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

June 1, 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 Second Quarterly Meeting at Kennedy Space Center, Florida, on May 15-17, 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 and Revised Recommendation resulting from the public meeting for your consideration.

Sincerely,

Patricia Sanders

Patricia Sanders
Chair

Enclosure

AEROSPACE SAFETY ADVISORY PANEL
Public Meeting
May 17, 2018
Kennedy Space Center, Florida

2018 Second Quarterly Meeting Report

Aerospace Safety Advisory Panel (ASAP) Attendees
Dr. Patricia Sanders, Chair
CAPT (Ret.) Christopher Saindon
CAPT (Ret.) Brent Jett
Dr. James Bagian
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, Writer/Editor

Telecon Attendees – see Attachment 1

Opening Remarks
Ms. Carol Hamilton, ASAP Executive Director, called the meeting to order at 10:30 a.m. EDT and welcomed everyone to the ASAP's second quarterly meeting of 2018. She indicated that the 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, thanked Mr. Robert Cabana, Kennedy Space Center (KSC) Director, and the personnel at KSC for hosting the ASAP this week. She noted that the Panel continues to be impressed with the progress that has been made at the Center. There have been many positive changes over the past eight years, and it is a different place today.

Dr. Sanders reported that the Panel had a busy and productive week. Several members spent a day conducting a deep, focused dialog with the NASA Engineering and Safety Center (NESC) personnel and the NASA Chief Engineer. Discussions involved a status assessment of the practice of system engineering principles with respect to the Commercial Crew Program's (CCP's) provider, SpaceX. The Panel also held two days of intense, fact-finding meetings on various topics of interest to the ASAP. Finally, the Panel had a very helpful tour of Pad 39A, with emphasis on the flow of Falcon 9 launch operations.

Dr. Sanders asked Dr. Donald McErlean to lead the Panel discussion on topics of interest with Exploration Systems Development (ESD).

Exploration Systems Development

Dr. McErlean reported that the Panel discussions with ESD centered around the Space Launch System (SLS). The Panel examined the Program in some detail and engaged with it in three principal areas: a contamination problem in the engine core stage tubing, schedule acceleration of the ascent abort system test, and the probability of using a Block 1 SLS configuration for the first crewed mission—Exploration Mission (EM)-2.

The contamination problem was a disappointing late development. A routine quality inspection of the engine core stage detected a contaminant in the tubing used in the plumbing for that section. This issue was a prime concern, because any contaminants could negatively impact the safe operation of the engine. The prime contractor determined the vendor was not fully cleaning the tubes, leaving residue in them. The principal contaminant was paraffin wax, which is used in the tube bending process to prevent crimping. Tube cleaning was a requirement in the prime contractor's specification, but it was not properly carried out by the vendor. Other tubes were sampled to determine if the same problem was resident in other parts and pieces, and unfortunately, it was. An action team was formed to correct the problem. The program is now in the process of inspecting and cleaning all tubes and instituting additional cleaning inspections and requirements. Dr. McErlean explained that the engine section and other places in the rocket contain a mass of tubing. The tubes are long, complex, and some are quite small, and cleaning them is a non-trivial process. The Program is working on the corrective actions and making changes to its quality assurance plan, instituting new inspections, using other cleaning mechanisms, and conducting more robust cleaning inspections. In the Panel's discussion and review with the ESD program, it was clear that all the actions the Panel would have anticipated and advised NASA to do were already underway. The Panel had no further recommendations on this issue but will continue to review the situation going forward. When the ASAP asked about other components, the program agreed to do some spot-checking to ensure that the issue of subcontractors not complying with required specifications did not manifest elsewhere.

The other two key areas discussed were positive. They both result from an activity undertaken in response to the Administration's request to look at the feasibility of flying crew on EM-1. The Program undertook the study and although it determined that the risk associated with flying crew on EM-1 was too high, there were specific changes to the program that would be beneficial. One of these involves the ascent abort system test, which the Program found it could rather easily accelerate. The acceleration of that test presents an opportunity to obtain important data much earlier than originally planned. The test is designed to validate the ascent abort system performance to remove the crew capsule from the primary rocket under near-transonic flow conditions. The system would maneuver the crew capsule to a safe distance if the rocket were to have a problem during launch. The ASAP has been in favor of this ascent abort system test from the beginning of the Program and was pleased to see that NASA is carrying out the test earlier to obtain flight data. The acceleration moves the test to mid to late April next year. Dr. McErlean emphasized that this is a key system in protecting the crew, and doing the test earlier provides a better opportunity to make any corrections indicated by the test data. He remarked that it was interesting to note that doing this test earlier also lowers program cost.

CAPT Brent Jett added that in addition to all the abort capabilities mentioned by Dr. McErlean, another important test objective is to gather environmental data. When the abort motor fires, the acoustic environment is very severe. The pyro shock testing and the qualifications that NASA is doing on other components (not part of the abort test) depend on understanding that environment. An early ascent abort test would be an important way for the engineering team to validate the testing being done on other components. If the Program finds something different in those environments, this early information would give the team time to make necessary adjustments.

Another positive aspect discussed involved the EM-1 uncrewed test and an improvement in the schedule of EM-2 relative to EM-1. As mentioned earlier, the study requested by the Administration was to examine the feasibility of launching crew on EM-1, and the study found that putting crew on this mission would entail too much risk. Dr. McErlean noted that the entire ESD program has been based on flying crew on EM-2 with the Block 1B configuration of the SLS system. The Block 1B would utilize the Exploration Upper Stage (EUS) instead of the Interim Cryogenic Propulsion Stage (ICPS) that is to be used on Block 1 (EM-1). The EUS will be fully human rated; the ICPS is not. Using the EUS on EM-2 would require modification of the Mobile Launch Platform

(MLP). Because there is only one MLP, this would result in a 33-month "gap" (the time required for the MLP modification) between the EM-1 launch and the EM-2 launch. The ASAP supported NASA's request to build a second MLP, designed explicitly for use with the EUS, for two reasons—it would prevent the gap in the launch schedule (which the ASAP felt would lead to safety problems), and it would enable additional missions to be flown with the ICPS, should that be desired. The decision to fund a second MLP has allowed the second MLP Program to move forward. This action provides an opportunity to use the Block 1 configuration for the first crewed mission (EM-2). NASA can launch crew on the ICPS upper stage earlier instead of waiting for the second MLP to be completed. However, this approach necessitates human rating the ICPS. When the EM-1 crew study was completed, NASA learned several positive things, one of which was that the ICPS is more tolerant to MMOD damage (its primary weakness for human rating) than anticipated. The Program is now moving forward to human rate the ICPS, and the modifications have turned out to be more modest than originally anticipated. Much of the prior work from the EM-1 study—even though it did not result in putting crew on EM-1—resulted in data that will enable using the Block 1 configuration for EM-2 and accelerating that launch. NASA is currently reviewing all the tasks necessary to human rate the ICPS. While the tasks are non-trivial, they are relatively modest. Those tasks include incorporating an emergency detection system into the vehicle, changing some of the electrical bus connections, including the flight termination system, and others. The Program is adding some extra Kevlar blankets in a few places in the ICPS, which makes the system more robust.

NASA is in the orbit planning process and is making some small changes to the mission orbit, but the general strategy is: launch the system, park it in orbit for some period for system checkout, then do a lunar injection burn, go around the Moon, and come back. The actual orbital critical points are somewhat different than previously planned, but the strategy is the same. Many other changes need to take place between EM-1 and EM-2, but many of those do not affect the upper stage and must be done regardless of the strategy.

In summary, the Program had an issue with regards to contamination, which it is proceeding to correct. The EM-1 crewed study showed that the launch of EM-2 could be accomplished earlier using the Block 1 vehicle (assuming the ICPS can be human rated). Part of that will be enabled by purchase of the second MLP, which the Panel applauds. The acceleration of the ascent abort system test is very positive, resulting in earlier data on the system as well as the environment.

Dr. Sanders emphasized that both accelerating the ascent abort system test and taking advantage of using the ICPS for EM-2 (made possible by funding for the second MLP) provide significant safety risk reduction. These are steps that the Panel has encouraged and is pleased to see implemented.

CAPT Jett commented that NASA is moving down this path, but formal changes are yet to come. Dr. McErlean added that at this point, all signs are positive, and the Panel sees no reason not to proceed in this direction. Detailed studies are continuing, and the Program will be making the formal change requests in the near future.

Dr. Sanders asked CAPT Jett to lead the Panel's assessment of the issues with respect to the CCP. This includes discussion resulting from the Panel's focused review with the NESC on its report on SpaceX's system engineering approach. She noted that this has been a topic of particular importance to the Panel, and one with which it has an outstanding formal recommendation.

Commercial Crew Program

CAPT Jett reported that since February 2017, the Panel has had an outstanding recommendation for NASA to obtain evidence that the CCP providers are successfully incorporating systems engineering and integration (SE&I) principles in a disciplined and rigorous manner. It is important to note that in the recommendation the Panel specifically did not use the term "SE&I process" or insist SE&I principles be incorporated using traditional

approaches. “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 absolutely essential to human spaceflight safety. NASA’s focus to close the Panel’s recommendation has centered primarily on SpaceX, which has operated with innovation, speed, and a continuous drive to lower cost and improve performance and reliability. SpaceX’s non-traditional approaches have significant benefits and they have many amazing achievements to show for it. But, along with those successes, there have been failures that could be attributed, at least in part, to gaps or lapses in these SE&I principles. While the Panel has heard from NASA that SpaceX is making progress in implementing innovative tools that should enable the desired SE&I outcomes, escapes attributable to SE&I continue.

At the request of the NASA chief engineer, the NESC performed an assessment of SE&I practices at SpaceX. The assessment took approximately 16 months, concluding in the fall of 2017. The Panel was given access to the report and met face to face with the NESC team previously this week for in depth discussions. Even though the NESC team was limited in its access to SpaceX, the Panel found the report credible, and this credibility was reinforced by the representation on the team from the NASA Launch Services Program (LSP). The LSP has had extensive interactions with SpaceX in certification of the Falcon 9 for launching payloads such as satellites or other non-crewed space vehicles. The observations in the NESC report were consistent with the LSP’s experience in dealing with SpaceX. The Panel also noted that the NESC’s assessment is much more critical than other views of SE&I that have been presented by the CCP. CAPT Jett noted that the Panel does not have the insight or data to determine which internal NASA view of SpaceX SE&I is most accurate but stated that he thought that it is probably somewhere in the middle. However, this report’s findings must be addressed by the CCP and higher levels of NASA with resolution or adjudication of all observations, findings, and recommendations. Independent of NASA’s internal reports, CAPT Jett stated that the Panel remains resolute in its recommendation that NASA should not fly NASA astronauts on either provider’s commercial crew system until it is convinced, with objective evidence, that fundamental SE&I principles have been effectively incorporated.

Before continuing with other CCP topics, CAPT Jett asked other members of the Panel for their comments.

Dr. George Nield emphasized that what the Panel is hearing from the CCP Program Manager, Ms. Kathy Lueders, and from senior NASA management is that NASA has no intention of proceeding with a commercial crew launch until NASA is satisfied with safety. However, the ASAP believes that the SE&I issue needs to be discussed, adjudicated, and a final conclusion reached prior to launch. It is reassuring to understand that everyone is in agreement that must be done before launch occurs.

Dr. Sanders added that as NASA comes into more commercial partnerships in the future, it is important that the Agency learn how to work with non-traditional development approaches. The focus needs to remain on the basics: understanding margins, how the margins are established, and how they are controlled. There must be clear understanding of the configuration that is being flown. CAPT Jett indicated that NASA has come a long way in trying to understand how best to work with SpaceX. NASA understands that the processes must be those of SpaceX, and SpaceX must develop and embrace their own tools in following these principles.

Dr. James Bagian noted that another way to say this is: the “what” and the “how.” The “what” are the appropriate understandings of risk and hazards and that they are being controlled adequately. The worry is sometimes in the “how.” There may be many ways to get to the goal. When using the word “adjudicate,” Dr. Bagian suggested the Panel means “reconcile.” Do they understand the risk and is the risk at an acceptable level? The way in which that reconciliation takes place and the way the final determinations are made needs to be transparently communicated. CAPT Jett agreed that “reconciliation” is probably a better term than “adjudication.”

CAPT Jett continued discussing the Program status and other issues. Both providers continue to work toward the first test flights of their systems. While the official schedules have both providers flying crewed test flights late this year, the Panel believes that, given the open work required, further schedule slips are likely. CAPT Jett noted that he personally feels that if both providers successfully fly their first test flight without crew this year, that would be a good outcome.

CAPT Jett reported that the Panel spent half a day with the CCP managers discussing the challenges ahead. They reviewed the technical issues and safety risks specific to each provider as well as those affecting both providers. The Panel found that NASA and the providers are approaching these challenges with the appropriate safety focus. While the schedule has become a factor in some decisions, as is normal for any program, the Panel found no evidence that any individual decision or cumulative effect of decisions would involve unacceptable risk.

CAPT Jett mentioned a couple of high-visibility issues that were presented. The first was the addition of a third crew member to the Boeing crewed test flight. This is being done in conjunction with the work required to provide the option to extend the docked time of that mission. All of this is to protect for potential slips of the first commercial crew flights past the last Soyuz flight purchased by NASA, which the ASAP discussed in its last report. While everyone hopes that commercial crew does not slip that far into the future, the Panel believes it is prudent for NASA to have a plan that mitigates the impacts to ISS operations should those slips occur. CAPT Jett noted that the ASAP had no issues with NASA's approach for this potential contingency.

The second issue was the qualification and testing efforts for the Falcon 9 Composite Overwrapped Pressure Vessel (COPV) 2.0 (the redesigned COPV). The Panel has consistently maintained that understanding the behavior of the COPV in the densified cryogenic environment and identifying all the potential ignition scenarios are critical to controlling potential hazards. Despite challenges, NASA and SpaceX are laser-focused on this task, and the Panel is comfortable with their approach of defining the boundaries through test and then establishing adequate safety margins for operations.

The other issue, which is somewhat related to COPV (which must be resolved regardless), is the "load and go" operations proposed for Falcon 9. This approach is essentially to load the crew first, then load propellant, and then launch. The Panel was recently provided another NESC report, which was an in-depth analysis of the hazards and controls associated with load and go. This report, which identified a few previously unrecognized hazard causes, proved very valuable to the CCP. Since the Panel expects the Program to soon make a decision on the appropriate sequence for loading crew and fuel onto the Falcon 9, now is the appropriate time for the Panel to provide advice to NASA. Assuming that adequate, verifiable controls are identified and implemented for all the credible hazard causes which could potentially result in an emergency situation or worse, it appears that load and go is a viable option for the Program to consider.

At this point, CAPT Jett invited other Panel members to comment on their impressions. Dr. Sanders echoed what CAPT Jett said. The Panel has had several discussions on this topic over the years. There are certainly items that must be carefully watched, but it appears that if all the appropriate steps are taken to address the potential hazards, the risks of launching the crew in the load and go configuration could be acceptable. Dr. Nield agreed with those comments. As NASA considers the recommendation, the other important factor is to consider this from a system point of view—not only flight crew safety, but also ground crew safety. In other words, where are the risks, how can they be mitigated, and what is the best sequence for safety as a whole? CAPT Jett added that whether crew is loaded first, or propellant is loaded first, the COPV issue must be resolved. NASA must be comfortable with the COPV, then consider the hazards associated with the transient of having crew on board

during fueling. If hazards can be adequately controlled, there are some positive aspects associated with load and go. Dr. Bagian emphasized that the COPV issue is more of a driving factor than anything else.

In summary, CAPT Jett opined that this is a critical time in the CCP. There are significant technical challenges and tough decisions ahead. The Panel will continue to closely follow the progress as NASA and the providers focus on the upcoming test flights. CAPT Jett provided a cautionary note: from his experience working with NASA, "getting to flight rationale" is part of NASA's "DNA." As NASA's independent safety panel, it is the ASAP's job to advise NASA if the Panel observes the focus on getting to flight rationale starts to overwhelm the higher-level obligation NASA has to uphold the safety standards and acceptable risk for human space flight. Dr. Sanders agreed with CAPT Jett on the Panel's responsibilities. She commented on the option for Boeing to launch an additional person on the first crewed test flight (and perhaps extend that flight's duration at the Station). It is prudent—actually imperative—that NASA have contingency plans to address schedule risk in CCP. It is unacceptable to either make decisions leading to increased safety risk because of schedule pressure or to risk inadequate manning of the International Space Station (ISS).

Dr. Sanders asked Dr. Nield to lead the discussion on the ISS.

International Space Station

Dr. Nield reported that the Panel had an excellent discussion with Mr. Kirk Shireman, the ISS Program Manager, at the insight meeting the previous day. Operations are going very well. Yesterday, the crew conducted a successful extravehicular activity (EVA) spacewalk, where they moved the pump flow control subassembly that controls the flow of ammonia through the exterior portion of the Station's cooling system. Another important milestone was mentioned: the Orbital/ATK (OA)-9 mission launch this Sunday. It will include 3268 kg upmass and allow for 2900 kg disposal. Many other activities are planned during the mission, including a development test objective that is very important to the Panel and the Program. The Cygnus spacecraft will conduct a short burn to try to reboost the ISS to demonstrate its capability. If successful, this will open additional options for End-Of-Life (EOL) planning.

Mr. Shireman reviewed the consumable status; the Panel noted that current O_2 levels leave a little less than desired reserves. However, crew usage has been averaging about 70 percent of the planned levels and several visiting vehicles are on the flight plan over the next few months. At present, it is not an item of concern. With regard to crew utilization, the actual time being logged by the crew is matching the plan fairly closely. Dr. Nield noted the current research statistics: there have been 2582 investigations conducted since beginning of the Station program with over 3000 investigators involved and over 1500 publications. This is very much an international activity, with participation of 103 countries to date in research or educational activities.

Dr. Nield noted that another area of emphasis that the ASAP applauds is future planning. There are several examples: potential major upgrades to the extravehicular mobility unit—spacesuits, helmets, heat exchangers, etc. The Program is examining how they can be demonstrated or incorporated into Station activities. A similar approach is being used for the Environmental Control and Life Support System (ECLSS)—both air and water—to improve and demonstrate significant run times on these new systems for the higher reliabilities needed for exploration missions.

With regard to the top ISS risks, NASA has listed the potential for external reductions to the ISS budget as its number one programmatic risk. Dr. Nield noted that the ASAP has had concerns about the budget process in the past and will watch how the Administration and Congress deal with it. Another top risk was the lack of assured access for crew, which is directly tied into progress by the CCP. The number three risk is ISS contingency deorbit capability, which has been a long-running area of ASAP concern. The Panel discussed contingency deorbit with

Mr. Charlie Gray, and benefited from a good update on the planning status. On the Russian side, the ISS Deorbit Strategy and Contingency Action Plan is awaiting final review and approval from Roscosmos. There has also been progress on NASA's open work. The Program is currently examining the altitude limits for controlling the ISS as it deorbits. Based on recent results, the control gyros may be effective as low as 220 km, which is lower than some had expected. NASA is studying how much propellant will be needed for attitude control when the Station reaches that altitude. Another area of open work is ISS survivability at vacuum should there be a breach in the hull. A gas trap plug is being designed to prevent internal thermal control system leakage in that scenario. However, there was a recent failure of that system during high pressure test, which will delay completion until next June at the earliest. A related issue was the recent deorbit and re-entry of the Chinese station on April 1. That event provided a reference model on natural orbit decay duration. In that case, the station deorbited on its own, fortunately landing in the south Pacific. NASA and the ISS community want to ensure a deliberate, safe-area target, such as open ocean. To do that, all the plans and capabilities should be in place to deorbit safely if there is a contingency scenario.

The final area discussed was commercializing LEO. Currently, there is considerable debate on what the lifetime of ISS should be and how to transition to something else. Clearly, there is an ongoing need for capabilities in LEO. NASA is planning to release a NASA Research Announcement in the next few days, soliciting ideas from industry on what a future capability could be. There is potential for multiple awards, up to $1M each, with a contract in the July timeframe and studies completed in December. The questions NASA is trying to answer are: What products and services would industry like to offer? What is the business plan that would enable those products and services to be delivered in a reasonable way? The goal is for private industry to have these capabilities and for NASA to serve as one of the customers, not the only customer. This would produce benefits not only for NASA and the space industry, but for the overall space program.

Dr. Sanders commented that there are many different concepts of what commercialization of LEO means. The Panel sees a continuing need for a persistent NASA presence in LEO to conduct operations that would reduce risk for further space exploration in the future.

CAPT Jett added that turning LEO over to the commercial sector seems to be the next evolutionary step, while NASA focuses on deep space exploration. It would also provide a marketplace for commercial entities to sell services.

Dr. Sanders turned the discussion on Enterprise Protection over to Dr. Bagian.

Enterprise Protection

Dr. Bagian noted that the ASAP has had an ongoing discussion on enterprise protection for several years. He explained how this relates to safety; enterprise protection can affect the information available to make mission-critical and safety-critical decisions. The Panel conducted discussions with several people who are involved with enterprise protection, and they have made progress since the last time the Panel talked with them. They appear to have a clearer understanding on the communication aspects.

Mr. Ray Taylor, the Principal Executive for the Enterprise Protection Program, provided an update on their progress on obtaining appropriate clearances, which has been an obstacle in the past. They have instituted an Enterprise Protection Board, chaired by the Associate Administrator, with Mr. Taylor as the Executive Director, to ensure interfaces with all Centers and programs, to identify topics, to effectively communicate what the risks are, and to understand how risks are perceived in the field. This is a positive step. They have outlined a plan, and progress is more firmly underway. Forward work includes conducting some surveys to understand what is occurring across the Agency. As that is understood, they will be in a much better position to act. In its visits to

the Centers, the ASAP has observed that in some instances, there has not been clear communication down to the program level.

Dr. Bagian felt that a famous Winston Churchill quote could describe where NASA is presently: "Now this is not the end. It is not even the beginning of the end. But it is, perhaps the end of the beginning." NASA now has some firm processes that they are putting in place and an organization by which to go forward. There is a lot of work ahead, and the ASAP expects NASA to continue along these lines.

Ms. Renee Wynn, NASA Chief Information Officer, discussed what they are doing proactively with information technology security. In addition to the security aspect, these actions also represent a more cost effective and efficient way to make data available, both internally and with partners. Having a better handle on how the data flows, where it resides, how it is secured, and how it is made available benefits everybody. If Centers and organizations work in their own "bubbles," communication is unclear, and it is difficult for people to get the data they need. One of the more concrete things her office will be doing will involve more standardization about what individuals and devices can access the NASA network. Starting this summer, the Agency will require NASA-controlled devices, as well as controlled access, for calendaring and email. This will be the first step and will begin with NASA, then include partners and contractors. Other applications, in addition to calendaring and email, will be implemented by end of 2019. Dr. Bagian indicated that the ASAP will continue to follow the progress.

Dr. Sanders commented that safety culture is an area of interest for the ASAP, and the Panel held a spirited dialog with Dr. Tracy Dillinger, Safety Culture Program Manager in the Office of Safety and Mission Assurance (OSMA). Dr. Sanders asked Mr. David West to report on the Panel's discussion.

Safety Culture

Before reporting on what the Panel learned this week about NASA's efforts to establish and promote an effective safety culture across the Agency, Mr. West provided some background on the Panel's visit to the NASA Safety Center (NSC) last year. At that visit, some of the Panel members inquired about safety audits – how often they were done and what subjects and areas they covered. The Panel learned that audits were done once every four years, and the audits had not been covering system safety at all. Following that visit, the Panel made a recommendation regarding audits. That recommendation, identified as 2017-02-01, consisted of two parts. The first part of the recommendation was that NASA should establish, prioritize, resource, and implement a rigorous schedule of audits, executed by the Office of Safety and Mission Assurance (OSMA), and conducted at the Center level. In the second part of the recommendation, the Panel specified that the audits should ensure documented safety requirements, processes, and procedures are consistently applied across the Agency.

Mr. West came back to this recommendation later, but first recounted a discussion the Panel had with Dr. Tracy Dillinger. Dr. Dillinger discussed five parts of the Safety Culture Toolkit: survey, education, engagement, media, and guidance. A Safety Culture Survey (SCS) was developed and sent to all NASA employees. The SCS is being conducted over several rounds, or cycles. There are 22 questions in the most recent round of the survey. The questions are designed to assess NASA workforce's impressions of the NASA Safety Culture in five key categories – Reporting Culture, Just Culture, Flexible Culture, Learning Culture, and Engaged Culture. In the aggregate, the responses were fairly high, generally averaging about five on a scale of one to six. NASA's Administrator supports these surveys and is using the results. Some of the most useful survey feedback was provided in the form of comments. The Panel learned that the KSC Center Director reads every single comment that is submitted. In the area of Education and Training, two programs have been put in place: an Orientation course and a Supervisor's course. The Orientation course is part of mandatory training for new employees. In the area of Engagement, a series of Organizational Safety Assessments is being conducted. To date, these assessments

have included over 1000 interviews across the human space flight programs. The interviews are conducted in a non-attribution environment, and the findings have provided useful insights about processes, communications, one-on-one counseling, leadership, etc.

After this fact-finding discussion, the Panel observed indications of strong institutional safety practices across NASA. There are, however, some lingering Panel concerns; specifically, the audit system is still not ensuring effective implementation of these practices and processes.

Mr. West returned to the recommendation that he noted earlier. With regard to the first part of the recommendation, he felt that the Panel is comfortable that OSMA has established, prioritized, and implemented a schedule and periodicity cycle for Center-level safety audits. However, the Panel wants assurance that OSMA has a mechanism in place to verify that the NASA safety policies, processes, and procedures are being followed to ensure effective employee safety, system safety, and program safety. Effective safety assurance involves far more than just checking programmatic safety compliance. It involves in-depth assessments of safety culture and first-hand observation of safety processes, in addition to the detailed programmatic compliance checks.

Mr. West proposed a revision to the existing recommendation, with a revised title "NASA Safety Assurance Process Scope and Quality:"

> *NASA SMA should develop a coordinated, in-depth system of safety assurance tools and processes to verify effective programmatic safety compliance, system safety practices, safety process function, safety culture, and overall safety posture at all levels of the organization.*

Dr. Sanders asked for discussion and input on whether the Panel was in agreement with the proposed revision.

Dr. Bagian indicated that he agreed with the proposed revision and emphasized that "effective" means not just a paper drill—it should be what is actually being done. Dr. Nield agreed and added that the ASAP is trying to move OSMA from having a policy to what is being done and to have that embraced across the Agency.

CAPT Jett observed that in theory, it is an excellent recommendation, but it may be asking for a lot. As expressed, it might be a tough recommendation for NASA to close.

Dr. Bagian noted that there may be a question about what "effective" means—clearly, it cannot be just a check sheet. Currently, the OSMA audits are at the other extreme—a paper exercise that assures that policies are in place without ensuring the spirit of the policies are being followed.

Dr. Nield commented that it is an ambitious and challenging action, and he would be very interested in seeing how NASA would respond to it. This would be an opportunity to take a fresh look across the Agency at what is being done to achieve the goal and measure progress. If the recommendation is too difficult or needs to be descoped, the Panel could have that discussion with NASA.

CAPT Jett questioned the word "develop"—it sounds like the ASAP is asking NASA to develop something new. What the Panel wants is for OSMA to ensure that safety processes are in place today. They may need improvement. The Panel is not asking OSMA to create something new but ensure that what they have is modified or updated to (1) include system safety, (2) to verify that the policies and practices are being followed on a daily basis, and (3) identify any "gaps" that are not being covered.

Dr. Sanders recommended that “develop” be replaced with “have” in the proposed revision. The proposed revision more accurately captures where the Panel intended to go with its original recommendation. The Panel adopted the revision; however, Dr. Sanders indicated that the ASAP would take an action to work with NASA to better define what the Panel is expecting and what “success” would look like.

Dr. Sanders opened the meeting for public comments. There were none, and she adjourned the meeting at 11:42 a.m. EDT.

2017-02-01 REVISED 2018-02-01: NASA Safety Assurance Process Scope and Quality

Recommendation: NASA Safety and Mission Assurance should have a coordinated, in-depth system of safety assurance tools and processes to verify effective programmatic safety compliance, system safety practices, safety process function, safety culture, and overall safety posture at all levels of the organization.

ATTACHMENT 1 – TELECON ATTENDEES

Name:	Affiliation:
Beck, Dan	Boeing
Brost, Josh	SpaceX
Chevalier, Maryanne	NASA
Clark, Stephen	Space Flight Now
Curie, Mike	NASA
Davenport, Chris	Washington Post
Eiseman, David	NASA JPL
Foust, Jeff	Space News
Gleeson, James	SpaceX
Grush, Loren	The Verge
Hugen, Colan	Lockheed Martin
Kabiri, Kelly	NASA OSMA
Karanian, Linda	Karanian Aerospace Consultant
Kronmiller, Theadore	Law Office
Lapidus, Michael	SpaceX
Loewy, Lynne	NASA HQ
Martin, Stephanie	NASA PAO
Masunaga, Samantha	LA Times
Oentv, Dan	Boeing
Pasalam, Mithia	SpaceX
Rausch, Diane	NASA HQ
Schierhold, Stephanie	NASA
Sheridan, Alison	Boeing
Siceloff, Steven	Boeing
Smas, Scott	Arizona State University
VanWychen, Kristin	USGAO