U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE
SUBCOMMITTEE ON SPACE AND AERONAUTICS

HEARING CHARTER

Live from Space: The International Space Station

June 14, 2005
2:00 p.m. – 4:00 p.m.
2318 Rayburn House Office Building

Purpose

On Tuesday, June 14, at 2:00pm, the Committee on Science, Subcommittee on Space and Aeronautics, will hold a hearing via satellite with National Aeronautics and Space Administration (NASA) astronaut John Phillips, a member of the current crew of the International Space Station (ISS). The other crew member on board ISS is Russian Cosmonaut Sergei Krikalev, the Commander of Expedition 11, who will not be participating in the hearing.

In addition to Phillips appearing via satellite, there will be two astronauts appearing in-person who have flown in space as part of the ISS program. The hearing will provide members with the opportunity to interact directly with those who are operating and performing research on ISS.

This is the first hearing in Congressional history with a witness testifying from space. It is possible because of advanced communications technology on ISS and significant preparation and coordination by NASA and the Committee. For technical reasons, the video communication link will only be available for a limited period of time, approximately 15 minutes.

Overarching Questions

The hearing will review the current activities onboard ISS, accomplishments of the crew, status of current research on the station, and observations on extended human spaceflight, and explore the following overarching questions:

1. What are the biggest challenges and opportunities of living and working on ISS?

2. What are the scientific (research) and engineering accomplishments that have resulted from operation of ISS?

Witnesses

The hearing will feature the following witnesses.[1]

Dr. John Phillips is a NASA astronaut and is currently living and working aboard ISS as the Science Officer and Flight Engineer of Expedition 11.

Dr. Peggy Whitson is a NASA astronaut, and was formerly a member of the ISS crew during Expedition 5 (June-Dec. 2002).

Lt. Col. Michael Fincke (USAF) is a NASA astronaut, and was formerly a member of the ISS crew during Expedition 9 (April-Oct. 2004).

Background

In-orbit assembly of ISS began in 1998 with the launch of the first two segments: the Zarya ("Dawn") module, built and launched by Russia, but paid for by NASA; and the Unity module, built by NASA and launched on the Space Shuttle in late 1998. In total, there have been 16 Shuttle missions to ISS (for assembly, logistics and utilization), as well as 30 Russian launches to ISS (which includes three launches of ISS modules, 10 Soyuz crew launches and 17 unmanned Progress re-supply launches). In addition, astronauts have performed 58 spacewalks in conjunction with ISS (25 Shuttle-based, and 33 ISS-based), totaling more than 348 hours.

ISS has been permanently occupied by joint U.S.-Russian "Expedition" crews, rotating on four to six month shifts, since November 2000. The current crew is the 11th rotation, or increment, and is thus designated Expedition 11.

The United States is building ISS in partnership with Russia, Canada, Japan, and 10 European countries. In addition, Brazil has a bilateral agreement with NASA to participate in the program. The attached diagram illustrates the layout of the various segments of ISS.

ISS assembly was approximately 50 percent complete (by mass) before the loss of the Space Shuttle Columbia in February 2003 halted construction. Because the Shuttle is the primary means of both assembly and re-supply for ISS, this has presented the ISS program with substantial challenges in conducting normal operations for the past two years. Without Shuttle, ISS crews have relied on unmanned Russian Progress vehicles as the primary means for re-supply of spare parts and consumables (water, food, etc.). Additionally the Russian Soyuz vehicles have been the only means of ferrying crew to and from ISS. (A single Soyuz vehicle is always docked at ISS at any one time to provide the crew with a lifeboat in case of emergency. Each Soyuz must be replaced every six months.)

[1] Detailed biographies of the witnesses are included in Appendix A

Prior to the Columbia tragedy, ISS Expedition crews were composed of three members: two Russians and one American or one Russian and two Americans. After Columbia, the crew size was reduced to two (one Russian and one American) to reduce the need for ISS to be re-supplied. The partners plan to restore the three-person crew size this fall with the addition of a crewmember who would be transported to ISS on STS-121 (the second Shuttle mission after return to flight), scheduled for later this year.

Despite the reduction in crew size, ISS Expedition crews have continued to conduct research while the Shuttle is grounded, primarily using equipment already aboard ISS. (For a list of experiments being conducted by the Expedition 11 crew, see Appendix B.) The post-Columbia accident Expedition crews have dealt with a variety of equipment failures, such as repeated shutdowns of the Russian oxygen generating device, known as the Elektron. According to NASA, there are sufficient alternate supplies of oxygen aboard ISS, or scheduled to be delivered by re-supply missions, that the Elektron failure is not currently a safety issue. A new Elektron unit is scheduled to be delivered to ISS later this summer.

There have also been failures of two of the four Control Moment Gyros (CMGs) that help keep the space station oriented properly. One CMG failed permanently and is scheduled to be replaced on the next Shuttle flight. A second CMG was repaired by crews on spacewalks, but has failed again. NASA hopes to repair this second unit on the next Shuttle flight as well. Only two CMGs are required to maintain the station's proper orientation. If another were to fail, however, proper orientation can be maintained using rocket thrusters on one of the Russian modules. In order to conserve rocket propellant, though, such an arrangement is not preferable.

NASA also is currently reformulating its scientific research program for ISS in light of President Bush's directive that the research be focused on projects that support the Vision for Space Exploration. In addition to gaining information about human adaptation to weightlessness that may be needed for eventual human trips to Mars, NASA Administrator Mike Griffin has cited the importance of the station's potential role in testing hardware intended to go to the Moon or Mars. One example could be closed-loop life support systems.

The Crew

NASA astronaut **John Phillips** currently serves as Science Officer and Flight Engineer for ISS Expedition 11. Phillips flew aboard the Space Shuttle in 2001 on STS-100, logging nearly 12 days and 5 million miles in space. He also served as a backup crew member to ISS Expedition 7, completing that assignment in February 2003.

The other crew member on board ISS is Russian Cosmonaut **Sergei Krikalev**, the Commander of Expedition 11, who will not be participating in the hearing. As commander, Krikalev is responsible for the overall safety and success of the mission. Krikalev is a veteran of five previous spaceflights, including two missions to the Russian space station Mir and two Shuttle flights. He was a member of the first ISS crew

(Expedition One), serving aboard a much smaller ISS than that of today, from Nov. 2, 2000, to March 18, 2001. Before Expedition 11, he had spent a year, 5 months and 10 days in space. At the conclusion of this mission, he will be the world's most experienced space traveler.

Expedition 11

Phillips and Krikalev are currently living and working aboard ISS on a six-month tour of duty. Expedition 11 was launched from the Baikonur Cosmodrome in Kazakhstan on April 14, 2005 aboard a Russian Soyuz, which docked with ISS on April 16, 2005.

Expedition 11 replaced Expedition 10, which was on ISS from October 2004 until April 2005 (191 days). Expedition 11 is scheduled to return to Earth in October after approximately 180 days on orbit. Plans call for Phillips and Krikalev to perform one spacewalk. The astronauts will continue outfitting the exterior of ISS and work with scientific experiments.

Phillips and Krikalev will also welcome the arrival of two Russian Progress unmanned supply vehicles, one of which is scheduled for launch on June 16 (and should reach the Station on June 18), and the other is scheduled for launch near the end of August.

Highlights of the Expedition 11 crew's mission are scheduled to include welcoming the return of Space Shuttle crews, STS-114 (Discovery) and STS-121 (Atlantis), if the current Return to Flight schedule holds. The Shuttle missions will deliver several tons of supplies and research equipment to ISS, and the Shuttle crews also are expected to conduct spacewalks. As noted, STS-121 may leave a third astronaut aboard ISS to serve as a long-duration crew member.

Questions for the Witnesses

The witnesses were asked to address the following questions in their testimony:

Questions for Dr. John Phillips

In your testimony, please describe (and, to the extent possible, show during the hearing) how you conduct a typical day on the International Space Station and what are the greatest challenges, with specific attention to the following questions:

1. How have the loss of the Columbia Shuttle and the inability to use the Shuttle to re-supply the station affected its operations during the last two years?
2. How do you deal with safety-related issues while on board ISS, such as taking shelter from solar flares, maintaining oxygen supplies, or keeping fit to reduce the bone loss associated with long-duration spaceflight?
3. What research does the crew of Expedition 11 plan to conduct while on board the station?

Questions for Dr. Peggy Whitson

In your testimony, please describe your most important accomplishments (both for assembly and operations) during your stay on the International Space Station, as well as problems you may have experienced, with particular emphasis on the following questions:

1. What are the challenges of performing extravehicular activity (EVAs, or spacewalks) from the station? What can EVAs from the station teach us that we can apply to future Exploration-related activities?
2. What role does the micrometeoroid shielding you helped to install play in the operation and maintenance of the station?
3. What impacts did your stay aboard the station have on your health? How quickly did you become re-acclimated to Earth? How did your experience in that regard compare to that of other astronauts?
4. What did you learn about the psychological dynamics and stresses of living with a small crew in space? What was most unexpected about your experience?

Lt. Col. Michael Fincke was added to the witness list after the delivery of the formal invitation letters, and thus did not receive questions to address for the hearing.

Appendix A

<u>Expedition 11 Crew Bio</u>

John Phillips (Ph.D.), ISS Science Officer and Flight Engineer, Expedition 11
John Phillips, 54, received a bachelor of science degree in mathematics and Russian from the U.S. Naval Academy in 1972 (where he graduated second in his class), a master of science degree in aeronautical systems from the University of West Florida in 1974, and a master of science and doctorate in geophysics and space physics from the University of California, Los Angeles (UCLA) in 1984 and 1987 respectively. He has been awarded the NASA Space Flight Medal and various military awards.

Phillips received a Navy commission upon graduation from the U.S. Naval Academy in 1972 and was designated a Naval Aviator in November 1974. He trained in the A-7 Corsair Aircraft at Naval Air Station Lemoore, California and made overseas deployment with Attack Squadron 155 aboard the USS Oriskany and USS Roosevelt. Subsequent tours of duty included navy recruiting in Albany, New York, and flying the CT-39 Sabreliner Aircraft at Naval Air Station North Island, California.

After leaving the Navy in 1982, Phillips enrolled as a graduate student at UCLA. While at UCLA he carried out research involving observations by the NASA Pioneer Venus Spacecraft. Upon completing his doctorate in 1987, he was awarded a J. Robert Oppenheimer Postdoctoral Fellowship at Los Alamos National Laboratory in New Mexico. He accepted a career position at Los Alamos in 1989. While there, Phillips performed research on the sun and the space environment. From 1993 through 1996 he was Principal Investigator for the Solar Wind Plasma Experiment aboard the Ulysses Spacecraft as it executed a unique trajectory over the poles of the sun.

After being selected as an astronaut by NASA in 1996 and completing astronaut candidate training, Phillips has held various jobs in the Astronaut Office, including systems engineering and as International Space Station Spacecraft Communicator (ISS CAPCOM).

In addition to his current space flight experience as Science Officer for ISS Expedition 11, Phillips flew aboard Space Shuttle Endeavour on the STS-100 mission (April 19 to May 1, 2001). During the 12-day, 187 orbit mission, the Shuttle crew successfully delivered and installed the Canadarm-2 Robotic Arm on ISS. They also delivered experiments and supplies aboard the Multi-Purpose Logistics Module *Raffaello* on its maiden flight. Phillips was the Ascent/Entry Flight engineer and was the intravehicular activity coordinator during two space walks. Phillips also served as a backup crew member to ISS Expedition 7, completing that assignment in February 2003.

Witnesses Appearing In-person

Peggy Whitson (Ph.D.), NASA Astronaut, ISS Science Officer, Expedition 5
Peggy Whitson received a bachelor of science degree in biology/chemistry from Iowa Wesleyan College in 1981, and a doctorate in biochemistry from Rice University in 1985. She has received numerous awards and honors, including the NASA Space Flight Medal, and the Group Achievement Award for Shuttle-Mir Program. Dr. Whitson has also had two patents approved.

Upon completion of her graduate work, Whitson continued at Rice University as Postdoctoral Fellow until October 1986, at which point she began her studies at NASA Johnson Space Center, as a National Research Council Resident Research Associate.

In 1992, Whitson was named the Project Scientist of the Shuttle-Mir Program (STS-60, STS-63, STS-71, Mir 18, Mir 19) through 1995. From 1993-1996 she held the additional responsibilities of the Deputy Division Chief of the Medical Sciences Division at NASA-JSC. From 1995-1996 she served as Co-Chair of the U.S.-Russian Mission Science Working Group.

In April 1996, Whitson was selected as an astronaut candidate. Upon completing two years of training and evaluation, she was assigned technical duties in the Astronaut Office Operations Planning Branch and served as the lead for the Crew Test Support Team in Russia from 1998-99. From November 2003 to March 2005 she served as Deputy Chief of the Astronaut Office.

Whitson served as NASA Science Officer on the Expedition 5 crew for ISS, which launched on June 5, 2002 aboard STS-111 (Endeavour) and docked with ISS on June 7, 2002. During her 6-month stay aboard ISS, Whitson installed the Mobile Base System, the S1 truss segment, and the P1 truss segment using the space station remote manipulator system, performed a 4 hour and 25 minute spacewalk to install micrometeoroid shielding on the Zvezda Service Module, and activated and checked out the Microgravity Sciences Glovebox, a science payload rack. She conducted 21 investigations in human life sciences and microgravity sciences, as well as commercial payloads. The Expedition 5 crew (one American astronaut and two Russian cosmonauts) returned to Earth aboard STS-113 (Endeavour) on December 7, 2002. Completing her first flight, Whitson logged over 184 days in space.

Michael (“Mike”) Fincke (Lt. Col., USAF) NASA Astronaut, ISS Science Officer, Expedition 9

Lt. Col. Fincke graduated from the Massachusetts Institute of Technology on an Air Force ROTC scholarship in 1989 with a bachelor of science in Aeronautics and Astronautics as well as a bachelor of science in Earth, Atmospheric and Planetary Sciences. He then received a master of science in Aeronautics and Astronautics from Stanford University in 1990 and a second master of science in Physical Sciences

(Planetary Geology) from the University of Houston, Clear Lake in 2001. He is the recipient of two United States Air Force Commendation Medals, the United States Air Force Achievement Medal, and various unit and service awards.

In April 1996, Lt. Col. Fincke was selected as an astronaut candidate. Upon completing two years of training and evaluation, he was assigned technical duties in the Astronaut Office Station Operations Branch serving as an International Space Station Spacecraft Communicator (ISS CAPCOM), a member of the Crew Test Support Team in Russia and as the ISS crew procedures team lead. He also served as back-up crewmember for the ISS Expedition-4 and Expedition-6 and is qualified to fly as a left-seat Flight Engineer (co-pilot) on the Russian Soyuz spacecraft.

Lt. Col. Fincke served as NASA Science Officer on the Expedition 9 crew for ISS, which was launched from the Baikonur Cosmodrome, Kazakhstan aboard a Soyuz spacecraft, docking with ISS on April 21, 2004. He spent six-months aboard the station during which time he continued ISS science operations, maintained Station systems, and performed four spacewalks. The Expedition-9 mission concluded with undocking from the station and safe landing back in Kazakhstan on October 23, 2004. Lt. Col. Fincke completed his first mission in 187 days, and logged over 15 hours of EVA time.

Appendix B

Expedition 11 Science Overview

(The following section is adapted from the Expedition 11 press kit, available from: http://www.shuttlepresskit.com/EXPEDITION11/index.htm)

Expedition 11 – the 11th long-duration crew on ISS – began in April 2005, when the 11th crew arrived at the Station aboard a Russian Soyuz spacecraft. NASA ISS Science Officer Phillips and Russian Commander Krikalev, will maintain the Station and work with science teams on the ground to operate experiments and collect data.

During Expedition 11, two Russian Progress cargo flights are scheduled to dock with ISS. The Progress re-supply ships will transport supplies to the Station and carry scientific equipment. Much of the research activities for Expedition 11 will be carried out with scientific facilities and samples already on board ISS, as well as with new research facilities transported by the next two Space Shuttle missions – STS-114 scheduled for launch in July 2005, and STS-121 scheduled for launch later in 2005. Additional experiments are being evaluated and prepared to make use of limited cargo space on the Soyuz or Progress vehicles. The research agenda for the expedition remains flexible. While most equipment and samples can remain on board the Station with minimal or no detrimental effects, a few perishable samples – urine samples, for example – may be returned to Earth on the Soyuz.

The Expedition 11 crew has more than 100 hours scheduled for U.S. payload activities. Space station science also will be conducted by remote “crewmembers” – the team of controllers and scientists on the ground, who will continue to plan, monitor and operate experiments from control centers across the United States. A team of controllers for Expedition 11 will work in the ISS Payload Operations Center – NASA's science command post for the space station – at NASA’s Marshall Space Flight Center Huntsville, Ala. Controllers work in three shifts around the clock, seven days a week in the Payload Operations Center, which links researchers around the world with their experiments and the crew aboard the station.

EXPERIMENTS USING ON-BOARD RESOURCES

Many experiments from earlier Expeditions remain aboard the Space Station and will continue to benefit from the long-term research platform provided by the orbiting laboratory. These experiments include:

Crew Earth Observations (CEO) takes advantage of the crew in space to observe and photograph natural and man-made changes on Earth. The photographs record Earth surface changes over time, as well as more fleeting events such as storms, floods, fires and volcanic eruptions. Together they provide researchers on Earth with vital, continuous images needed to better understand the planet.

Dust Aerosol Measurement Feasibility Test (DAFT) tests the ability of different equipment to measure the levels of dust and air quality in order to improve fire detection capabilities in space.

Materials on the International Space Station Experiment (MISSE) is a suitcase-sized experiment attached to the outside of the Space Station. It exposes hundreds of potential space construction materials to the environment. The samples will be returned to Earth for study during a later expedition. Investigators will use the resulting data to design stronger, more durable spacecraft.

Protein Crystal Growth Single-locker Thermal Enclosure System (PCG-STES) will continue to process crystals that have been growing since Expedition 6, launched in October 2002. Crystals that also were grown on Expeditions 2 beginning in March 2001, as well as Expedition 4 launched in December 2001, and Expedition 5 beginning in June 2002, were returned to Earth for analysis. The facility provides a temperature-controlled environment for growing high-quality protein crystals of selected proteins in microgravity for later analyses on the ground to determine the proteins' molecular structure. Research may contribute to advances in medicine, agriculture and other fields.

Space Acceleration Measurement System II (SAMS-II) and **Microgravity Acceleration Measurement System (MAMS)** sensors measure vibrations caused by crew, equipment and other sources that could disturb microgravity experiments.

HUMAN LIFE SCIENCE INVESTIGATIONS

Many continuing experiments will use measurements of Expedition 11 crewmembers to study changes in the body caused by exposure to the microgravity environment.

Chromosomal Aberrations in Blood Lymphocytes of Astronauts (Chromosome), will study space radiation on humans. The expected results will provide a better knowledge of the genetic risk of astronauts in space and can help to optimize radiation shielding.

Promoting Sensorimotor Response to Generalizability: A Countermeasure to Mitigate Locomotor Dysfunction After Long-duration Spaceflight (Mobility) studies changes in posture and gait after long-duration spaceflight. Study results are expected to help in the development of an in-flight treadmill training program for Station crewmembers that could facilitate rapid recovery of functional mobility after long duration space flight.

Behavioral Issues Associated with Isolation and Confinement: Review and Analysis of Astronaut Journals collects behavioral and human factors data for analysis, with the intention of furthering our understanding of life in isolation and confinement. The objective of the experiment is to identify equipment, habitat and procedural features that help humans adjust to isolation and confinement and remain effective and productive during future long-duration space expeditions.

Advanced Diagnostic Ultrasound in Microgravity (ADUM) involves crewmembers conducting ultrasound exams on one another with minimal training and with direction from a ground based sonographer. Verification of these advanced ultrasound techniques and telemedicine strategies could have widespread applications in emergency and rural care situations on Earth.

The **Biopsy** experiment allows researchers to take biopsies of the astronauts' calf muscles before and after their stay on board the Space Station. This will allow scientists to begin developing an in-space countermeasure exercise program aimed at keeping muscles at their peak performance during long missions in space.

Foot/Ground Reaction Forces During Space Flight (Foot) studies the load on the lower body and muscle activity in crewmembers while working on the Station. This study will provide better understanding of the bone and muscle loss in the lower extremities experienced by astronauts in microgravity. The results of this experiment will help in future space flights, as well as have significance for understanding, preventing and treating osteoporosis on Earth.

The **Renal Stone** experiment collects urine samples from the crew and tests a possible countermeasure for preventing kidney stone formation.

A Comprehensive Characterization of Microorganisms and Allergens in Spacecraft (Swab) will use generic techniques for the first time to comprehensively evaluate microbes on board the Space Station, including pathogens, and to study how the microbial community changes as spacecraft visit the Space Station and modules are added. This study will monitor Station modules prior to launch to evaluate sources of new germs and find ways of preventing additional contamination onboard spacecraft.

Space Flight-Induced Reactivation of Latent Epstein-Barr Virus (Epstein-Barr) performs tests to study changes in human immune function using blood and urine samples collected before and after space flight. The study will provide insight for possible countermeasures to prevent the potential development of infectious illness in crewmembers during flight.

DESTINY LABORATORY FACILITIES

Several research facilities are in place aboard the Station to support Expedition 11 science investigations:

The **Human Research Facility** is designed to house and support a variety of life sciences experiments. It includes equipment for lung function tests, ultrasound to image the heart and many other types of computers and medical equipment.

The **Microgravity Science Glovebox** is the other major dedicated science facility inside Destiny. It has a large front window and built-in gloves to provide a sealed environment for conducting science and technology experiments. The Glovebox is particularly suited for handling hazardous materials when a crew is present. The Destiny lab also is outfitted with five **EXPRESS** Racks. EXPRESS (Expedite the Processing of Experiments to the Space Station) racks are standard payload racks designed to provide experiments with a variety of utilities such as power, data, cooling, fluids and gasses. The racks support payloads in a several disciplines, including biology, chemistry, physics, ecology and medicines. The racks stay in orbit, while experiments are changed as needed. EXPRESS Racks 2 and 3 are equipped with the **Active Rack Isolation System (ARIS)** for countering minute vibrations from crew movement or operating equipment that could disturb delicate experiments.