National Aeronautics and Space Administration

International Space Station Advisory Committee

October 16, 2017
NASA Headquarters
Washington, DC

OPEN MEETING REPORT

Original signed by

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

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Executive Director

NASA INTERNATIONAL SPACE STATION ADVISORY COMMITTEE

October 16, 2017
NASA Headquarters
Washington, DC

TABLE OF CONTENTS

NASA INTERNATIONAL SPACE STATION ADVISORY COMMITTEE

MEETING REPORT

October 16, 2017
NASA Headquarters
10:00 AM EST

Patrick Finley: *From 26-30 June 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 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 mitigation strategy for the MS-04/65 Progress anomaly from December 2016, and an ISS module life cycle status. Additionally, the Joint Commission was updated on ISS medical operations and the human research program and the status of Joint Research and Utilization on station. Experts from Roscosmos, RSC Energia, Khrunichev Space Center, TsNIIMash, the Institute of Biomedical Problems, and NASA's ISS Program Office participated in the meeting and gave 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 June fact-finding meeting in Moscow. 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

To begin the Joint Commission meeting, Roscosmos and NASA representatives provided overview presentations on the ISS Program. The ISS Program Overview presentations were extensive and included detailed discussions on ISS technical and operational topics.

The Russian Segment overview began with a review of the ISS flight plan and discussed recent and future operations. The overview started with Expedition 51 in April 2017, which included the dockings of a Soyuz crew vehicle and the Orbital ATK (OA) 7 cargo mission, as well as US extravehicular activities (EVAs) 42 and 43 and a service module thruster reboost of ISS. Expedition 52, which started with the undocking of Soyuz MS-04, included a number of docking and undocking operations as well as a Russian EVA and an ISS reboost utilizing Russian thrusters. A Russian EVA was planned to include a number of science tasks as well as preparatory activities for the arrival of the Russian Multipurpose Laboratory Module.

Roscosmos representatives explained that almost all systems are operating nominally on the Russian Segment. There is one small issue with the solar electric system in which five of eight

batteries are operating, but there is a recovery operation underway to return a sixth battery to an operational state. The remaining two batteries will be replaced on a future cargo mission. The available stores of fuel and propellant are within nominal operational levels. The Functional Cargo Block, or FGB, MDM kit was tested recently and it was determined both MDMs are fully operational. It is possible there is an issue with the compressor that was delivered by a previous Progress vehicle. The compressor provides an important function that allows the ISS to transfer propellant.

During Soyuz landing in April 2017, there was an issue experienced with the vehicle parachutes. When the parachute system is being stowed into its hatch, there is a design element that functions like a buckle. When the parachute was deployed during crew return, the buckle impacted the Soyuz vehicle superstructure. The buckle struck a welding seam, and as a result there was a depressurization event, which resulted in some air escaping the capsule. Upon review, the commission investigating the anomaly said there was nothing dangerous that resulted from this situation. This was the first time there was an event of this nature during crew landing operations. The action impact took place at the elevation of eight kilometers. Nominally, at the five-kilometer mark, air starts coming into the capsule through an automated relief valve. Since the crew were suited, the depressurization presented no issue for the crew. The crew knew about the anomaly from sensors on the vehicle. There was no determination to change hardware, but efforts will be made to more carefully install and place the parachute in the future. The exact way the parachute was folded and packed (in addition to the exact conditions of the angle of the capsule) may have contributed to the event. Thorough work has been done to review the anomaly and mitigation steps have been implemented to ensure this event will not happen in the future.

Roscosmos representatives also gave an update on the planned Multipurpose Laboratory Module, which is expected to be launched to the ISS in late 2018. The propulsion system for the module is currently under construction and testing for design specifications and physical contamination will be conducted in Moscow, while tests on the electrical system will be conducted in Baikonur, Kazakhstan. The module is expected to be shipped to Baikonur by the end of 2017 and ultimately launch on a Proton launch vehicle. After the MLM, RSC Energia will begin preparations for the Node module and Science Power Module, which will be the first Russian module dedicated exclusively to science investigations on ISS. The Russian science community is awaiting the delivery of the science module and believes there will be many opportunities for international collaboration when the new systems come online.

The USOS overview briefing reviewed the ISS flight plan and discussed recent and future operations. The OA-7 mission launched successfully in April 2017 on an Atlas-V launch vehicle from the Kennedy Space Center in Florida, but the next OA mission will return to utilizing an Antares launch vehicle and launch from Wallops Island in Virginia. The SpaceX-11 mission launched in June 2017, and is scheduled to return cargo in the Dragon capsule in July 2017. This mission included a roll-out solar array (called ROSA), a new technology demonstrating a solar array deployment mechanism. There were issues getting the array to roll up again uniformly. As a result, NASA jettisoned ROSA and the array has left the vicinity of the ISS without incident.

The flight plan calls for SpaceX-12 to fly in August 2017 followed closely by a Soyuz launch in September. NASA will have two US crew members on the September Soyuz launch, which will begin at least a year-long configuration which will keep four USOS crew members on orbit at all

times and allow more time for scientific investigations. Today NASA has a goal of 35 hours of joint US-Russian science utilization time per week onboard ISS, but with the addition of the fourth USOS crew member, this goal will increase to 70 hours of science per week. During Expeditions 51 and 52, USOS crew conducted 221 investigations, with 73 being new or originated during these expeditions. From April through September 2017, 42 hours of joint utilization is planned on ISS, with participation from the US, Russia, Japan, and Europe.

NASA representatives also presented information on ISS consumable levels. In summary, the ISS has enough consumables to last six months without resupply. The NASA and Russia operations teams work well together, and in the case of a specific need, both sides work together to provide additional logistics support. A summary of EVAs was also provided. Usually NASA tries to execute two or three EVAs in quick succession because this minimizes the impact on science research. During Expeditions 51 and 52, NASA completed three EVAs. Two EVAs were completed in March 2017, but a third was delayed until May due to the hardware needed for the EVA being manifested on an Orbital ATK cargo flight that was slightly delayed. The next series of EVAs are planned for fall 2017, and are focused on adding some high-definition cameras and wireless access points on the exterior of ISS to better support payloads.

NASA also provided a description of Contingency EVA 43. A few days after the May EVA, there was a failure of one of the computers that had been installed. Based on a software programming issue, the computer automatically transferred to another MDM. The crew built a spare computer from spare parts on board, and then went out and replaced the malfunctioning MDM within three days. This particular MDM is a critical computer that allows solar array manipulation. NASA is returning the affected MDM for failure analysis on a Space X capsule. The MDM was only installed in March, operating less than two months before failure. The crew did not find any obvious damage such as an MMOD hit or charring.

NASA also provided a briefing on the progress on integrating US commercial crew vehicles into the ISS Program. Basic training of US crews began in May 2017. EVAs have been preparing ISS to receive the new vehicles by moving docking adapters. NASA has increased interaction with international partners to provide data on commercial vehicles and believes progress is being made on answering questions from the international partners, but acknowledges that there is more work to be done on this issue. At a previous meeting, Roscosmos had a number of questions asking for different data. The Joint Commission asked if it was possible to give the Russian side the requirements documents NASA levied on the commercial providers. To date, Roscosmos has been provided these requirements documents. The ISS multilateral safety panel also recently met to discuss the ongoing questions related to safety, and the international partners indicated there was progress being made to answer outstanding questions.

Roscosmos representatives noted a change in the information flow on commercial vehicles as a result of previous Joint Commission meetings which brought attention to this topic. However, these reports have generated additional questions from the Russian side related to emergency rescue systems during launch, safety certification for launch vehicles, and vehicle approach and rendezvous sequencing with ISS. The Russian side believes this data is not proprietary and expects that information will be provided as it becomes available. NASA pointed out that the requirements documents for the commercial providers have been provided to the Russian side, and provides the framework of requirements that begins to address these questions. Commercial providers are scheduled to provide NASA the plans and procedures for contingency on launch

this year and NASA will make these available to the Russian side. NASA understands the Russian side has questions and is working to answer these questions.

The Joint Commission believes the ISS is technically sound and the international partnership should be commended for increasing ISS science utilization. The JC is pleased with progress by NASA on distributing information on U.S. commercial crew vehicles to international partners, but notes there are remaining open questions from the Russian side. This is a topic we will continue to follow closely and anticipate an update from NASA at the next meeting.

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

Mitigation Strategy for the MS-04/65P Anomaly (December 1, 2016)

Roscosmos briefed on the mitigation strategy related to Progress MS-05/65P anomaly in December 2016. The Russian investigation into this anomaly revealed a high-speed event which happened within a few milliseconds, and the telemetry sample rate was not sufficiently fast to capture definitive data about the event. Subsequently, sensors (accelerometers and video monitors) and data processing center upgrades have been introduced to allow higher launch vehicle polling frequency. These vehicle and ground processing upgrades enable better understanding and analysis of vibration conditions as well as telemetry data processing redundancy. In addition to telemetry enhancements, Roscosmos reviewed and updated quality controls related to launch vehicle and spacecraft manufacturing. The JC commends the Russian side for the steps to improve the understanding of launch vehicle characteristics and to better assess any possible future anomalies.

Following the December 2016 anomaly, Roscosmos approved a new plan for preparing for the launch of Progress vehicles. The implementation plan for launching new Progress vehicles and most high priority measures have been implemented. Additional measures have execution dates in 2018 and are underway currently. The rest are considered long-term. The points and measures were split into different fields of activity. Specifically, quality assessment at the production facilities for launch vehicles has been improved, including installing video surveillance to watch assembly. Improvements in the quality check during the assembly of the launch vehicle unit have been implemented as well.

The Russian side has introduced a quality check system for crucial parts of the system and for controlling foreign objects in the engine chamber. Additionally, new video surveillance (internal and external cameras) were installed on the launch vehicle. Roscosmos also instituted a plan to take pictures of 100% of the vehicle elements for documentation. Long-term measures have been focused on the installation of new sensors on the launch vehicle to focus on acceleration, vibration, and force and pressure during flight. In the long-term, Roscosmos is focused on replacing the telemetry system with a new one. A new information storage system for the telemetry data was introduced and this is a stand-alone storage system. Over the next year, Roscosmos plans to install a real-time information processing system and an upgraded digital radio-telemetric system capable of measuring variable parameters. Additional acceleration and vibration and force sensors will be installed by the end of 2017 on the Progress MS and Soyuz MS systems. Additionally, new filters will be introduced on the 11D55 engine and will be introduced in the third quarter of 2017. In conclusion, the priority mitigation measures are

complete, which allowed the launch of new progress missions utilizing the various Soyuz-U, Soyuz-FG, and Soyuz-2 vehicles. The success of these measures is evident by the success of two Progress vehicles this year.

I will now open the floor for Committee questions or discussion regarding the Mitigation Strategy for the MS-04/65P Anomaly. There were no questions or additional discussion.

Gen. Stafford: *Patrick (Finley), when was the timeframe when NASA changed from calling them "failures" to "anomalies"?*
Mr. Finley: *I will look into that and get an answer back to you.*

ISS Module Life Cycle Status

Roscosmos provided an update on the life extension engineering analysis of the FGB module. NASA and Roscosmos recently signed a protocol for Roscosmos to continue sustaining the FGB through December 2020. The Joint Commission requested that Roscosmos provide an update at the next meeting. The FGB topic also led to a brief discussion on the status of contingency deorbit planning. The Joint Commission requested that NASA present a schedule of contingency planning at the next meeting.

The most important function of the FGB module is to store propellant, and currently more than 4,000 kilograms of propellant are stored on FGB. Since 2016, the amount of propellant onboard decreased because it was used to restore the nominal attitude of station. There were five refueling operations in 2016 and 2017. There was an issue with the propellant transfer system that impacted the last refueling operation. The compressor unit failed, and a spare was sent to ISS. This new compressor has been installed onboard and is awaiting an opportunity to be tested.

FGB has seen an increase in old and dysfunctional parts that have been replaced - more than 50 items with a mass of 305 kilograms which took about 100 hours of labor. There were five equipment failures on FGB, but it was possible to mitigate these failures because there were spares and consumables onboard. Not all the equipment onboard FGB would be able to function after a depressurization event, but FGB should sustain its structural integrity and some core functions. In 2015, the Russian side started to implement procedures to mitigate the failure of some systems in the event of depressurization. The Russian side has been developing software that would automatically initiate the propellant transfer sequence (via a "trigger signal") in the event of a depressurization event. It is not clear where on the ISS the trigger signal for this automatic sequence should initiate – NASA and Roscosmos are working to determine the answer to this question. NASA noted that there is a draft strategy document that is out for agency review. While not exhaustive, the strategy document is a good starting place for a dialogue among the international partners. There are three more technical meetings on this topic scheduled in the next twelve months, with the goal to have nearly all work completed by August 2018.

I will now open the floor for Committee questions or discussion regarding the ISS Module Life Cycle Status. There were no questions or additional discussion.

Medical Operations Update and the Human Research Program

A representative from the Institute of Biomedical Problems provided a medical and human research update and reported that the integrated medical group supported the health of ISS crews to a level sufficient to perform the established flight program. The JC notes the positive joint biomedical research programs underway to prepare for human flights beyond low-Earth orbit and for solving fundamental space biology and medicine problems. In response to a question on rodent research, NASA provided a briefing on handling procedures.

IBMP reported that the 65 Progress failure resulted in the loss of some personal items for the Crew, and it was good that NASA was able to launch these items on backup cargo missions. During recent ISS increments, all medical operations onboard ISS went nominally, and there are no specific medical issues that arose. Air quality levels were presented as nominal and within acceptable thresholds. However, there was an incident of odor in the ISS during a battery cycling process. This process is performed every month and involves heating the battery. The crew documented the event and undertook steps to purify the ISS atmosphere. An analysis of this event concluded that the odor likely resulted from particles within the battery itself that were burned while the batteries were heated. Samples were analyzed on the ground, and analysis showed no harmful chemicals were present.

After sampling, the Bigelow Expandable Activity Module had no dangerous or harmful indications. The surfaces and atmosphere are being monitored by NASA and Russian specialists consider the module stable and see no need to further monitor BEAM. Sound and noise levels still registered slightly above Russian norms, but the trend is heading is a positive direction. Russian and U.S. systems continue to monitor radiation levels on board ISS, and all crew members are closely monitored for radiation dosage during EVAs. Exercise equipment has been functioning well and during a previous expedition, the treadmill was repaired, which led to an improvement in crew exercise levels.

During the Soyuz landings in 2017, researchers observed an increase in microbiological growth in ISS. Surfaces were treated with a detergent that helped curb microbiological growth. IBMP believes FGB has a potential for hazardous microbiological growth. NASA deferred the decision to transfer these samples to Roscosmos, which determined that with a lack of requirement to return the sample, there was no imperative to do so. NASA suggested that Roscosmos and IBMP discuss this issue directly and develop a resolution.

Biomedical experiments continue onboard ISS, including fluid shifts investigation. This was started during the one-year mission and has been continued during the six-month missions. The field tests post landing have also been continued, which provides insight into the vestibular system during its exposure to microgravity as well as testing out the efficacy of countermeasures programs.

I will now open the floor for Committee questions or discussion regarding Medical Operations and the Human Research Program. There were no questions and no additional discussions.

Joint Research and Utilization

Roscosmos briefed on the progress of increasing ISS utilization and joint research. The Joint Commission believes it is critical to maintain a high level of joint ISS utilization. Due to the reduction of Russian crew time, NASA has proposed establishing a crew time pool for joint research tracking, and this proposal is pending Roscosmos approval. The Joint Commission supports this approach and requests NASA and Roscosmos provide a status update at the next meeting. In addition to science research underway on ISS, the Joint Commission discussed the importance of ISS utilization to support future human spaceflight exploration beyond low-Earth orbit, and requested an update on technology development and testing on ISS to support future exploration activities at the next meeting.

Roscosmos reported that research has been broken down into six major disciplines: physical and chemical materials in space, biology and bio technology, Earth and space science, technology, human research, and education. The largest total of joint research is in the field of physical and material science, which is due to the fact that the Russian segment does not currently have equipment to conduct these studies unilaterally. The benefits of joint research were described as increasing research effectiveness, strengthening the scientific team, reducing costs, and fostering integration and coordination. Joint experiment effectiveness is measured by the number and quality of publications and journals in which research results are published.

Roscosmos is working not just with NASA, but with all the international partners, including strong research programs with ESA and JAXA. The joint Roscosmos-ESA agreement on joint utilization goes through 2020. A protocol between NASA and Roscosmos initially agreed to achieve 5 hours of joint utilization time per week on ISS. Later, this five-hour limit was removed and even more join research time has been accomplished. Roscosmos has delegated the responsibility of selecting joint research experiments to TsNIIMash. Since 2014, TsNIIMash has identified 47 joint investigations and are now working with NASA to execute this utilization, and fifteen of these experiments have been completed to date. In this timeframe, joint research between NASA and Roscosmos has been gradually increasing, and continues to trend in a positive direction. Roscosmos believes there is value being derived from joint utilization on ISS, and it is still early in the process of research publication to fully assess the value of research on ISS.

The NASA side believes joint utilization is a positive story that has been good for all the international partners. NASA and Roscosmos are planning 42 hours of joint utilization from April – September 2017, but the plan is to increase this number 163 hours of joint utilization between September 2017 and April 2018. Research teams are working closely with crew time schedulers to develop plans to implement joint science utilization. This is affected by real time operations, and especially dependent on delivery of investigation materials on cargo vehicles. Another issue is the reduction of Russian crew from three to two. A utilization crew time pool has been proposed to track on-orbit time for joint research that was agreed to, but not completed.

While some of the science utilization will support future exploration, other exploration topics are being supported by technology demonstration projects. NASA is also looking at work being done on ISS that is focused on helping facilitate a future of commercial efforts in LEO. Roscosmos representatives noted that there could be additional benefit from undertaking joint technology development akin to the joint science utilization to derive the benefits of working together.

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

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.

Based on the recent fact-finding meeting in Moscow 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 seeing all of you, and our Russian counterparts, in Houston this winter. We are still working on scheduling that date. This meeting is adjourned at 10:42 a.m.

Attachment A

NASA International Space Station Advisory Committee

NASA Headquarters
Washington, DC
October 16, 2017

ADVISORY COMMITTEE MEMBERSHIP

Chairman

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

Members

Col. James Adamson, U.S. Army (Ret.)
Mr. Hal Bell
Mr. Joseph Cuzzupoli
Dr. Charles Daniel
Dr. Michael Foale
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Dr. Ronald Merrell
Capt. William Readdy, USN (Ret.)
Dr. Josef Schmid
Col. Jeff Williams, U.S. Army (Ret.)

Technical Advisors

Maj. Gen. Joe Engle, 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
October 16, 2017

Meeting Attendees

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

Lt. Gen. Thomas Stafford
Capt. William Readdy
Col. Jim Adamson
Mr. Joe Cuzzupoli
Dr. Dan Heimerdinger
Dr. Chuck Daniel
Dr. Ron Merrell
Mr. Harold Bell (in person)
Dr. Josef Schmid

Executive Director

Mr. Patrick Finley (in person)
Ms. Holly Stevens

Technical Advisers

Maj. Gen. Joe Engle
Maj. Robert Maiberger

NASA Attendees

Rebecca Gilchrist, OGC (in person)
Kim Hurst, OIIR (in person)
Rick Irving, OLIA (in person)
Stephanie Schierholz, PAO (in person)

Media

Jeff Foust, SpaceNews
Brian Harvey ??