termination commands, if needed, would be sent manually for the first two missions, with an autonomous capability being implemented after that. Although such a capability does have cost implications, the Panel encourages NASA to continue to look at how to incorporate an autonomous system when it is feasible to do that.

Lt. Gen. Susan Helms was introduced by Dr. Sanders to comment on the Panel's limited engagement with the HLE Program.

Human Lunar Exploration
The Panel had the opportunity to review ongoing work for the HLE Program. First, as has been mentioned at the start of this meeting, the HLE Program has also experienced some of the issues related to COVID-19 and the execution of planned work. Productive work is being accomplished using telework strategies, but as with other areas of NASA, particularly the ESD Program, the HLE mission development that involves hardware checkouts and other types of 'touch labor' has been delayed until a safer workforce environment is in place. Nevertheless, Lt. Gen. Helms remarked, great progress is ongoing in the area of Artemis Mission Design, including extensive studies looking at how to balance risk across the multi-mission enterprise. One major milestone that is shortly upcoming is the announcement of the Human Lander System (HLS) source selection outcomes. Once NASA makes public their choices for the next phase, the ASAP will engage on the forward development work and the planned negotiation and integration of the chosen HLS proposals as a part of the broader HLE enterprise Concept of Operations.

Dr. Sanders asked Mr. Paul Hill to cover the Panel's more extensive discussions concerning the ISS Program.

International Space Station
Mr. Hill indicated that the ISS Program continues to take care of business, managing risk while juggling the still difficult business of maintaining the human presence in space with the new complication of COVID-19 on the ground.

On-board, with the return of Soyuz 61S, there is now an ISS crew of only three. Mr. Hill stated that this obviously halves the crew time available to do all work, from maintenance to utilization, and presents various logistics challenges balancing resupply with NASA's best estimates for who will be on-board over the next six months and when. It also poses a challenge for scheduling EVAs. The current crew complement, with only one U.S. operating segment astronaut, has the training necessary to conduct contingency extravehicular activity (EVA) and robotic operations if required in response to a failure. However, normally scheduled U.S. extravehicular mobility unit (EMU) EVAs–like the series of U.S. electrical system battery replacements–have now been put on hold until there are more crewmembers on board with the level of training NASA prefers for less time-critical needs.

The crew size will return to at least six and the planning constraints will be relieved when the commercial crew vehicles are flying crews to the ISS. In the interim, agreements are in progress to add a U.S. crewmember on Soyuz 63S in October 2020, and NASA is considering the need to increase EMU and robotic training for additional Russian crewmembers.

Mr. Hill noted that this is directly related to the concern that precipitated ASAP recommendation 2018-04-02: Action to Ensure U.S. Access to the International Space Station Given Commercial Crew Program Schedule Risk. In that regard, the Panel advises NASA to consider sustainable solutions in the event of continuing operations with reduced crew capacity that ensure that the critical crew skill sets are on board at all times. For example, manifesting every crew rotation flight to have at least one U.S. and one Russian crewmember on board to facilitate this kind of "insurance." Mr. Hill specified that would mean one U.S. seat on each Soyuz and one Russian seat on each U.S. commercial, crew-rotation flight; or, training U.S. and Russian crews on each segment's core and EVA systems. In any case, the Panel advises NASA to resolve this recurring risk as part of normal practice and not on an increment-by-increment basis.

The panel has been concerned for some time about the limited capability for a controlled ISS deorbit after a worst-case, ISS failure that leaves the vehicle untended by an on-board crew. As the Panel saw in developments last year, progress on this topic has come a long way, stated Mr. Hill. The Panel commends the ISS Program for its work in both studying and preparing capabilities for a controlled deorbit at the end of life and in response to a significant failure like a rapid cabin depressurization. On-board software has already been updated to optimize failure response, attitude control, and altitude management (deorbit burns). Future work includes further propellant management studies, studies and potential additional software for multiple ISS configurations and deorbit burn attitudes, and more. Although the Panel requests briefings on future developments, recommendation 2012-01-02: ISS Deorbit Capability, has been closed.

In a follow-on discussion, the Panel discussed the ISS lifetime in general. As a way of staying ahead of events, the Panel suggests NASA document the ISS life-limiting systems and components–through and beyond 2028–which are considered by test, analyses, or engineering judgment to be highest risk to ISS lifetime, as defined by both critical functions and time to effect (i.e., which have the worst impact and earliest need of replacement). The Panel also suggests NASA assess the engineering lead time required to develop and fly solutions to the highest risk failures if they were to occur before 2028. Further, if extending the ISS beyond 2028 is to be considered a candidate for longer term low-Earth orbit presence and/or commercialization, this assessment should be updated early enough before 2028 to support initiating any development and manufacturing required as a result of these high-risk items.

Dr. Sanders noted that at the time the ASAP formally recommended deorbit planning, no such effort existed. The Panel is pleased with the response to that recommendation and moves to close that formal recommendation at this time.

Dr. Sanders pointed out that the Panel intends to address topics not covered this week in the second portion of this Quarterly meeting next month. Before closing, she mentioned that the Panel has taken on a task from the NASA Administrator to provide advice on how best to sustain and manage risk and safety in the operation of NASA's unique and diverse aircraft fleet. This will be part of the ASAP's program of work over the remainder of the year.

Dr. Sanders opened the meeting up for public comments; there were none. Dr. Sanders adjourned the meeting at 12:32 p.m.

ATTACHMENT 1

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

Telecon Attendees:

Cat Hosacker	Aerospace America
Eric Berger	Ares Technical
David Hitt	ASRC Federal
Brian Harvey	Associates
Alan Deluna	ATDL Incorporated
Marina Corin	Atlantic
Megan	Axiom
Marcia Smith	Space Policy Online.com
Michael Sheetz	CNBC
Beckman	Boeing
Carrie Arnold	Boeing
Deann Reilly	Boeing
Debra	Boeing
Dee Russell	Boeing
Maribeth Davis	Boeing
Rebecca Regan	Boeing
Siceloff	Boeing
Thomas Culligan	Boeing
Tony Castioleja	Boeing
Damien Mills	Boeing Company
Kaitlyn Torres	Boeing Communication
Bill Harwood	CBS News
Name not provided	CNN
Daniel Morgan	Congressional Research Service
Angiey	Embassy of Russia
Estina	European Space Agency
Zachary Sivo	Government Accountability Office
Shaulter	General Public
John	Government
Tonya Woodbury	Government Accountability
Lauren Wright	Government Accountability Office
Jonathan Munetz	Government Accountability Office
Griffin Reinecke	Health Science Committee
Evan Brooks	House Science Committee
Linda Karanian	Karanian Aerospace Consulting
Theodore Kronmiller	Law Office
Anthony	Main Engine
Gina Anderson	NASA
Joshua Sinch	NASA

Kathryn Hambleton	NASA
Marcos Cena	NASA
Martin	NASA
Meredith McKay	NASA
Richard Fischer	NASA
Stephanie Schierholz	NASA
Mike Churi	NASA Commercial
Diane Rausch	NASA Headquarters
Lynn Lowy	NASA Headquarters
Victor Herod	NASA Johnson Space Center
Dimitra Tsamis	NASA Office of Inspector General
Lindy	NASA Office of Inspector General
David Eisenman	NASA Jet Propulsion Laboratory
Philip Sloss	NASAspaceflight.com
Keith Cowing	NASAwatch.com
Alexandra Witze	Nature Magazine
Jamie Lentz	No affiliation provided
Kelly Kabiri	Office of Safety and Mission Assurance
Douglas Messier	Parabolic Arc.com
Kevin Ford	Public
Joey Roulette	Reuters
Ashley Wilkins	Science Committee
Pam Whitney	Science Committee
Stephen Clark	Space Flight Now
Jeff Foust	Space News
Michael Lapidus	SpaceX
Mike Wall	Space.com
Dillon MacInnis	SpaceX
James Gleeson	SpaceX
Gene Mikulka	Talking Space
Jessica Landa	The Boeing Company
Cindy Anderson	The Boeing Company
Loren Grush	The Verge
Julie Arnold	ULA
Paul Brinkman	United
Kristin Vanwychen	USGAO
Jared Stout	Venable LLP
Chris Davenport	Washington Post
Asha Caoakrishnan	No affiliation provided
Emre Kelly	No affiliation provided
Erin Kennedy	No affiliation provided
Joy Kim	No affiliation provided
Tom Hammond	Science Committee