National Aeronautics and Space Administration

International Space Station Advisory Committee

November 18, 2019
NASA Headquarters
Washington, DC

OPEN MEETING REPORT

Original Signed by

Lt. General Thomas P. Stafford, USAF (Ret.)
Chairman

Original Signed by

Mr. Patrick T. Finley
Executive Director

NASA INTERNATIONAL SPACE STATION ADVISORY COMMITTEE

November 18, 2019
NASA Headquarters
Washington, DC

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NASA INTERNATIONAL SPACE STATION ADVISORY COMMITTEE

MEETING REPORT

NASA ISS Advisory Committee
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November 18, 2019
NASA Headquarters
11:00 AM ET

OPENING

Executive Director Patrick Finley: *Welcomed participants; called roll of International Space Station (ISS) Advisory Committee (AC) members and thanked everyone for participating.*

From August 12 - 16, 2019, the International Space Station Advisory Committee met with the Roscosmos Advisory Expert Council as a Joint Commission and held a fact-finding session in Moscow, Russia. The purpose of the Joint Commission is to review ISS operations, with a focus on crew safety and utilization.

The Joint Commission heard briefings by U.S. and Russian specialists covering a broad range of topics, including presentations on the status of the ISS Program, the Functional Cargo Block (FGB) module, a medical operations and human research status update, and an update on extravehicular activity readiness. Additionally, the Joint Commission was updated on ISS post- 2024 planning, ISS structure and onboard system status, joint research, and ISS contingency planning. Experts from Roscosmos and NASA's ISS Program Office participated in the meeting and provided presentations.

With that introduction, I will now turn the meeting over to our Chairman, General Thomas Stafford, to review the results of our recent fact-finding meeting in Moscow.

General Stafford: *Good morning and thank you for participating in this open meeting of the NASA International Space Station Advisory Committee.*

For our meeting today, we will be discussing information we gathered from the August fact-finding meeting in Moscow. I have asked Committee Member William Readdy to summarize each of the main areas that we reviewed, and then allow time for Committee members to ask questions and discuss each topic.

Captain Readdy:

ISS Program Overview

Roscosmos and NASA representatives presented the current status of the Russian and U.S. Operational Segments of the ISS. Water, food, propellant, and other critical consumables are all at levels with sufficient margin to support ISS operations.

Although the JC commends the partnership for the current status of ISS, the near-term future of the Program is at risk due to the current state of U.S. crew vehicles (USCV) and the probability of additional delays. Without USCV, the ISS crew would fall to two cosmonauts and one astronaut in April 2020. A single U.S. astronaut on ISS is not sufficient to conduct contingency extra-vehicular activities, or EVA, critical to the U.S. operational segment. Anticipating this possibility, NASA and Roscosmos have been training cosmonauts to support contingency EVA activities. This training will only provide the capability necessary to sustain the ISS through October 2020, as there is no arrangement in place between NASA and Roscosmos to fly a U.S. astronaut beyond that point. The JC strongly recommends that, as soon as possible, NASA and Roscosmos find a mutually agreed solution to ensure the continued presence of appropriately trained U.S. and Russian crew members on the ISS.
The Russian ISS Program status update described the crewed Soyuz launch anomaly in October 2018. Fortunately, the crew landed safely, and ultimately launched to the ISS later. A special commission was formed to review the launch anomaly, and the root cause was determined to be mechanical damage to the sensor that enables the pressurizing gas to activate and separate the launch vehicle stages. As a result, Roscosmos has implemented video monitoring during the vehicle assembly to prevent such issues from arising in the future. The new generation of Soyuz vehicles, the Soyuz 2.1a, will have an electronic backup system that will ensure the vehicle separation issue.

Later in August 2019, the Russian side will launch an un-crewed mission of the Soyuz 2.1a and Soyuz launch vehicle. The launch was scheduled for August 22, 2019, with a planned stay on ISS until September 7, 2019. The vehicle delivered the FEDOR robot, and the robot returned to Earth with the Soyuz MS vehicle. The vehicle has two control loops, both manual and automatic. Since this launch was un-crewed, there will be additional automatic control loops to ensure safe interactions with ISS.

On September 25, 2019, the Russian side is planning the last launch of a Soyuz FG launch vehicle. After this point, launches will be discontinued from Gagarin's launch pad at the Baikonur Cosmodrome, because it cannot support launches of Soyuz 2.1a.
Therefore, all subsequent launches will take place from pad 31 in Baikonur. In order to decrease risks to the launch pad, the Russian side plans to start launching Progress cargo resupply missions from the Vostochny Cosmodrome.

The ISS Program is planning for a large number of EVAs on both the Russian and the USOS segments in the near future. The Russian side is planning an EVA to address a number of maintenance tasks associated with the FGB module. The EVA is planned to take about six hours. There will need to be a series of EVAs to prepare for the Multipurpose Laboratory Module.

The Russian side favors extension of the ISS program until at least 2030. This would allow time to launch the remaining modules to the ISS, take advantage of scientific utilization, and test and mature future exploration systems, including the Federation and lunar science projects. The Russian side is planning to test the future Federation crew vehicle, with dockings scheduled with the ISS in 2023 and 2024. The Russian side needs to confirm the technical feasibility of ISS extension to 2030 but has not identified significant technical reasons why the ISS cannot be extended to this time period.

NASA specialists noted that the USOS crew has been achieving about 80 hours/week of scientific investigation and research. Based on this performance, NASA is hopeful of setting a new record of research averages during this increment. The previous record was about 63 hours per week, and this team is targeting about 68 hours per week. ISS research threshold allocations are determined ahead of increments, and then they are adjusted during the mission to account for changes in priorities. For the lifetime of the ISS, the partnership has hosted more than 2,800 scientific investigations, representing more than 3,900 investigators, more than 1,700 publications, and involving 107 countries/areas from around the world.

The 11th Northrup Grumman cargo resupply services mission launched in April 2019 and un-berthed from the ISS in August. There will be a few post-un-berth activities to perform, including raising its altitude to more than 400km to deploy Nanoracks cubesats, a "slingshot" cubesat deployer, and deployment of the "seeker" payload. The seeker is a free flier designed to demonstrate proximity operations around the Cygnus spacecraft.

The 18th SpaceX cargo resupply services mission successfully delivered its cargo in July 2019 and berthed to ISS. This is the third flight of the Dragon capsule, and this will be the last mission for this Dragon. The Falcon 9 launch vehicle was re-used from the 17th SpaceX CRS mission. This mission delivered an additional international docking adapter that will provide a redundant docking capability and will enable direct crew handovers in the future. The mission also delivered another rodent research experiment.

NASA was preparing for the Japanese to launch the HTV-8 cargo resupply mission in September 2019 to deliver an additional six lithium ion batteries. This will allow NASA to change the batteries on the p6 solar array. This mission will only stay on station for about one month before making room to enable the 12th Northrop Grumman commercial resupply services mission to visit the ISS. NASA is pushing to get this Cygnus launched to enable delivery of hardware critical to perform repairs on the Alpha Magnetic Spectrometer, or AMS. The cooling pumps on the AMS are operating past their intended lifespan, so EVAs are planned to replace the cooling pumps. Unfortunately, AMS was not designed to be EVA-repairable, and so the EVA team has been required to overcome a number of hurdles in preparation.

Later in September, Roscosmos flew a mission which included a visiting astronaut from the United Arab Emirates. Meanwhile NASA, JAXA, and ESA are partnering with the UAE to conduct scientific experiments and educational outreach during the short-increment flight. This is a great example of Roscosmos expanding the reach of the ISS partnership. The extended missions of astronauts Christina Koch and Drew Morgan enabled a seat to be available for UAE to launch. Ultimately, Koch will be on orbit for 328 days. Drew Morgan will stay on orbit for more than 250 days.

Functional Cargo Block (FGB) Module Status

Russian specialists continue to monitor the status of the FGB, or Zarya, module closely. All systems functions remain nominal and are performing within expected parameters. However, many FGB components are past envisioned service life thresholds, and Russian specialists

have observed a number of failures. The FGB recently experienced a damaged cable that affected onboard complex control. The replacement cable was manufactured and delivered onboard as a replacement.

Occasionally, specialists have noted the presence of gas bubbles in the hydraulic control loops. This is believed to be the result of maintenance and repair work on various systems, during which gas bubbles are introduced into the systems. There is a concern that if the gas bubbles grow to a certain extent, they could disrupt the pump system. If the pump system failed to function, then the thermal control for the module could be affected. Russian specialists are developing a system to detect, locate, and remove these bubbles from the hydraulic loops.

Microbiological contamination is being monitored onboard FGB, but analysis is showing an improvement on contamination due to a variety of mitigation steps taken in recent years. The main source of noise onboard the module are the approximately fifteen cooling fans that have been in operation for more than 20 years. In response to the noise challenges, Khrunichev has designed low-noise fans. NASA has decided to take audio measurements before and after four of the new fans are installed. If a positive outcome is observed, NASA may replace all the fans onboard the module. Finally, Khrunichev has completed and uploaded software upgrades to ensure propellant transfer in the event of a depressurization event.

Medical Operations Update and Human Research Status

Russian and U.S. medical experts reported that the health and performance of the crew is at a sufficient level to perform all necessary ISS mission objectives. The Russian and USOS operate a joint and integrated medical assessment team; flight surgeons and medical specialists discuss crew health status on a weekly basis. Medical specialists noted that the mission duration for U.S. astronauts Christina Koch and Drew Morgan were each extended. The Multilateral Medical Operations Panel thoroughly reviewed physical and psychological profiles for each crew member and supported the decision to extend these missions.

During the SpaceX Demo-1 mission, the Russian medical team noted that the crew observed a strong smell associated with concentrations of isopropanol and other air contaminants. Ultimately, this was not a significant event and posed no risk to the crew. The Russian side attributes this to insufficient degassing actions of the spacecraft during manufacture. The level of air contamination observed was higher than in cargo vehicles. The contamination was quickly removed due to venting actions by the crew, but the Russian side recommends additional air quality cleaning and monitoring of the internal volume of the SpaceX vehicle in the future. The Russian side has provided this feedback through the integrated ISS Program medical structure. NASA captured this and other lessons learned from the SpaceX Demo-1 mission.

The Russian medical team continues to monitor micro bacterial and air contamination levels in the FGB. While higher than desired, the levels are decreasing due to cleaning and decontamination efforts implemented. In particular, the Russian medical community concludes that there is no microbiological hazard onboard the FGB. Noise levels on the ISS continue to exceed requirements but remain steady and not increasing. False triggers of the smoke detectors continue as a result of high concentrations of dust in the ISS

atmosphere. Both U.S. and Russian systems for radiation monitoring are operational and crew radiation exposure remains with established thresholds.

EVA Readiness

In August, NASA will conduct an EVA to install international docking adapter, or IDA, #3. The IDA will be robotically removed from the SpaceX Dragon's 18th cargo resupply mission prior to executing the IDA installation via EVA. In September, NASA will conduct an EVA to continue work to upgrade batteries for one pair of solar arrays. The batteries were replaced at least once before, utilizing the Space Shuttle. NASA is also preparing for a series of EVA to focus on repairs for the Alpha Magnetic Spectrometer onboard ISS.

These EVA are planned to begin in November 2019 and much of the schedule has been dependent on when tools and other hardware can be manufactured and delivered to ISS. Due to the EVA complexity, crews conducted virtual training, Neutral Buoyancy Lab training, and zero-gravity sling training at JSC.

Russian specialists reported that at this time, the Hydrolab renovations at the Gagarin Cosmonaut Training Center have been completed, and testing has been performed to ensure there are no leaks or malfunctions in the pool. Currently, GCTC is developing the lifting mechanisms and platform for executing training activities and plans to commission the new platform in October 2019. If everything goes correctly, it is expected that EVA training can resume in November 2019. Without the Hydrolab, crews train on a weight-release system at GCTC. The Russian crew members have been certified with this system and are prepared to perform an EVA. In the future, the plan is to certify the crews in the Hydrolab.

ISS After 2024 Planning

NASA briefed on plans for ISS beyond 2024, including efforts to increase commercial activities in low-Earth orbit, and dates international partners need for ISS transition. The ISS partners convened an ISS Transition Working Group in June 2019 to better understand international planning for ISS requirements post-2024. NASA noted that discussions with the partners indicate an interest in extending use of ISS until 2030.

In addition to considering extension of ISS activities, NASA has been tasked by the U.S. government with increasing commercial activities onboard the ISS. NASA envisions a need to access LEO in order to support crew training and proficiency, fundamental and applied research, as well as advanced system development and testing.

NASA has also determined that the ISS will be the last U.S. government-led destination in LEO.

The Russian side noted that the international partners should be consulted in the event that the U.S. government determines to turn over ISS operations to a commercial entity. The Russian side noted concerns regarding responsibility for safety and operational review in the event the ISS would be operated by a non-government entity. The JC emphasized the importance of consultations with the international partners for any commercial activities affecting the management of the ISS.

ISS Structure and Onboard Systems

NASA and Roscosmos specialists briefed on the service life of ISS systems and reported that the ISS is technically capable of operations up to at least 2024. The Zvezda service module was originally designed to operate until 2013, and has been extended to operate to 2020, with annual technical review and certification. Russian specialists monitor any hardware and software discrepancies onboard ISS, and there has been no general trend or increase in discrepancies as the ISS ages, which bodes well for supporting system lifetime extension. There are some elements on ISS that require replacement parts that are no longer manufactured. As a result, the Russian side is looking at redesign and upgrades to support function, including: guidance and navigation, thermal control, life support (waste and hygiene), solar array orientation, and data management controls. Propulsion systems onboard the Russian segment continue to operate per design specifications. There has been some degradation in performance over the years, but this differential should be overcome when the Multipurpose Laboratory Module is launched to the ISS in the future. Similarly, NASA specialists have reviewed and analyzed loads ISS hardware has experienced through dynamic operations over its lifetime.

Through a projection analysis to 2024, NASA has not identified any challenges that are considered problematic. Now, the NASA team is looking at certification through 2028 or even 2030. Starting in 2003, NASA has observed degradation in solar panel power generation. Current electricity production is enough to meet NASA needs, but there is a concern about sustaining required levels through 2024 and beyond. NASA is also in the process of upgrading batteries in the primary power system to higher capacity lithium-ion batteries. NASA has conducted research and testing on the batteries to protect against cascade failures from the battery cells. The new batteries could provide additional capability to provide power to 2030 or beyond.

U.S. Crew Vehicles (USCV) Update

The JC received briefings on USCV topics related to schedule, development, and operations. NASA holds technical interchange meetings with its international partners to continue discussions on USCV, and Roscosmos informed the JC that Russian specialists are planning to participate. The ISS program is engaging with international partners regularly, with more than twenty meetings held since April 2019.

NASA has received feedback from the international partners that there have been problems accessing data portals – and so NASA has also distributed data sets directly to partners. There was a multilateral technical meeting held in June 2019 that the Russian side did not attend, and so NASA provided copies of all the presentations subsequently. NASA is also conducting bi-weekly videoconferences with Roscosmos and Energia. Additional face-to-face technical meetings will be hosted through the fall at Johnson Space Center, and all international partners are invited to attend. Additionally, the NASA ISS Program Manager is providing letters to his counterparts quarterly on the status of USCV integration into the ISS program.

NASA considers the SpaceX Demonstration-1 mission a success with a nominal launch, ascent,

and docking. Like all visiting vehicles, there were requirements for the vehicle to approach ISS, including rendezvous and control (retreats and holds at different points on approach path). All these requirements were satisfied and performed well.

While attached to the ISS, the Dragon vehicle was tested for ability to perform cargo transfers and completed several development test objectives. On the Dragon 2 vehicle, the solar arrays are body mounted, instead of deployed. So testing was conducted to understand how much electricity could be generated while attached to ISS. NASA also demonstrated that the robotic arm could survey the vehicle and confirmed the communication system between the Dragon and ISS.

U.S. crew training has begun for USCV crewed flights by SpaceX and Boeing. NASA has proposed to Roscosmos to enable cosmonaut readiness training for USCV while NASA and Roscosmos continue to assess and evaluate USCV development. NASA has asked for Roscosmos to identify cosmonauts to enable individually tailored suit fabrication. Both sides see benefit of starting this process without waiting for a formal agreement to exchange crew members.

Planning is also underway to establish USCV crew rescue procedures. Crew rescue will be performed through a variety of means depending on the scenario, including: helicopters with para-rescue jumpers, U.S. Coast Guard sea assets, and international Search and Rescue forces (including, Canada, Ireland, and the United Kingdom). Initial abort or early ascent abort involves a radius of 200 miles from the launch site at Kennedy Space Center. Rescue in this scenario would be performed by helicopter. Downrange abort profiles parallel the U.S. eastern coastline leading up to Canada over the Atlantic Ocean. This includes an exclusion zone in the North Atlantic east of Canada and west of Ireland that are considered too difficult to execute rescue given rough seas and low temperatures.

These requirements have been levied on the USCV providers, however overall responsibility for a crew rescue will be led by NASA and not the providers.

Documentation to cover both nominal and contingency crew rescue is in process. The documentation will identify requirements for U.S. team, as well as inclusion of any affected international partner. For nominal crew return, the providers are responsible, but NASA will participate. NASA expects for Russian and other international colleagues to participate in crew return activities as is accomplished with the Soyuz. For contingency situations, international partners will not participate and will be conducted by U.S. Air Force.

NASA also provided a briefing on the static fire anomaly that took place during a SpaceX ascent abort test in April 2019. On April 20, 2019, the spacecraft exploded during the test sequence.

SpaceX is investigating the explosion. A joint anomaly investigation team that includes SpaceX and NASA participation has dispositioned 90% of the main fault tree to determine the initial issue that led to the primary explosion. Three of the fault tree lines have been determined credible, all related to an ignition caused with the oxidizer pressurization system due to a nitrogen tetroxide, or NTO, fluid slug. The leading scenario suggests that after the NTO

loading, slugs of oxidizer entered into the high flow helium system. At the launch escape startup, the oxidizer slugs were accelerated through the helium system with sufficient energy that the NTO reacted energetically with the high flow check valve titanium material. This led to an explosion within the NTO system.

The JC supports efforts between Roscosmos and NASA to enable Russian crew members to fly on future USCV flights when USCV prove their reliability and safety. The JC also supports the efforts to find ways for Russian crew members to train while discussions on formalizing an agreement to exchange U.S. and Russian crew members on USCV and Soyuz proceed in parallel.

ISS Joint Research

Roscosmos and NASA specialists provided a status on ISS joint research. While Roscosmos and NASA specialists noted different research priorities, both noted the significant benefits derived by conducting research together. Roscosmos and NASA have developed a plan for near-term joint research on ISS. The Russian side is hoping to make more Russian crew time available for joint research but are awaiting a request by NASA.
Roscosmos has approved a new approach to scientific research onboard ISS, including joint research. Activities will be divided into three areas: scientific research, technological research, and education and commercial research. This more closely aligns the Roscosmos and NASA research approaches. TSNIImash will oversee this program on behalf of Roscosmos and ensure unified coordination and interaction with international partners. The JC supports efforts to streamline processes for joint research and encourages Roscosmos and NASA to expand joint research in the future.

ISS Contingency Planning

NASA and Roscosmos briefed the JC on a plan to finalize a document describing technical procedures for off-nominal and nominal ISS reentry scenarios, while introducing into the technical document a disclaimer that nothing therein should be interpreted to imply any legal and financial liability to the signatories. NASA and Roscosmos have agreed to document legal and financial responsibilities for the ISS deorbit in a separate arrangement. The Russian side inquired about utilizing future U.S. spacecraft for deorbit, and the JC will seek an update at a future meeting.

CLOSING

Patrick Finley: *Thanks again to the Committee for all the hard work on this assessment. I look forward to your participation at future meetings. I look forward to seeing all of you, and our Russian counterparts, in Moscow later this year. This meeting is adjourned at approximately 11:40 am.*

Attachment A

NASA International Space Station Advisory Committee

NASA Headquarters
Washington, DC
November 18, 2019

ADVISORY COMMITTEE MEMBERSHIP

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Lt. Gen. Thomas Stafford, USAF (Ret.)

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Executive Director

Mr. Patrick Finley

Dep. Executive Director

Ms. Holly Stevens

Attachment B

NASA International Space Station Advisory Committee Meeting

NASA Headquarters
Washington, DC
November 18, 2019

Meeting Attendees

NASA International Space Station Advisory Committee
Lt. Gen. Thomas Stafford, USAF (Ret,), Chairman
Col. James Adamson, U.S. Army (Ret.)
Dr. Charles Daniel
Dr. Michael Foale
Dr. Frank Groen
Dr. Daniel Heimerdinger
Capt. William Readdy, U.S. Navy (Ret.)
Dr. Josef Schmid
Dr. William Vantine
Col. Jeff Williams, U.S. Army (Ret.)

Executive Director
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Ms. Holly Stevens

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Kevin Metrocavage, ISS Program Office
Andrew Parks, OIIR
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Press
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