

National Aeronautics and Space Administration

International Space Station Advisory Committee

September 1, 2015
NASA Headquarters
Washington, DC

OPEN MEETING REPORT



Original signed by

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

Original signed by

Mr. Patrick Finley
Executive Director

NASA INTERNATIONAL SPACE STATION ADVISORY COMMITTEE

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Washington, DC

TABLE OF CONTENTS

Meeting Report:		Page 1-8
Attachment A:	Advisory Committee Membership	Page 9
Attachment B:	Meeting Attendees	Page 10

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MEETING REPORT

Mr. Patrick Finley, Executive Director of the NASA International Space Station (ISS) Advisory Committee (AC), welcomed the participants and opened the meeting with a brief overview of the topics to be covered during the Open Meeting:

Mr. Finley: *From July 13th to 17th, 2015, the ISS Advisory Committee met with the Roscosmos Advisory Expert Council as a Joint Commission (JC) and held a fact-finding session in Korolev, Russia. The purpose of the Joint Commission is to gather information on the viability of the ISS, with a specific focus on crew safety and utilization issues.*

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 ammonia leakage false alarm, one-year mission issues, the Robonaut-2 experimental project, and on the planned Bigelow Expandable Activity Module (BEAM) inflatable module. Additionally, the Joint Commission was updated on the status of medical operations on ISS, the ongoing investigation on the Progress M-27M / 59P loss, the Soyuz TMA-15M / 41S inadvertent jet firing analysis, and the SpaceX-7 cargo resupply mission failure. Experts from RSC-Energia, the Khrunichev Space Center, the Gagarin Cosmonaut Training Center (GCTC), Mission Control Center-Moscow (MCC-M), TsNIIMash, and NASA's ISS Program Office (ISSPO) participated in the meeting and gave presentations.

I will now turn the meeting over to General Stafford to review the results of our recent fact-finding meeting in Russia.

Lt. General Thomas P. Stafford, USAF (Ret.): *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 July fact-finding meeting in Russia. 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

US and Russian presentations provided an update on the current status and operations onboard the ISS. The Russian Segment (RS) overview briefing addressed increments 43 and 44, impacts of the Progress M-27M / 59P failure on launch schedules, logistical impacts of the short-duration mission, docking and relocation logistics for crew and cargo vehicles, and Russian extra-vehicular activities (EVAs). In addition, briefings assessed the status of Russian consumables, resources, and propellant levels. The Russian presentation concluded that the onboard systems status and the supplies available on the Russian segment allow for further performance without any additional restrictions for Expedition-44.

The NASA overview reviewed recent US EVAs, reconfiguration plans for commercial crew docking, and revised plans for rebuilding and getting on-orbit the international docking adapter hardware lost in the SpaceX-7 cargo mission failure. The briefing noted US EVAs are undergoing review due to the loss of the SpaceX-7 resupply vehicle. Planned SpaceX missions are still under review after their recent launch failure. The scheduled November 2015 Orbital-4 mission (now planned for December) will be their first cargo mission following their October 2014 launch failure and will launch on a United Launch Alliance Atlas-V. This will be the first use of Atlas-V with the Cygnus spacecraft.

The NASA overview also covered the recent cargo resupply vehicle failures, the impacts to the status of the ISS consumables, and upcoming cargo vehicle launches to the ISS. In eight months, the ISS Program experienced failures in three of its four resupply launch vehicles. At the same time, the Committee commends the Program for pre-positioning supplies and research, which limited the impact on ISS operations despite cargo delivery failures. The ISS appears to have sufficient consumables until the end of the year and there will be a few more cargo vehicles launching before then. While the state of consumables, fuel, research, and other cargo remains healthy, we nevertheless remain concerned about the recent vehicle failures.

The next round of NASA's planned commercial cargo resupply services (CRS-2) request for proposal was released in September 2014 and a final selection is expected later this year. It was explained that while this program is being implemented with a different approach than previous NASA programs, it is still following the same certification process. The briefing addressed the overall plan for the commercial crew program, its development strategy, the certification process strategy, requirements, and the implementation of the contracts. We have requested and look forward to an update on the Commercial Crew Vehicle status.

The final analysis of the January 2015 false ammonia leak emergency and automatic software response was caused by a previously unknown type of failure in the node-2 data processing computer or multiplexer and de-multiplexer (N2-2 MDM). The crew immediately executed their memorized ammonia response and were safely in the Russian Segment within two minutes. Although Mission Control-Houston (MCC-H) did correctly determine that this was a false alarm and allowed the crew to return to the USOS, an unanticipated increase in pressure in the USOS prompted the MCC-H team to return the crew to the Russian Segment. The crew was ultimately isolated for about 13 hours until the situation was completely understood. In parallel, while in the RS, there was a (false) fire alarm on the Russian side, which added to confusion on the ground and the ISS. The failure was attributed to a Node 2 MDM or computer anomaly.

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

ISS One-Year Missions

The Joint Commission received a top-level briefing of how the research data from the one-year mission can contribute to the planning for and understanding of future deep space missions. The ISS Program Office is ready to support more one-year missions in the future and suggests that a one year on, one year off, schedule for these missions is a workable approach. The Multilateral Human Research Panel for Exploration (MHRPE) program would prefer to have twelve

subjects, and would like data as soon as possible. The ISSPO also noted that if ISS partner agencies agree to more of these one-year missions, adjustments to science priorities will be required.

The JC had a robust debate on the pros and cons of flying additional one-year missions. Three areas of medical concern were noted: events that require extended duration monitoring, such as renal stones and visual impairment; physiological deconditioning that requires countermeasures, like muscle atrophy and bone loss; and behavioral health and performance that requires countermeasures developed in Earth analogs. Effects on ISS operations were also discussed as these longer missions could have significant impact on crew training, non-medical research programs, and testing exploration technologies. Before making any recommendation on the merits of additional one-year flights, the Committee will would like additional presentations that outline the benefits of expanding this program versus one with shorter flight duration.

I will now open up the floor for Committee questions or discussion regarding one-year missions on ISS. There were no questions or additional discussion.

Robonaut-2

Robonaut-2 is a joint development between NASA and General Motors. The objective of the program is to assess the feasibility of having a robot onboard assisting ISS crewmembers. The long-term goal is to save time and relieve some of the tedious tasks currently required by crew members, such as cleaning filters, rack inspection, inventory management, etc. Once NASA has demonstrated basic capabilities, it will be possible to have student and education activities to allow demonstration of remote operations capabilities. NASA is working with seven universities in the U.S., testing various projects and processes. Robonaut-2 is currently a technology demonstration activity on the inside of ISS. As more capabilities are understood, there may be opportunities move on to EVA tests and further activities. The Robonaut-2 program is not currently funded to support EVAs, but NASA is interested due to the potential application for future Lunar and Mars missions.

Robonaut-2 is the second generation of the robot, and a major focus of the designers has been the interaction with ISS crew members. Robonaut-1 was smaller and the upgraded version is closer to the size of a human. Robonaut-2 will eventually have a battery pack, but it is not yet certified and for now will rely on the ISS for power to operate. NASA is interested in testing the robot in microgravity environments, radiation environments, and in interaction with crew. NASA is exploring the potential for EVA activities, but noted that even with funding it will take at least three years to develop EVA capability.

From a safety standpoint, multiple sensors have been distributed through the robot to make sure it does not grab with too much force and can release with a command. In addition, it has a "heartbeat" function where it is constantly checking the status of the robot – so if the robot is not sending a 100% "all ok" message as part of the "heartbeat," it automatically shuts down. Robonaut-2 is fairly large, so part of the testing will involve evaluating how much it gets in the way of the crewmembers while in orbit. One of the testing challenges was that it was stopping the tasks too often, as the safety measures (trajectory monitoring) were too effective (too sensitive). The Robonaut-2 program was reviewed by the ISS Safety Review Panel and to

achieve safety certification, Robonaut-2 will have to pass over 100 tests for each software release to ensure it poses no human harm or damage risk to ISS hardware.

I will now open up the floor for Committee questions or discussion regarding Robonaut-2. There were no questions or discussion.

Bigelow Expandable Activity Module (BEAM) Overview

The ISS Program Office provided a presentation to the JC on the Bigelow Expandable Activity Module (BEAM). NASA will deliver the BEAM to ISS on SpaceX-8, which is currently scheduled for a November 2015 launch date. The exact launch date is still under discussion. The BEAM project will demonstrate commercial inflatable module technology which may help with Lunar and Mars surface habitat mission architectures. It will launch to ISS in a compact, deflated, mode and will be expanded while on orbit after delivery.

The BEAM mission is planned to have a two-year lifespan on orbit, and afterward will be released and jettisoned robotically. NASA did look at some contingencies, such as a situation where the BEAM would not be fully inflated, and whether it could still be released as planned and meet safety requirements. Once inflated, BEAM will host several different sensors deployed to measure debris and the atmosphere inside the module in preparation for eventual crew access. The ISS Program Office also explained that the crew would be able to ingress the module as needed without protective equipment once the module was fully operational.

I will now open up the floor for Committee questions or discussion regarding the Bigelow Expandable Activity Module. There were no questions or comments.

ISS Life Support / Medical Status Report

The Institute of Biomedical Problems (IBMP) gave a briefing on biomedical research planned for station in the near term. The briefing noted the ISS is a platform that allows researchers to gain insight on space exploration and supports new pathways for medical discovery in space as well as on Earth. For the one-year mission, the US and Russian medical community worked together to identify data needed for future deep space exploration missions. One of first issues to be explored is the issue of visual impairment and intracranial pressure in space flight. This testing is currently underway as the joint Fluid Shift experiment. There is also a ground-based joint experiment, the Field Test, now underway.

The Joint Commission commends the medical and research communities for their significant efforts in planning a multidisciplinary human research program in support of future deep space exploration that have been stimulated by the current one-year mission. The JC would also like to highlight the increased joint research being implemented by the Partners that maximizes the integration of Russian and USOS resources and crew. We strongly encourage the Program to expand on the success of this model in future expeditions.

I will now open up the floor for Committee questions or discussion regarding ISS medical issues. There were no questions or discussion.

Progress M-27M / 59P Loss

The Joint Commission received a briefing from the Roscosmos Advisory Expert Council on the status of the State Commission investigation into the loss of the Progress M-27M / 59P cargo spacecraft in April 2015. Analysis is still ongoing, but preliminary findings indicate the most probable cause of failure was the design of the stack consisting of the Progress vehicle and the 3rd stage of the Soyuz 2.1a launcher which was overlooked during the process of design work on this new stack. This structural peculiarity, which was not apparent during testing, brought about oscillation in the 3rd stage and caused depressurization of the propellant tanks of the 3rd stage. All this happened at the time when the engines were normally cut off.

According to the AEC, there are some significant differences between the newer Soyuz 2.1a and legacy Soyuz FG/U launch vehicles, including the shape of the fuel compartment. These differences affect mass and dynamics. In other words, the Russian Commission did not find any problems with the vehicle or the launcher, but rather in their combination. The Joint Commission asked how long the production of the Soyuz FG/U configuration could be sustained. This version is no longer produced, but warehouse supplies could allow building additional launch vehicles. Roscosmos is preparing to launch another 2.1a in Progress cargo configuration in the fall if results of the investigation and testing allow.

There was a vigorous discussion on the ongoing anomaly investigation. It was clear that there has been a thorough effort to model the accident and develop appropriate mitigation measures for future flights, but the Committee is nevertheless concerned with risks associated with this configuration. Unless mitigation measures are implemented, the risk to these flights is considered unacceptable. We are also concerned with the limited number of FG/U launchers available to sustain operations while the 2.1a Progress/Soyuz integration issues are explored.

Understanding too little time has passed since the SpaceX-7 failure to make final conclusions on its root cause, the Committee encourages the close coordination between NASA and SpaceX experts to finalize this investigation and looks forward to hearing the findings of the investigation as soon as they are available.

I will now open up the floor for Committee questions or discussion regarding Progress M-27M / 59P loss.

General Stafford asked the Executive Director, Patrick Finley, if he had any new information on the Progress loss.

Mr. Finley: *The initial findings were released by Shotwell (Gwynne Shotwell, President and Chief Operating Officer, SpaceX Corporation) at a conference in California. She said that the initial findings released after the Space X failure continued to hold true, that it was a strut failure, and in the press today there was an update that I will send out to members. It contains more details into the context of the investigation by SpaceX. They haven't had any changes in their initial understanding of what caused the failure.*

Soyuz TMA-15M / 41S Inadvertent Jet Firing

The Committee heard a presentation by the Roscosmos Advisory Expert Council on an inadvertent thruster firing by the Soyuz TMA-15M / 41S vehicle. According to the presentation, the anomaly resulted from insufficient coordination between the Soyuz vehicle and Russian ISS flight control teams. We appreciated the thorough and open technical discussions on the jet firing. The anomaly was reviewed by the JC and accepted as fully investigated.

I will now open up the floor for Committee questions or discussion regarding the Inadvertent Jet Firing. There were no questions or comments.

Conclusion

Once again, 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 any Committee members have any final questions or comments? Do the Committee members have any objections to the findings of this report? There were no questions, comments, or objections.

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. It was a very productive time in Moscow and we got to the bottom of these issues. Now, I'll turn this over to the Executive Director to wrap things up.

Patrick Finley: Thanks again for all of your hard work on this assessment. I look forward to your participation at future meetings. We have started planning for our next meeting in Houston, tentatively scheduled for December 7-11, 2015. I look forward to seeing all of you and our Russian counterpart at JSC in a couple months. Rebecca Gilchrist will lead the Ethics Briefing for the Special Government Employees and all SGEs should remain on the line.

The meeting adjourned at 1:33pm.

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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

NASA International Space Station Advisory Committee

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September 1, 2015

Meeting Attendees

NASA International Space Station Advisory Committee

Thomas P. Stafford (*via telecom*)

James Adamson (*via telecom*)

Harold Bell

Joe Cuzzupoli (*via telecom*)

Charles Daniel (*via telecom*)

Michael Foale (*via telecom*)

Kevin Ford (*via telecom*)

Ron Merrell (*via telecom*)

William Readdy (*via telecom*)

Executive Director

Patrick Finley

Holly Stevens (*via telecon*)

Technical Advisers

Joe Engle (*via telecon*)

Robert Maiberger (*via telecon*)

NASA Attendees

Rebecca Gilcrest, Office of the General Counsel

Others

Paul Korkemaz, Korkemaz Business Advisors

Frank Moring, *Aviation Week*

Theodore Kronmiller, United Launch Alliance

Kate Kronmiller, Orbital ATK

Henry Martoh, Nano Racks

Ajeeth Ibrahim, Nano Racks

Marcia Smith, *SpacePolicyOnline* (*via telecon*)

James Dean, *Florida Today* (*via telecon*)

Mike Lapidus, Space Exploration Technologies, Inc. (*via telecon*)