National Aeronautics and Space Administration

International Space Station Advisory Committee

March 30, 2020
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

March 30, 2020
NASA Headquarters
Washington, DC

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NASA INTERNATIONAL SPACE STATION ADVISORY COMMITTEE

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March 30, 2020
NASA Headquarters
10:00 AM ET

Executive Director Patrick Finley: Mr. Finley welcomed the participants, called roll, and gave a brief overview of the topics discussed during the fact-finding meeting held in Houston, Texas.

From December 9 - 13, 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 Houston, Texas. 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, an update on U.S. Crew Vehicles, technology demonstration activities, and ISS joint research status. Additionally, the Joint Commission was updated on NASA ISS commercialization efforts, crew cross-training, the status of the Functional Cargo Block module, deorbit strategies, Mars analog research opportunities, and a medical update. 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 Houston.

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 December 2019 fact-finding meeting in Houston. I will summarize each of the main areas that we reviewed, and then allow time for Committee members to ask questions and discuss each topic.*

ISS Program Overview

After opening comments by the Co-Chairs, Roscosmos and NASA representatives presented on the current status of the Russian and U.S. Operational Segments of the International Space Station. Water, food, propellant, and other critical consumables are all at levels with sufficient margin to support operations. While the ISS currently supports partner agency objectives, the Joint Commission believes there is a significant technical risk due to further delay in the U.S. crew vehicle (USCV) schedule. Without USCV, and without procuring additional U.S. Soyuz seats, there will be no U.S. crew member on ISS after October 2020. The ISS has always required at least one U.S. and Russian crew member for safe operations. Without U.S. crew onboard, a pair of critical U.S. Orbital Segment failures would result in loss of the ISS. It is

imperative that NASA and Roscosmos find a way to guarantee at least one appropriately-trained U.S. and Russian crewmember onboard the ISS at all times.

NASA and Roscosmos are discussing procuring additional transportation on Soyuz missions to the ISS. Both sides are planning for the reality that there may be only one USOS crew member on the ISS for the foreseeable future, until USCV is available. Starting with spring 2020, cosmonauts are being trained to support U.S. extravehicular activities (EVA) and robotic operations. Discussions are still underway to swap crew members on future USCV and Soyuz flights. This exchange would ensure ISS operations in the event of an anomaly on a crew vehicle or an on-orbit issue that could require a vehicle to return to Earth ahead of schedule. The Russian side noted that prior to agreeing to the mixed crew plan, there is a need for successful USCV launches. Roscosmos will consider participation after successful launches, but will not participate in the first launches of the vehicle.

NASA specialists noted the busy nature of activities on ISS, including a number of extra-vehicular activities (EVA) to repair the Alpha Magnetic Spectrometer, or AMS – an especially complicated undertaking as the AMS was not designed to be repaired in this manner. From August to December 2019, there were seven U.S. EVAs, which installed international docking adapter number three, replaced batteries, and worked to repair the AMS. Despite this increased EVA activities U.S. crew time utilization has been high, in fact exceeding planning numbers. In the future, when there is likely to be only one USOS crew member, NASA expects utilization numbers to correspondingly fall. While the utilization will be reduced, NASA is still optimistic to have time for research activities on top of maintenance.

Roscosmos specialists noted that in August 2019, a new Soyuz 2.1a and Soyuz MS spacecraft configuration launched for the first time. The launch was successful and Roscosmos plans to use this configuration on upcoming launches in 2020. This new configuration will replace the Soyuz FG launch vehicle. In September 2019, the final launch of the Soyuz FG launch vehicle took place, which included United Arab Emirates astronaut Hazza Al Mansouri. Additionally, Roscosmos has closed Pad 1 in Baikonur for renovations and have moved operations to Pad 31. Pad 31 is an older pad that was returned to operation in 2009. Prior to that, Roscosmos only had one pad (Pad 1), so in this regard this is a return to this previous status. Roscosmos is currently in discussions with other parties to refurbish Pad 1, but this could take many years.

In 2020, Roscosmos plans for six vehicle dockings – two crewed Soyuz launches, three Progress cargo missions, and the launch of the Multipurpose Laboratory Module (MLM). MLM is in the process of final assembly at a Khrunichev facility in Baikonur. Between 2019 and 2025, Roscosmos plans to conduct 36 EVAs to prepare and ensure MLM operations. If only two Russian crew members are available on ISS, then additional EVA support would be required from the USOS crew member to conduct the preparatory EVA. Science Power Module preparations are also starting to ramp up. Autonomous testing of all systems and instruments have been completed. Integrated system testing is underway right now. The flight article assembly has started, and Roscosmos is hoping to launch the module in 2022, but there is a lot of work remaining.

Roscosmos specialists provided an updated on the Orel, the next generation Russian crew transportation vehicle. Autonomous testing of systems is underway for the new vehicle. Preparations for testing a mockup vehicle is underway. For low-Earth orbit flights, the plan is to use the Angara launch vehicle from the Vostochny Cosmodrome. Roscosmos plans to send an

uncrewed test flight without docking to the ISS, followed by an uncrewed flight is planned to dock with the ISS, culminating by a crewed flight to ISS in the mid-2020s. Roscosmos is also planning to use a super-heavy lift currently under development for flights to the Moon. The plan is for this new vehicle to match the NASA Space Launch System capabilities, with an uncrewed flight to low-lunar orbit (LLO) and a later crewed flight to LLO with a lunar ascent/descent system test.

I will now open up the floor for Committee questions. There were no questions from the floor.

U.S. Crew Vehicle (USCV) Update

NASA specialists provided an update on USCV topics related to schedule, development, and operations. NASA continues to hold briefings with international partners to provide updates on USCV tests and development. Coordination meetings are held before flight readiness reviews and topic specific briefings are held on occasion related to specific topics, such as ascent abort tests and static fire tests.

Specialists described plans for the Boeing Orbital Flight Test (OFT) scheduled for December 2019, which included testing an uncrewed CST-100 spacecraft configured with two seats, one with a sensor suite to capture measurements. The Boeing Crewed Flight Test mission will be set in the future and depend on results of the OFT mission. While the date for a SpaceX crewed demonstration mission (Demo-2) is fluid, it could take place in the first half of 2020. NASA is assessing the opportunity to expand that mission duration beyond current plan of two weeks. This would potentially assist with the crew rotation challenges currently being experienced on the U.S. side. If the mission is extended, there will likely be more crew training required.

NASA is continuing to review development progress for each commercial provider, including plans for a SpaceX in-flight abort test which will also demonstrate the Crew Dragon vehicle parachutes and provide data to allow NASA and SpaceX to determine the best parachutes for use with crewed flights. The Russian side raised several questions related to the relatively compressed timeline for nominal parachute deployment, noting that Soyuz deploys parachutes at much higher elevations. The Boeing systems plan to deploy parachutes at a higher level, however, during a Boeing pad abort test, one of the three CST-100 parachutes did not perform or open correctly. This failure was determined to be caused by human error during the packing of the parachute, despite having two people involved in the process. As a result, Boeing is going to implement process changes to eliminate the possibility the chutes are packed incorrectly in the future.

I will now open up the floor for Committee questions. There were no questions.

ISS Technology Demonstration

NASA specialists updated the Joint Commission on efforts underway to utilize the ISS to demonstrate a range of technologies required for exploration, with a focus on environmental control and life support systems. Highlights from the technology demonstration briefing include: roll-out solar arrays that are designed to be more compact than traditional arrays, zero boil-off tank design to reduce fuel boil-off and increase efficiency, experiments to validate radiation monitoring systems, advanced carbon dioxide scrubber systems, and water recovery systems that

could result in recovering almost 98% of water used in microgravity. NASA is continuing to evaluate technology demonstration projects in a number of fields for future demonstration on ISS, including potable water dispensers, condensing heat exchange, and environmental monitoring.

NASA is updating an ISS Technology Demonstration Plan on an annual basis. NASA has also produced a book called the ISS Benefits for Exploration, which explains how technologies developed on ISS are supporting future exploration.

I will now open up the floor for Committee questions. There were no questions.

ISS Joint Research Status

In coordination with Russian colleagues, NASA provided a status on ISS joint research, recalling the benefits of international collaboration, including: expanded access to science team expertise, access to a wider variety of investigation resources (facilities, crew time, etc.), and expanded access to recent and historical research data. Specialists noted several challenges impacting ISS utilization, including limited crew time due to a busy maintenance schedule and the uncertain USCV schedule in 2020. However, NASA noted improvements in executing joint research as a result of process discussions between U.S. and Russian specialists. Specifically, NASA identified rodent research, Standard Measures, and cooperation on crew interaction with the Robonaut technology demonstration unit as opportunities for additional joint research.

Rodent research has been suspended from the joint US – Russian program since November 2017. The US side values rodent research because of the implications for human physiology. NASA and Russian scientists plan to collaborate on Bion M2, a free flyer mission, and there is interest in resuming ISS rodent research. There is hope to organize a new tissue-sharing agreement to support rodent research resumption starting as soon as 63S in fall 2020. However, rodent research requires a long-lead training time and at least two crew members to execute. Roscosmos recently withdrew from the Robonaut technology demonstration project. This project supports NASA research on logistics demonstrations to support Gateway development, including radio frequency identification search and inventory. NASA may ask Roscosmos to reconsider participation in this project. However, NASA would prioritize rodent research cooperation over Robonaut cooperation.

The ISS Program is engaged in trying to map the ISS research that is being used or cited by scientific researchers all around the world. Since the beginning of the ISS program to March 2019, there have been more than 2000 investigations with more than 4000 researchers from 108 countries. At the IAC in 2020 in the United Arab Emirates, there are plans to present on highlights from twenty years of research on ISS. The next Program Science Forum meeting is planned to be held in conjunction with the GLEX 2020 conference in St. Petersburg in June 2020.

I will now open up the floor for Committee questions. There were no questions.

NASA ISS Commercialization Activities

NASA specialists presented on plans to increase commercial activities on the ISS. Until recently, the USOS utilization is divided into three categories: the ISS National Lab, NASA, and international partners. NASA is moving to a paradigm in which a portion (5% of crew time,

upmass, and downmass) of NASA utilization resources are set aside for commercial (non-research and development) use. Commercial companies can propose certain activities that are in line with the ISS code of conduct and the NASA Interim Directive on Use of International Space Station for Commercial and Marketing Activities. The companies are required to pay NASA for the crew time, upmass, and downmass utilized. NASA outlined these opportunities in a new policy document in mid-2019 with requirements and restrictions; the policy also includes a cost schedule. These pricing schedules will be reviewed every six months or so. To date, there have been four proposals from commercial entities.

Additionally, NASA plans to enable Private Astronaut Missions to ISS using vehicles in development by SpaceX and Boeing under NASA's Commercial Crew Program (CCP). NASA noted the precedent of selling individual rides to the ISS initiated by the Russian side, which made eight short-duration missions to the ISS available on Soyuz from 2001-2009. There is a possibility NASA will offer a private astronaut mission as soon as 2020, but it will not be feasible until CCP vehicles are operational. NASA is also planning to accommodate up to two private astronaut standalone missions per year in addition to two planned USCV flights for NASA purposes to the ISS. The intent of private astronaut missions is to build U.S. industry capability and provide opportunities for industry to meet transportation needs without the US government being involved in the transaction. This could also produce additional flight rate for CCP providers and potentially increase the availability of crew time and logistics support for NASA.

On the topic of future commercial low-Earth orbit (LEO) platforms, NASA is evaluating two potential models: a commercial module attached to ISS and a free-flying commercial LEO platform. NASA issued solicitations to U.S. industry in June 2019 to bid on opportunities in both or either model. The goal is not to buy hardware or a module, but to provide seed money for a company to enable a new capability.

I will now open up the floor for Committee questions. There were no questions.

Crew Cross-Training

Due to USCV delays, NASA and Roscosmos are faced with challenges to crew rotation on the ISS. There is an analogue to the situation after the Columbia accident when Soyuz was the only capability available to enable access crew. The Multilateral Crew Operations Panel has been thinking through ways to deal with challenges that could arise on ISS with a limited crew cadre. A significant issue is ensuring a continued contingency EVA capability – a topic on which the U.S. and Russian side have been working to ensure training on both sides on contingency EVA. The ISS Program now expects a minimum crew presence (two Russian and one U.S.) starting in April 2020. The crew scheduled to launch in April 2020 have been trained to support contingency USOS EVA capability.

It is critical that there are always appropriately trained U.S. and Russian crew members onboard the ISS. Given that USCV is not yet operational and NASA and Roscosmos continue to discuss the possibility of NASA procuring additional Soyuz transportation, the Joint Commission recommends NASA and Roscosmos identify an achievable joint ISS flight plan to ensure U.S. and Russian crew presence for the foreseeable future. It must also be taken into account that flying a minimum crew on ISS results in lower utilization for the Russian side during a period in the near future when Roscosmos is preparing for the arrival of the Multipurpose Laboratory Module.

Flying mixed crews will ensure there is a U.S. and Russian crew member on ISS at all times. The Joint Commission encourages NASA and Roscosmos to develop the appropriate documentation to fly mixed Russian – U.S. crews on both Soyuz and USCV. In the meantime, the Joint Commission supports cross-training to ensure crews have all necessary qualifications to support ISS with only one U.S. crewmember onboard. The Joint Commission further recommends that the agencies establish the requirements based on which Roscosmos crew members will be approved to fly on USCV.

I will now open up the floor for Committee questions. There were no questions.

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, it was noted that FGB has been flying longer than any other module on the ISS or any module that Russia has flown previously during the MIR program. Specifically, the Russian side continues to monitor issues with microbiological growth on the FGB structure. The Russian side has proposed to NASA a plan to treat these areas to arrest the growth. There is still microbiological growth on FGB, but mostly in hard-to-access areas. Additionally, Roscosmos specialists have identified potential risks associated with critical welds in the FGB, but the welds are considered sufficient at this time. However, as ISS has operated longer than any previous human space system it is reasonable to closely monitor the ISS structure. Therefore, the JC will seek a briefing from NASA and Roscosmos specialists at a future meeting on monitoring and assessing structural risks to the ISS, including the most critical FGB welds.

I will now open up the floor for Committee questions. There were no questions.

ISS Deorbit Planning

NASA provided a briefing on ISS Partnership efforts to develop and refine technical plans for both nominal and contingency ISS reentry scenarios. There is still open work on the issue of FGB Propellant Maintenance at vacuum, which would be an issue for an unforeseen or contingency deorbit scenario. These technical plans currently rely on Progress spacecraft to initiate and maintain ISS attitude control during reentry. For nominal reentry plans, NASA believes it is possible to control ISS deorbit with two Progress vehicles, but would be even better if there were three Progress vehicles. For nominal reentry, NASA and Roscosmos are working together to develop software updates to support ISS deorbit. These software upgrades are associated with ensuring the Service Module main engines remain operable and a Progress vehicle docked aft at the same time. NASA is also modeling the footprint estimate for ISS reentry. This modeling is informed by previous European and Russian modeling efforts.

The Russian side encouraged exploring the possibility of using U.S. vehicles for deorbit, and NASA agreed to evaluate further. Roscosmos suggested it would perhaps be possible to use one U.S. vehicle and one Russian vehicle. NASA and Roscosmos have not had detailed discussions on this concept, but NASA agreed there is potential for investigating the concept of utilizing U.S. vehicles. However, NASA noted U.S. vehicles were not designed with an ISS reboost or deorbit mission in mind. The U.S. side has some ideas about upgrades for U.S. vehicles, but it would require significant engineering changes.

I will now open up the floor for Committee questions. There were no questions.

ISS for Mars – Analog Opportunities

Russian specialists, in coordination with NASA, presented on efforts to realize ISS analog study opportunities in support of Mars exploration. Currently, both sides use analogs on Earth to simulate space exploration hazards, including: radiation, isolation and confinement/distance from Earth, altered gravity, and hostile closed environments. Exploration missions to Mars will take far longer than current missions to the ISS, from orbital missions that could take 22 Months to surface missions that could last much longer. The distance will require different capabilities than are available in LEO, including the need to produce food in transit. More is needed to address radiation exposure as crews move away from Earth's magnetic field. There will likely be communications delays and conceivably communications blackout periods.

Given the array of preparatory activities that are needed for Mars exploration, U.S. and Russian specialists believe more can be done on ISS to simulate Mars conditions, including: mission durations, isolation, autonomy and communications delay, medical responses, surface operations after long transit. Executing these analogs would require changes to operational rules on ISS, as well as training and hardware changes in preparation for missions. NASA and Roscosmos have each conducted spaceflight missions greater than nine months in duration (roughly equivalent to Mars transit timelines), and NASA is planning additional long-duration missions on the ISS.

Medical autonomy could also be tested on ISS – crews could be given several days without real time medical support, although crews would require different training. For communications isolation, recent data from Mission Control Center Houston shows that crew members spend an average of two hours per day speaking with the ground. It maybe be possible to set up circumstances to limit or delay communications and study effects on crew. Medical specialists believe it is possible crews will end up being more efficient because they have less time spent in communications.

I will now open up the floor for Committee questions. There were no questions.

Medical Update and Human Research Status

Russian and U.S. specialists reported that the crew medical status is nominal and research continues to examine the effects of spaceflight on human physiology. Specifically, NASA noted the Fluid Shifts experiment designed to study the relationship between fluid shifts in the body and spaceflight. In part, this experiment has also been used to investigate the intracranial pressure issue. This experiment has components pre, during, and post-flight to take measurements on crew members. Specialists are also investigating Deep Vein Thrombosis, or DVT. It is not clear if the terrestrial risk of DVT is applicable to spaceflight. Approximately 90% of DVT on Earth happen in the lower extremities (which are also the most risky forms of DVT). There has been an observation of an upper extremity DVT on ISS. NASA reviewed its procedures and medical kits and confirmed that they are appropriate to treat the instance of DVT. However, medical teams are planning to increase research on DVT to ensure this issue is given appropriate focus. The joint medical teams have started to surveil crews for this issue, and all astronauts are welcome to opt in to the surveillance for DVT. The JC commends the ISS partner medical

community for assuring the health and safety of the crews, and encourages continued close cooperation and dialogue in preparation for future USCV flights.

There were no questions or comments regarding the issues discussed.

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 10:50 a.m. Eastern Time.*

Attachment A

NASA International Space Station Advisory Committee

NASA Headquarters
Washington, DC
March 30, 2020

ADVISORY COMMITTEE MEMBERSHIP

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Dr. Charles Daniel
Maj. Gen. Joe Engle, USAF (Ret.)
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Technical Advisors

Col. Kevin Ford, USAF (Ret.)
Maj. Bob Maiberger, U.S. Army (Ret.)

Executive Director

Mr. Patrick Finley

Dep. Executive Director

Ms. Holly Stevens

Attachment B

NASA International Space Station Advisory Committee Meeting

NASA Headquarters
Washington, DC
March 30, 2020

Meeting Attendees

NASA International Space Station Advisory Committee
Lt. Gen. Thomas Stafford, USAF (Ret.)
Col. James Adamson, U.S. Army (Ret.)
Maj. Gen. Joe Engle, USAF (Ret.)
Dr. Michael Greenfield
Dr. Frank Groen
Dr. Daniel Heimerdinger
Dr. William Vantine
Col. Jeff Williams, U.S. Army (Ret.)

Executive Director
Mr. Patrick Finley
Ms. Holly Stevens

Technical Advisors
Col. Kevin Ford, USAF (Ret.)
Maj. Robert Maiberger, United States Army (Ret.)

NASA/National Lab
Dr. Michael Roberts, VP and Interim Chief Scientist, U.S. National Lab

Industry/Academia
Dr. Gale Allen, International Astronautical Federation/American Society for Gravitational and Space Research Board of Governors
Robin Frank, Consultant
Cat Hofacker, American Institute of Aeronautics and Astronautics
Dillon MacInnis, SpaceX
Scott Smas, Arizona State University

International:
Ms. Sylvie Espinasse, European Space Agency Washington, DC Representative

Media:
Mr. Jeff Foust, *Space News*
Mr. Bill Harwood, *CBS News,* Space Reporter (KSC)
Ms. Irene Klotz, *Aviation Week*
Ms. Marcia Smith, *Space Policy Online*