

National Aeronautics and Space Administration

International Space Station Advisory Committee

**June 1, 2017
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

June 1, 2017
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Washington, DC

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NASA INTERNATIONAL SPACE STATION ADVISORY COMMITTEE

MEETING REPORT

June 1, 2016
NASA Headquarters
2:00 PM EDT

OPENING

Mr. Patrick Finley, Executive Director of the NASA ISSAC, opened the meeting, called the roll, and made the following remarks:

Patrick Finley: *From 27-31 March 2017, 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, at NASA's Johnson Space Center. The purpose of the Joint Commission is to review the 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, a summary of the Investigative Committee findings on the 65 Progress anomaly from December 2016, and an overview of technology demonstration activities onboard ISS to support future exploration. Additionally, the Joint Commission was updated on status of ISS contingency plans, the status of Joint Research and Utilization on station, and an overview of Medical Operations and Results from the Kelly-Kornienko one-year mission to ISS. Experts from RSC Energia, TsNIIMash, and NASA's ISS Program Office participated in the meeting and gave presentations.

Our Chairman, General Thomas Stafford had an unexpected schedule conflict, and has asked Mr. William Readdy to lead the meeting in his absence, I will now turn the meeting over to Mr. Readdy to review the results of our recent fact-finding meeting in Houston.

Mr. Readdy: *Good afternoon 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 March 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

The meeting started with ISS Program Overview presentations from Rocket and Space Corporation Energia and NASA representatives. The Program Overview presentations were extensive including detailed presentations on ISS technical and operational topics. The briefings provided the Joint Commission status updates on the full array of operations onboard the ISS.

The US overview briefing reviewed the ISS flight plan and discussed recent and future operations. Under the current flight plan, beginning with Soyuz 50S launch in April 2017, Russian crew will be reduced from three to two on the ISS. This issue has been briefed to the JC in the past and was not unexpected. The April launch will have one U.S. astronaut and one Russian cosmonaut, while the third seat on Soyuz will fly cargo. NASA is procuring (through

Boeing) an extra seat on Soyuz launches starting in September 2017, which will result in having four USOS crew on ISS.

The successful HTV-6 cargo mission launched in January 2017 and brought replacement batteries to ISS. The mission went very well, but there were some issues with a planned “kite-experiment,” which attempted to test a tether concept, which ultimately did not succeed. The SpaceX-10 mission launched on March 19, 2017 and for the first time NASA flew male mice on ISS. SpaceX-10 also returned three payloads from ISS to Earth. An update was provided on the Orbital ATK (OA)-7 cargo mission. OA-7 will launch in April 2017 on the Atlas-V vehicle from Florida instead of the Antares launch vehicle in Virginia.

The NASA briefing explained that the planned SpaceX-11 mission will be the first re-flight of a dragon capsule (Dragon 6). The launch vehicle will not be refurbished. NASA has been working with SpaceX to monitor the progress of this mission development. On SpaceX-10 there was a technical issue as the mission approached ISS and NASA is working with SpaceX to understand what happened and how to avoid on future missions. The NASA Commercial Resupply Services (CRS)-2 contract award was announced in January 2016. The contract was awarded to Orbital ATK, Sierra Nevada Corporation, and SpaceX. The CRS-2 missions are scheduled to begin in 2019.

NASA also provided an update on the integration status of Commercial Crew Vehicles. Boeing and SpaceX are the providers contracted to provide crew transportation services to the ISS and the NASA ISS Program is working with International Partners to gather and provide information that is needed to support crew operations. Each provider will have a demonstration mission without crew followed by a demo mission with crew. SpaceX is planning to have its demonstration mission in November 2017. Boeing is planning its demonstration mission in June 2018. After the successful demonstration missions, there will be a series of Post Certification Missions.

NASA briefed on the list of activities accomplished during increment 49 and 50 as well as plans for utilization on upcoming increments 51 and 52. USOS utilization crew time (not counting autonomous experiments) on ISS is quite high. The current USOS crew is averaging 48 hours of utilization per week, which is well exceeding the target of 35 hours per week. The 35 hour per week target is going to raise to 70 hours of crew utilization on station every week in September with the addition of the fourth USOS crew member. NASA is planning to support 216 science investigations during increment 51 and 52. There has also been good progress recently on joint utilization. There were 178 hours of joint U.S.-Russian utilization since the start of Increment 49. This is a priority and NASA hopes that despite the temporary reduction in Russian crew, joint science utilization on ISS should be emphasized and not lost.

The Program Overviews also included briefings on current consumable levels. Food is the most limiting consumable, but current on-orbit supplies would allow crew to have enough food until November without resupply. These numbers would decrease slightly if NASA and Roscosmos come to agreement on keeping one of the current USOS crew onboard over the summer. NASA also provided a status update on ingress and environmental conditions within the Bigelow Expandable Activity Module (BEAM). The hatch to this module is normally closed, but the crew has entered BEAM on occasion to take measurements. So far, there have been no issues with the module observed. There were some struggles with deployment (as previously briefed to the Committee), and that information will feed back into future expandable module design.

Last summer, the Committee received an interim briefing on an incident of water presence in a helmet during Extra Vehicular Activity (EVA) 35 in early 2016. Since then, NASA determined there was a small amount of water in the suit (approximately 15 milliliters). NASA determined a variety of operational and environmental conditions overwhelmed the suit. NASA conducted a readiness review in August 2016 with senior NASA safety representatives and international partners and received permission to proceed with EVAs, and there has been no problems with EVAs conducted since. NASA does not intend to update or change the suit before 2024. A pair of EVAs during increment 50 successfully replaced two batteries.

There are relatively few anomaly issues onboard ISS at the present time. With the installation of high definition cameras, it was easier to see small “snowflakes” that appear to be the result of a very small ammonia leak. On March 24, 2017, Shane Kimbrough and Thomas Pesquet conducted an EVA in an attempt to find the source of the small “snowflakes” from the area near a radiator. Kimbrough and Pesquet were sent to try and find some indication of leak, but the result was inconclusive. This is something that the Program will continue to monitor and there is more work to be done to solve this issue, and while not an alarming issue, is one NASA is keen to find the source of and fix. In addition to the ammonia leak issue, there is issue with the Urine Processor Assembly. While this does not affect the water the crew drinks because there are multiple filtration systems the water passes through before being consumed, there has been some malfunction of the processor. This issue is open and NASA is still assessing the issue.

The Russian overview briefing also emphasized the busy operational schedule for ISS including upcoming Soyuz and Progress launches. Training for the crew of the Soyuz 52S launch in September 2017, the first in which NASA will procure a seat from Boeing, is underway and progressing. The Russian overview also mentioned plans to deploy the new Multipurpose Laboratory Module to ISS in December 2017, although it is possible that this schedule could be delayed. There will be a meeting in mid-2017 to determine whether or not the new module is ready to be shipped to Baikonur Cosmodrome for launch preparations.

The ISS Program Overview presentations were of the highest quality and the Committee believes the ISS is technically sound.

I will now open up the floor for Committee questions or discussion regarding the ISS Program Overviews. There were no questions and no discussion.

Investigative Committee Summary of the 65P Anomaly

The Russian side presented on the Russian State Commission findings on the investigation into the Progress MS-04/65P anomaly that occurred on December 1, 2016. The State Commission was established under the authority of State Space Corporation Roscosmos General Director, Igor Komarov. The presentation highlighted the extremely short period of time (on the 383rd second of flight) in which the anomaly occurred. This speed of the event made it difficult for pressure sensors to register the anomaly. This created a situation where the information available to analyze is particularly limited and makes it difficult to rely on the sensor data that was collected. The State Commission reviewed 10 different failure scenarios to assess the probable cause of the failure. It was determined the most probable cause of the anomaly was a failure of the oxygen turbo pump that ultimately led to a fracture of the oxidizer tank and separation between the launch vehicle and the spacecraft before engine shutdown, which resulted in the loss of the ISS cargo resupply mission. It was noted that an independent NASA analysis

arrived at the same conclusion. Subsequent to the State Commission findings, Roscosmos instituted a number of mitigating actions on the third stage and conducted a successful Progress flight in February 2017. Roscosmos felt confident that it is safe to fly crew on Soyuz in April 2017.

The State Commission analyzed telemetry information on the launch vehicle flight, system customization data, and data on the launch vehicle and Progress cargo spacecraft fabrication and testing at the production facility and at the Baikonur launch site. Progress spacecraft are not used for crewed flight, and therefore have no abort system. The Soyuz (crewed spacecraft) sensor suite is more refined than Progress and might have provided better sensor data. The Soyuz engine is also a nearly 40 year old design. As such, the Russian side does not believe there is a design problem, but perhaps an issue in development or manufacturing. Roscosmos looked at the personnel in key positions in the manufacturing process to see if there had been turnover, but the conclusion was that there was no strong change or turnover in the personnel involved in manufacturing. The head of the factory was replaced as a result of the State Commission findings, but the personnel on the assembly line were not fired.

Components from the spacecraft have been located, but no launch vehicle parts have been recovered. Roscosmos is hopeful some launch vehicle elements can be found later this spring when weather allows for a better search. The Committee notes the cooperation between the U.S. and Russian sides on this investigation appears to have been productive.

I will now open up the floor for Committee questions or discussion regarding the summary of the 65P Anomaly. There were no questions and no discussion.

Technology Demonstration for Future Exploration

NASA presented on ISS partner effort to develop technology onboard station to support future exploration beyond low-Earth orbit. Agencies are utilizing the unique environment on ISS to test a range of technologies that will be required for exploration, such as: radiation, crew health and performance, and environmental control and life support systems (ECLSS). Funding for technology demonstration on ISS comes from International Partners, other U.S. agencies, as well as other funding lines within NASA, such as the Space Technology Mission Directorate. Technology demonstration focuses on a broad array of subject areas:

- Crew Health and Performance: There are some experimental exercise devices on orbit to focus on maintaining strength and fight medical degradation to address crew health and performance issues.*
- Space Power and Energy: After several years of ground development, NASA is testing a new solar array deployment. This particular array is one option for future solar array designs. It is a small scale on the end of the robotic arm, and is not integrated currently into the ISS electrical system (although the potential for doing so later exists). The array rolls out similar to a window shade rather than multi-fold structure. The arrays under development are approximately three times more efficient than the arrays currently installed on ISS.*
- Radiation: Unfortunately, it is likely that the mitigation effort on radiation effects will be medical, and currently the partners are not attempting to develop technologies focused on mitigating radiation.*
- Robotics, Telerobotics, and Autonomous Systems: There are quite a few technology demonstration projects in these fields. There are examples from across the international*

partnerships. The focus is on trying to enhance the crew's ability to help themselves without help from the ground.

NASA presented its ECLSS exploration technology roadmap, which outlines the technologies that will be tested on ISS and directly support exploration mission scenarios, including a baseline three-year Mars transit scenario. Life support has been challenging even in low-Earth Orbit and is only going to get more difficult further from earth and in more challenging environments. The ISS partners was to use ISS to demonstrate new technologies so there is more confidence moving further into the solar system. NASA has an ECLSS technology development roadmap and there is another roadmap that includes the inputs of the international partners. 2022 is an important year on the roadmap, as NASA is aiming to have all its critical technologies to ISS by 2022 to allow for at least a 3 year period before the end of the ISS program (which parallels a 3 year mars transit mission). The intention is to develop technologies that will be flexible regardless of destination. While Mars transit is a baseline (because it is difficult), these technologies could be used to support missions to other destinations, such as the Moon.

A number of technologies being tested on ISS will fly on Orion to include the toilet system and the air monitoring system. The NASA SS program focusing on developing the ECLSS system. There is consistent feedback from NASA management that this is the most important technology to mature. The Committee believes the development of this ECLSS is logical and should be a high priority for the ISS partnership in order to support exploration missions beyond low-Earth orbit.

I will now open up the floor for Committee questions or discussion regarding the Technology Demonstration onboard ISS. There were no questions and no discussion.

ISS Contingency Planning Status

NASA presented on the ongoing effort to develop a plan for nominal and contingency ISS de-orbit. There is an effort underway to develop a strategy document related to ISS de-orbit and NASA has been working with all the international partners, including Roscosmos. Right now, the target footprint for ISS de-orbit is a 6,000 mile-long footprint in the SPOUA (south Pacific oceanic uninhabited area). The current ISS mass is about 400 tons, but will increase when Russian modules are launched deployed on ISS. Currently, there is enough propellant on ISS available to support de-orbit in a contingency situation, but it may be challenging to maintain these levels over time. The Committee notes the progress towards a baseline de-orbit plan with much work ahead to analyze and implement alternative de-orbit scenarios. The Committee commends this work and continued focus by all of the ISS partners.

I will now open up the floor for Committee questions or discussion regarding ISS Contingency Planning. There were no questions and no discussion.

ISS Joint Research and Utilization

The Joint Commission also received a briefing from NASA on ISS utilization and joint U.S.-Russian research onboard station. Joint research improves scientific return by increasing scientific expertise, access to resources and facilities, and access to research data. There are two major factors limit on-orbit research - facilities and crew time. Collaboration allows the ISS Partnership to better balance these resources to increase research and joint research has been

gradually increasing over recent increments. From the beginning of the ISS Program through the end of Expedition 46 (1998 - March 2016), more than 2000 investigations have been undertaken on ISS and more than 3,000 senior investigators have taken part on these projects.

NASA has been working with TsNIIMash to improve the process for selecting joint research. There are three levels of agreement to prepare a joint investigations - agreement among scientists, agreement between organizations funding the research, and an ISS programmatic agreement. TsNIIMash works on all these agreements and interfaces with Roscosmos to ensure mission success. The ISS Program is working toward three key objectives: 1) enabling Russian and U.S. scientists to work together at an earlier stage, during experiment design phase; 2) Increasing the number of subjects in human research; 3) Measuring and maintaining balance across disciplines, because certain types of experiments take more time or there is a heavy emphasis on a particular field of study. Challenges to joint research remain in understanding Russian documentation processes and status, the availability of Russian crew member training time, differences in Russian and NASA planning timelines, procedure translation, and the reduction to two Cosmonauts going forward and the possible presence of four USOS crew members.

While there is some lag between investigations on ISS and research publications, the rate of publishing is increasing each year. The Program Science Forum is actively working on products to make statistics and findings available to the partners and the public. Research statistics are released every six months, research results are released annually, and a Benefits for Humanity book is released every two years (next to be published in 2018). The ISS Program is trying to put together products including data analytics and various metrics to allow agencies to describe and display the breadth and depth of science utilization being accomplished on ISS.

I will now open up the floor for Committee questions or discussion regarding Joint Research and Utilization. There were no questions and no discussion.

Medical Operations and Results of the One-Year Mission

Specialists from NASA and the Institute of Biomedical Problems presented on the status of medical operations onboard ISS and preliminary results of the one-year mission of Mikhail Kornienko and Scott Kelly. The one-year mission was an excellent opportunity for the U.S. and Russian science and medical communities to work together more efficiently. The crew was fully occupied during its year in orbit, with more than a steady dose of national and joint investigations as well as participation in multilateral investigations. Two flagship investigations undertaken jointly: Fluid Shifts (using U.S. hardware in the Zvezda module) and the Field Test (conducted on the ground in Kazakhstan post landing). All of the post-flight testing and sample collection has been completed and preliminary reports were prepared in January 2017. A multilateral workshop for investigators on the one-year mission was held in March 2017 at the Johnson Space Center in Houston. Investigators shared results with each other and publications are allowed to begin, but judging from presentations in the meeting, it may be a while before results are published. Due to the small sample size (two), NASA is required to receive permission from the participants before publication because the results would be “identifiable.” Initial findings from the one-year mission showed no significant negative impact to the crew associated the long-duration spaceflight, but the research community stresses the need for more data to validate and strengthen this research. The JC believes safety and crew health questions could be addressed by additional long-duration missions and encourage NASA and Roscosmos

to continue the successful research protocols of the Kornienko-Kelly mission and consider pursuing additional joint long-duration missions when resources are available.

In 2017, Roscosmos will reduce crew until the delivery of MLM module. This means there will be only one Russian crew member on each Soyuz, and they will be the commander. The crew launch on April 20, 2017 will have this configuration. The atmosphere on station continues to be within norms and there are no major signs of contamination. All tests show BEAM air quality is good, with no water and no microorganisms found. Biological contamination is something the Russian side is monitoring closely, because through experience on Mir Station, the Russian side noted that biological degradation could negatively impact hardware and systems. Radiation monitoring on station continues to be a major focus of the medical community and currently radiation monitors are functioning well. A new treadmill canvas was installed recently in order to help the crew build strength and prepare for landing operations.

The Committee notes that medical protocols of the ISS Partners are providing health and efficiency of the ISS crews at a level sufficient to support all flight programs. The Committee also notes the positive experience and impact of integration and expansion of biomedical research programs of the ISS Partners in order to clarify the nature and prevention of critical risk factors connected to human flights beyond low-Earth orbit. The Committee supports the close cooperation of the ISS partner medical and technical structures in order to optimize the environment of the ISS crews, including joint biomedical research and exploitation of commercial facilities on the ISS.

I will now open up the floor for Committee questions or discussion regarding Medical Operations or the One-Year Mission. There were no questions and no discussion.

Conclusion

In summary, the Committee commends the ISS Program and the International Partners for the continued successful operation of the ISS and for maintaining an international crew with the existing flight vehicle assets. We also stress that continued vigilance is necessary to maintain safe and productive operations of the space station.

Given the information we discussed today, do the Committee members have any objections to the findings of this report? There were no objections to the findings of the report.

Based on the recent fact-finding meeting in Houston and this discussion, the ISS Advisory Committee concurs with the assessment outlined here today. Thank you all again for the expertise you bring to our Committee. Now, I'll turn this over to the Executive Director to wrap things up.

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 see all of you, and our Russian counterparts, in Moscow this summer. This meeting is adjourned at 2:35pm EDT.*

NASA International Space Station Advisory Committee

NASA Headquarters
Washington, DC
June 1, 2017

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Executive Director

Mr. Patrick Finley

Dep. Executive Director

Ms. Holly Stevens

NASA International Space Station Advisory Committee Meeting

NASA Headquarters

Washington, DC

June 1, 2017

Meeting Attendees

NASA International Space Station Advisory Committee *(via telecom_unless otherwise noted)*

Mr. William Readdy

Mr. Jim Adamson

Mr. Joe Cuzzupoli

Dr. Dan Heimerdinger

Dr. Chuck Daniel

Dr. Mike Foale

Dr. Ron Merrell

Mr. Harold Bell

Dr. Josef Schmid

Mr. Jeff Williams

Executive Director

Mr. Patrick Finley

Ms. Holly Stevens *(via telecon)*

Technical Advisers

Gen. Joe Engle

Mr. Robert Maiburger

NASA Attendees

(OCOMM)

(OLIA) - Rick Irving

Media *(via telecon)*

James Dean (Florida Today)

Frank Moring (Aviation Week)

Jeff Foust (SpaceNews)

Marcia Smith (SpacePolicyOnline)

Irene Klotz (Reuters)

N. Phuong Zenny (The Media

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Ryan Faith, House SS&T Committee

Industry

Ethan Hopper, SpaceX

Dave Greenidge, ViaSat

USG

Sam Black, OMB

Juli Digate, GAO

Kristin Van Wychen, GAO

Lisa Fisher, GAO