Expedition 7:
A Mission of Education and Science

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Overview

Expedition 7: A Mission of Education and Science

The next crew to live and work aboard the International Space Station is scheduled to launch no earlier than April 26, 2003, aboard a Russian Soyuz spacecraft from the Baikonur Cosmodrome in Kazakhstan to replace two American astronauts and a Russian cosmonaut who have been living and working on the ISS since November.

Russian Commander Yuri Malenchenko, a Russian Air Force colonel, left, and NASA International Space Station Science Officer and Flight Engineer Edward Lu, right, will launch on the Soyuz TMA-2 spacecraft for a two-day flight to dock to the nadir port of the Zarya Control Module of the ISS. Once on board, Malenchenko and Lu will conduct up to six days of handover activities with Expedition 6 Commander Ken Bowersox, Flight Engineer Nikolai Budarin and ISS Science Officer Don Pettit.

Malenchenko and Lu will assume formal control of the station at the time of hatch closure before the Expedition 6 crew undocks its Soyuz TMA-1 craft from the station's Pirs Docking Compartment. With Budarin at the controls of TMA-1, Bowersox and Pettit will become the first U.S. astronauts to land in a Soyuz vehicle in the steppes of north central Kazakhstan to wrap up more than five months in orbit. The TMA-1 craft was delivered to the ISS last November, just a few weeks before Bowersox, Budarin and Pettit arrived.

Bowersox and Pettit will remain at the Gagarin Cosmonaut Training Center in Star City, Russia, for initial physical rehabilitation and debriefings for about two weeks after landing and their return from Kazakhstan, which should occur about eight hours after touchdown.

Malenchenko and Lu are expected to spend about six months aboard the ISS. After the Columbia accident on Feb. 1, 2003, the ISS Program and the international partners determined that the station would be occupied by only two crewmembers until the resumption of shuttle flights because of limitations on consumables.

Expedition 7 Commander Yuri Malenchenko (left) and Flight Engineer and NASA ISS Science Officer Ed Lu take time out from practicing launch procedures in a Soyuz capsule simulator.

Malenchenko, a veteran cosmonaut, was commander of the Mir 16 mission in 1994 and served on Atlantis' crew on STS-106 in September 2000, preparing the International Space Station for its first permanent crew. Malenchenko performed a 6-hour, 14-minute spacewalk with Lu on that mission to connect power, data and communications cables to the newly arrived Zvezda Service Module. Lu, a research physicist, began his astronaut training in 1995, and has flown in space twice.

There are no scheduled spacewalks planned during Expedition 7, and no station assembly tasks scheduled until shuttle flights resume.

Once the Expedition 6 crew has departed, the Expedition 7 crew will settle down to work.

Station operations and station maintenance will take up a considerable share of the time of the two-person crew. But science will continue, as will science-focused education activities and Earth observations.

Astronaut Edward T. Lu, Expedition 7 flight engineer and NASA ISS science officer, participates in Human Research Facility training in the International Space Station Destiny laboratory mockup/trainer at Johnson Space Center's Space Vehicle Mockup Facility.

Experiments make use of the microgravity environment in the Destiny laboratory and the orientation of the station to conduct investigations in a variety of disciplines. Those fields include life sciences, physics and chemistry, and their applications in materials and manufacturing processes. The station also studies the Earth – its environment, climate, geology, oceanography and more. Indeed, Earth observations are expected to occupy a relatively large share of this crew's time for scientific activity. The crew is scheduled to devote nearly 200 hours to U.S., Russian, and other partner research during its stay on orbit.

The science team at the Payload Operations Center at the Marshall Space Flight Center in Huntsville, Ala., will operate some experiments without crew input and other experiments are designed to function autonomously. Together, operation of individual experiments is expected to total several thousand hours, adding to the more than 100,000 hours of experiment operation time already accumulated aboard the station.

In addition, some Expedition 6 science activities will be continued. Many of the Expedition 7 Russian science experiments were delivered on Progress 10, which docked to the International Space Station Feb. 4.

Among Expedition 7's most important functions will be to provide motivation and inspiration for today's youth, the next generation of explorers. These young people will add to human knowledge using information space station science will provide, taking us further and further into yet uncharted scientific waters.

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In this demonstration of surface tension, food coloring has been added to water that is being held in place by a metal loop. Astronaut Donald R. Pettit, Expedition 6 NASA ISS science officer, photographed these demonstrations for educational purposes.

This crew will build on the education efforts of Expedition 6 NASA ISS Science Officer Pettit, whose explanations and activities from his “Saturday Morning Science” demonstrations focused on physical phenomena in microgravity, and became a popular part of NASA Television’s portrayal of ISS activities during the increment. Lu is expected to continue those demonstrations, taking advantage of available time on orbit.

Malenchenko and Lu will oversee the upgrade of one or two new software packages on the station. This new ISS software is scheduled to be installed in early summer and later this fall. The first upgrade will bring the station to the configuration needed to accept new truss segments beginning with the STS-115/12A mission. The second will bring the station to the STS-116/12A.1 software configuration, and supports additional data flow from experiments to the ground. Performing these software upgrades now will allow bonus time to test the software before the assembly elements are installed.

Also on the crew’s agenda is work with the station’s robotic arm, Canadarm2. Robotics work will focus on observations of the station’s exterior, maintaining operator proficiency, and completing the schedule of on-orbit checkout requirements that were developed to fully characterize the performance of the robotic system.

Two unmanned Progress cargo craft are scheduled to dock with the ISS during Expedition 7, bringing food, water, clothing, personal items, fuel and equipment to the station. Progress 11 is scheduled for launch in early June. Progress 12 is to be launched in late summer. Another ISS first will occur with the docking of Progress 11, placing three Russian vehicles at the station at the same time. Progress 10 remains docked to the aft port of Zvezda, while the Soyuz TMA-2 will be docked to Zarya, leaving the Pirs Docking Compartment available to receive Progress 11.

Periodic routine reboost of the station can be controlled with the Progress which is attached to Zvezda.

The first visitors Malenchenko and Lu will likely see will be their replacements, Expedition 8. That crew is scheduled to be launched aboard Soyuz TMA-3 in October. After about a week of joint operations, Malenchenko and Lu will return to Earth aboard the Soyuz TMA-2 that brought them to the station.

Expedition 7 Crew

Commander: Yuri Malenchenko

Cosmonaut Yuri Malenchenko, a colonel in the Russian Air Force, will command the Expedition 7 crew of the International Space Station. Malenchenko is a veteran of a long-duration spaceflight aboard the Russian space station Mir. He also flew on STS-106 aboard Atlantis in September 2000.

On his shuttle flight to the space station, Malenchenko performed a spacewalk with fellow Expedition 7 crewmember Ed Lu to connect cables between the newly arrived Zvezda Service Module and the rest of the station. It was Malenchenko's third spacewalk.

Malenchenko was born Dec. 22, 1961, in Svetlovodsk, Ukraine. He graduated from Svetlovodsk public schools. In 1983, he received a pilot-engineer's diploma from S.I. Gritsevets Kharkov Higher Military Aviation School. In 1993, he graduated from the Zhukovsky Air Force Engineering Academy.

After completing Military Aviation School, he served as pilot, senior pilot, and multi-ship flight lead. In 1987, he was assigned to the Cosmonaut Training Center. From December

1987 to June 1989, he underwent a course of general space training. Since September, he has continued training as a member of a group of test cosmonauts.

He was the commander of the backup crew for Mir 15. From July 1 to Nov. 4, 1994, he served as Commander of Mir 16. During this flight, he controlled the first manual docking of Progress.

The STS-106 flight launched Sept. 8, 2000, and landed Sept 20. The STS-106 crew, five astronauts and two cosmonauts, delivered more than 6,600 pounds of supplies and installed batteries, power converters, a toilet and a treadmill on the space station. The focus of the mission was to prepare the space station for the arrival of the first permanent crew, which was launched Oct. 31, 2000.

During their 6-hour, 14-minute spacewalk, Malenchenko and Lu connected power, data and communications cables between the station and its new Zvezda Service Module.

Malenchenko has logged over 137 days in space and more than 18 hours of spacewalk time.

NASA ISS Science Officer and Flight Engineer: Edward Lu

Ed Lu is a veteran of two spaceflights, including the STS-106 mission with Expedition 7 commander Yuri Malenchenko. He holds a Ph.D. in applied physics from Stanford University. He also holds a commercial pilot certificate and has more than 1,200 hours of flight time.

Lu was born July 1, 1963, in Springfield, Mass. He considers Honolulu and Webster, N.Y., to be his hometowns. Hobbies include aerobatic flying, coaching wrestling, piano, tennis, surfing, traveling, cooking, and working on his experimental airplane.

Lu graduated from R.L. Thomas High School, Webster, N.Y., in 1980. He earned a B.S. in electrical engineering from Cornell University in 1984 and was awarded his doctorate in applied physics from Stanford in 1989. He was also a collegiate wrestler, and coached high school wrestling for six years.

After receiving his Ph.D. he worked as a research physicist in solar physics and astrophysics. He was a visiting scientist at the High Altitude Observatory in Boulder, Colo., from 1989 until 1992. During his final year there, he held an appointment with the Joint Institute for Laboratory Astrophysics at the University of Colorado. From 1992 until 1995, he was a postdoctoral fellow at the Institute for Astronomy in Honolulu.

He has developed a number of theoretical advances that provided for the first time a basic understanding of the underlying physics of solar flares. He has published articles on a wide range of topics including solar flares, cosmology solar oscillations, statistical mechanics, and plasma physics.

He was selected as an astronaut in December 1994 and reported to the Johnson Space Center in Houston the following March. Technical assignments included working in the astronaut office computer support branch and serving as lead astronaut for space station training issues.

He first flew aboard Atlantis on STS-84 in May 1997, the sixth shuttle mission to dock with the Russian space station Mir. During the nine-day-plus flight he logged 221 hours in space.

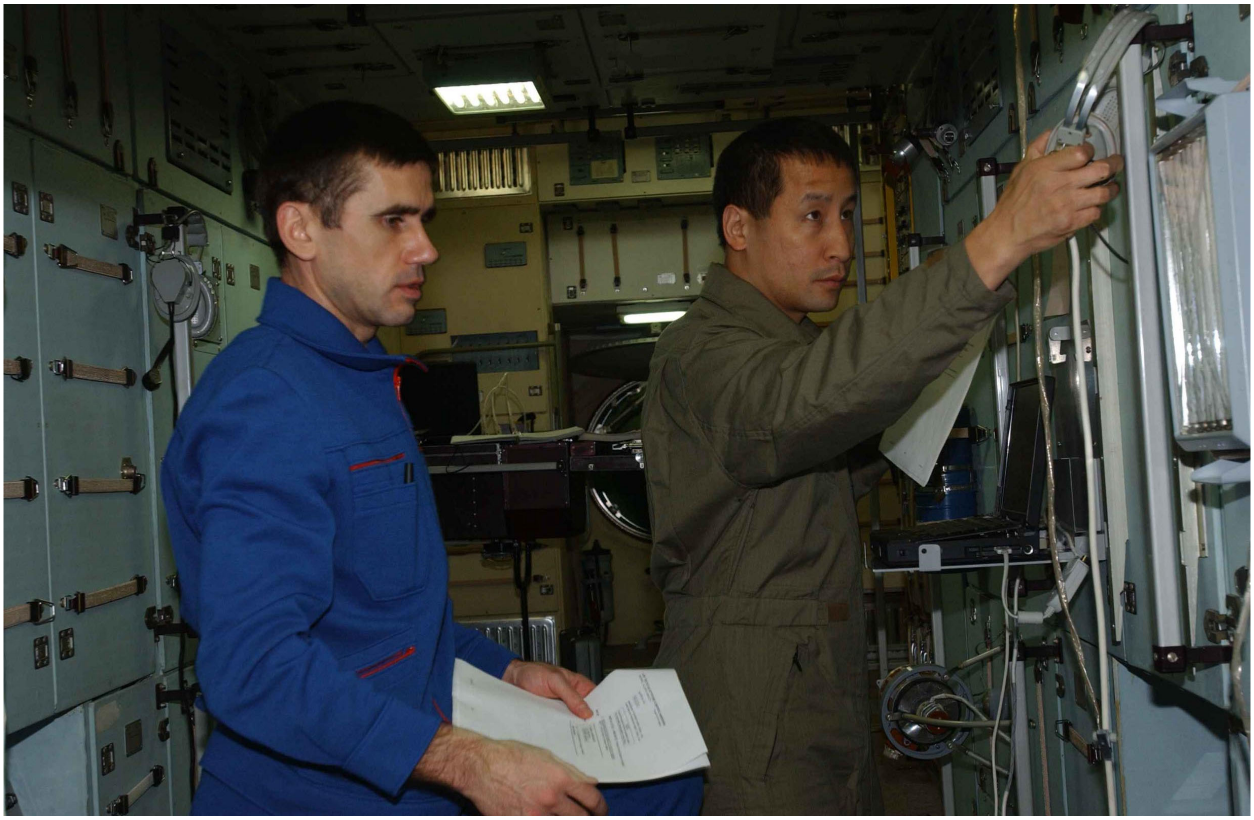
Lu’s flight aboard Atlantis on STS-106 gave him a total of more than 504 hours in space, including one spacewalk, conducted with Malenchenko during Atlantis’ mission to the ISS.

Crew Activities and Training

Expedition 7 Commander Yuri Malenchenko and Flight Engineer and NASA ISS Science Officer Ed Lu are scheduled to be launched April 26, 2003, from the Bakonur Cosmodrome in Kazakhstan in a Soyuz TMA-2 capsule to begin a six-month stay on the International Space Station.

Expedition 7 Commander Yuri Malenchenko (left) and Flight Engineer and NASA ISS Science Officer Ed Lu don masks to practice prebreathe procedures as part of their training at the Gagarin Cosmonaut Training Center in Star City, Russia.

Expedition 7 Commander Yuri Malenchenko (left) and Flight Engineer and NASA ISS Science Officer Ed Lu practice in a Soyuz capsule simulator.



Expedition 7 Commander Yuri Malenchenko (left) and Flight Engineer and NASA ISS Science Officer Ed Lu practice in a Zvezda Service Module simulator.

Mission Objectives

Soyuz 6 Flight Tasks (in descending prioritized order):

These tasks, listed in order of International Space Station Program priority, are to be executed during this flight. The order of execution for these tasks in the nominal plan may vary depending on timeline efficiencies.

- Dock Soyuz TMA-2 to the Zarya nadir port
- Rotate Expedition 6 crew with Expedition 7 crew, transfer mandatory crew rotation cargo, and perform mandatory tasks consisting of the safety briefing
- Perform minimum crew handover of 12 hours per crewmember
- Transfer critical items
- Undock Soyuz TMA-1 from Pirs Docking Compartment
- Return critical equipment on the Soyuz TMA-1 capsule
- Perform Expedition Crew Station Support Computer (SSC) software loads
- Perform experiments under the scientific and applied research program
- Perform photo/video imagery of the ISS Russian Segment
- Perform PAO events and commemorative activities
- Perform an additional four hours per crewmember of ISS crew handover (16 hours per crewmember total)
- Perform communications with the Russian MCC (Soyuz vehicle and ISS)

Soyuz TMA-1 Undock to 11 Progress-M1 Dock Requirements:

This section identifies requirements applicable from Soyuz TMA-1 undock through 11 Progress M1 dock.

These tasks, listed in descending order according to ISS Program priority, are to be executed during this stage. The order of execution for these tasks in the nominal plan may vary depending on timeline efficiencies.

- Perform U.S./Russian maintenance for those systems with no redundancy or those systems required as Launch Commit Criteria for the next flight
- Dock 11 Progress-M1 to Pirs Docking Compartment
- Perform U.S./Russian medical operations
- Perform training and preparation required for 11 Progress-M1 docking
- Perform EMU donning/doffing demonstration
- Perform high priority USOS/Russian payload operations.
- Perform on-board training
- Unpack Soyuz TMA-2 cargo
- Perform software load updates for Flight 12A
- Perform USOS/Russian maintenance activities for those systems with redundancy
- Perform medium priority USOS/Russian payloads operations
- Perform remaining maintenance
- Perform other U.S./Russian medical operations
- Perform remaining USOS/Russian payload operations

Russian Soyuz TMA

The Soyuz TMA spacecraft is designed to serve as the International Space Station's crew return vehicle, acting as a lifeboat in the unlikely event an emergency would require the crew to leave the station. A new Soyuz capsule is normally delivered to the station by a Soyuz crew every six months, replacing an older Soyuz capsule already docked to the ISS.

The Soyuz spacecraft is launched to the space station from the Baikonur Cosmodrome in Kazakhstan aboard a Soyuz rocket. It consists of an Orbital Module, a Descent Module and an Instrumentation/Propulsion Module.

Orbital Module

This portion of the Soyuz spacecraft is used by the crew while on orbit during free-flight. It has a volume of 6.5 cubic meters (230 cubic feet), with a docking mechanism, hatch and rendezvous antennas located at the front end. The docking mechanism is used to dock with the space station and the hatch allows entry into the station. The rendezvous antennas are used by the automated docking system -- a radar-based system -- to maneuver towards the station for docking. There is also a window in the module.

The opposite end of the Orbital Module connects to the Descent Module via a pressurized hatch. Before returning to Earth, the Orbital Module separates from the Descent Module -- after the deorbit maneuver -- and burns up upon re-entry into the atmosphere.

Descent Module

The Descent Module is where the cosmonauts and astronauts sit for launch, re-entry and landing. All the necessary controls and displays of the Soyuz are located here. The module also contains life support supplies and batteries used during descent, as well as the primary and backup parachutes and landing rockets. It also contains custom-fitted seat liners for each crewmember's couch/seat, which are individually molded to fit each person's body -- this ensures a tight, comfortable fit when the module lands on the Earth. When crewmembers are brought to the station aboard the space shuttle, their seat liners are brought with them and transferred to the existing Soyuz spacecraft as part of crew handover activities.

The module has a periscope, which allows the crew to view the docking target on the station or the Earth below. The eight hydrogen peroxide thrusters located on the module are used to control the spacecraft's orientation, or attitude, during the descent until parachute deployment. It also has a guidance, navigation and control system to maneuver the vehicle during the descent phase of the mission.

This module weighs 2,900 kilograms (6,393 pounds), with a habitable volume of 4 cubic meters (141 cubic feet). Approximately 50 kilograms (110 pounds) of payload can be returned to Earth in this module and up to 150 kilograms (331 pounds) if only two crewmembers are present. The Descent Module is the only portion of the Soyuz that survives the return to Earth.

Instrumentation/Propulsion Module

This module contains three compartments: intermediate, instrumentation and propulsion.

The intermediate compartment is where the module connects to the Descent Module. It also contains oxygen storage tanks and the attitude control thrusters, as well as electronics, communications and control equipment. The primary guidance, navigation, control and computer systems of the Soyuz are in the instrumentation compartment, which is a sealed container filled with circulating nitrogen gas to cool the avionics equipment. The propulsion compartment contains the primary thermal control system and the Soyuz radiator, which has a cooling area of 8 square meters (86 square feet). The propulsion system, batteries, solar arrays, radiator and structural connection to the Soyuz launch rocket are located in this compartment.

The propulsion compartment contains the system that is used to perform any maneuvers while in orbit, including rendezvous and docking with the space station and the deorbit burns necessary to return to Earth. The propellants are nitrogen tetroxide and unsymmetric-dimethylhydrazine. The main propulsion system and the smaller reaction control system, used for attitude changes while in space, share the same propellant tanks.

The two Soyuz solar arrays are attached to either side of the rear section of the Instrumentation/Propulsion Module and are linked to rechargeable batteries. Like the Orbital Module, the intermediate section of the Instrumentation/Propulsion Module separates from the Descent Module after the final deorbit maneuver and burns up in atmosphere upon re-entry.

TMA Improvements and Testing

The Soyuz TMA spacecraft is a replacement for the Soyuz TM, which was used from 1986 to 2002 to take astronauts and cosmonauts to Mir and then to the International Space Station.

The TMA increases safety, especially in descent and landing. It has smaller and more efficient computers and improved displays. In addition, the Soyuz TMA accommodates individuals as large as 1.9 meters (6 feet, 3 inches tall) and 95 kilograms (209 pounds), compared to 1.8 meters (6 feet) and 85 kilograms (187 pounds) in the earlier TM. Minimum crewmember size for the TMA is 1.5 meters (4 feet, 11 inches) and 50 kilograms (110 pounds), compared to 1.6 meters (5 feet, 4 inches) and 56 kilograms (123 pounds) for the TM.

Two new engines reduce landing speed and forces felt by crewmembers by 15 to 30 percent and a new entry control system and three-axis accelerometer increase landing accuracy. Instrumentation improvements include a color "glass cockpit," which is easier to use and gives the crew more information, with hand controllers that can be secured under an instrument panel. The Soyuz TMA can spend up to one year in space.

New components and the entire TMA were rigorously tested on the ground, in hangar-drop tests, in airdrop tests and in space before the spacecraft was declared flight-ready. For example, the accelerometer and associated software, as well as modified boosters (incorporated to cope with the TMA's additional mass), were tested on flights of Progress unpiloted supply spacecraft, while the new cooling system was tested on two Soyuz TM flights.

Descent module structural modifications, seats and seat shock absorbers were tested in hangar drop tests. Landing system modifications, including associated software upgrades, were tested in a series of airdrop tests. Additionally, extensive tests of systems and components were conducted on the ground.

Soyuz Launcher

Throughout history, more than 1,500 launches have been made with Soyuz launchers to orbit satellites for telecommunications, Earth observation, weather, and scientific missions, as well as for human flights.

The basic Soyuz vehicle is considered a three-stage launcher in Russian terms and is composed of:

- A lower portion consisting of four boosters (first stage) and a central core (second stage).
- An upper portion, consisting of the third stage, payload adapter and payload fairing.
- Liquid oxygen and kerosene are used as propellants in all three Soyuz stages.

First Stage Boosters

The first stage's four boosters are assembled laterally around the second stage central core. The boosters are identical and cylindrical-conic in shape with the oxygen tank located in the cone-shaped portion and the kerosene tank in the cylindrical portion.

An NPO Energomash RD 107 engine with four main chambers and two gimbaled vernier thrusters is used in each booster. The vernier thrusters provide three-axis flight control.

Ignition of the first stage boosters and the second stage central core occur simultaneously on the ground. When the boosters have completed their powered flight during ascent, they are separated and the core second stage continues to function.

First stage booster separation occurs when the pre-defined velocity is reached, which is about 118 seconds after liftoff.

Second Stage

An NPO Energomash RD 108 engine powers the Soyuz second stage. This engine differs from those of the boosters by the presence of four vernier thrusters, which are necessary for three-axis flight control of the launcher after the first stage boosters have separated.

An equipment bay located atop the second stage operates during the entire flight of the first and second stages.

Third Stage

The third stage is linked to the Soyuz second stage by a latticework structure. When the second stage's powered flight is compelte, the third stage engine is ignited. Separation of the two stages occurs by the direct ignition forces of the third stage engine.

A single-turbopump RD 0110 engine from KB KhA powers the Soyuz third stage.

The third stage engine is fired for about 240 seconds, and cutoff occurs when the calculated velocity increment is reached, After cutoff and separation, the third stage performs an avoidance maneuver by opening an outgassing valve in the liquid oxygen tank.

Launcher Telemetry Tracking & Flight Safety Systems

Soyuz launcher tracking and telemetry is provided through systems in the second and third stages. These two stages have their own radar transponders for ground tracking. Individual telemetry transmitters are in each stage. Launcher health status is downlinked to ground stations along the flight path. Telemetry and tracking data are transmitted to the mission control center, where the incoming data flow is recorded. Partial real-time data processing and plotting is performed for flight following and initial performance assessment. All flight data is analyzed and documented within a few hours after launch.

Baikonur Cosmodrome Launch Operations

Soyuz missions use the Baikonur Cosmodrome's proven infrastructure, and launches are performed by trained personnel with extensive operational experience.

Baikonur Cosmodrome is located in the Republic of Kazakhstan in Central Asia between 45 degrees and 46 degrees North latitude and 63 degrees East longitude. Two launch pads are dedicated to Soyuz missions.

Final Launch Preparations

The assembled launch vehicle is moved to the launch pad horizontally on a railcar. Transfer to the launch zone occurs two days before launch, during which the vehicle is erected and a launch rehearsal is performed that includes activation of all electrical and mechanical equipment.

On launch day, the vehicle is loaded with propellant and the final countdown sequence is started at three hours before the liftoff time.

Rendezvous to Docking

A Soyuz spacecraft generally takes two days after launch to reach the space station. The rendezvous and docking are both automated, though once the spacecraft is within 150 meters (492 feet) of the station, the Russian Mission Control Center just outside Moscow monitors the approach and docking. The Soyuz crew has the capability to manually intervene or execute these operations.

Soyuz Booster Rocket Characteristics

First Stage Data - Blocks B, V, G, D	
Engine	RD-107
Propellants	LOX/Kerosene
Thrust (tons)	102
Burn time (sec)	122
Specific impulse	314
Length (meters)	19.8
Diameter (meters)	2.68
Dry mass (tons)	3.45
Propellant mass (tons)	39.63
Second Stage Data, Block A	
Engine	RD-108
Propellants	LOX/Kerosene
Thrust (tons)	96
Burn time (sec)	314
Specific impulse	315
Length (meters)	28.75
Diameter (meters)	2.95
Dry mass (tons)	6.51
Propellant mass (tons)	95.7
Third Stage Data, Block I	
Engine	RD-461
Propellants	LOX/Kerosene
Thrust (tons)	30
Burn time (sec)	240
Specific impulse	330
Length (meters)	8.1
Diameter (meters)	2.66
Dry mass (tons)	2.4
Propellant mass (tons)	21.3
PAYLOAD MASS (tons)	6.8
SHROUD MASS (tons)	4.5
LAUNCH MASS (tons)	309.53
TOTAL LENGTH (meters)	49.3

Prelaunch Countdown Timeline

T- 34 Hours	Booster is prepared for fuel loading
T- 6:00:00	Batteries are installed in booster
T- 5:30:00	State commission gives go to take launch vehicle
T- 5:15:00	Crew arrives at site 254
T- 5:00:00	Tanking begins
T- 4:20:00	Spacesuit donning
T- 4:00:00	Booster is loaded with liquid oxygen
T- 3:40:00	Crew meets delegations
T- 3:10:00	Reports to the State commission
T- 3:05:00	Transfer to the launch pad
T- 3:00:00	Vehicle 1st and 2nd stage oxidizer fueling complete
T- 2:35:00	Crew arrives at launch vehicle
T- 2:30:00	Crew ingress through orbital module side hatch
T- 2:00:00	Crew in re-entry vehicle
T- 1:45:00	Re-entry vehicle hardware tested; suits are ventilated
T- 1:30:00	Launch command monitoring and supply unit prepared
	Orbital compartment hatch tested for sealing
T- 1:00:00	Launch vehicle control system prepared for use; gyro instruments activated
T - :45:00	Launch pad service structure halves are lowered
T- :40:00	Re-entry vehicle hardware testing complete; leak checks performed on suits
T- :30:00	Emergency escape system armed; launch command supply unit activated
T- :25:00	Service towers withdrawn
T- :15:00	Suit leak tests complete; crew engages personal escape hardware auto mode
T- :10:00	Launch gyro instruments uncaged; crew activates on-board recorders
T- 7:00	All prelaunch operations are complete
T- 6:15	Key to launch command given at the launch site
	Automatic program of final launch operations is activated
T- 6:00	All launch complex and vehicle systems ready for launch
T- 5:00	Onboard systems switched to onboard control
	Ground measurement system activated by RUN 1 command
	Commander's controls activated
	Crew switches to suit air by closing helmets
	Launch key inserted in launch bunker
T- 3:15	Combustion chambers of side and central engine pods purged with nitrogen

T- 2:30	Booster propellant tank pressurization starts
	Onboard measurement system activated by RUN 2 command
	Prelaunch pressurization of all tanks with nitrogen begins
T- 2:15	Oxidizer and fuel drain and safety valves of launch vehicle are closed
	Ground filling of oxidizer and nitrogen to the launch vehicle is terminated
T- 1:00	Vehicle on internal power
	Automatic sequencer on
	First umbilical tower separates from booster
T- :40	Ground power supply umbilical to third stage is disconnected
T- :20	Launch command given at the launch position
	Central and side pod engines are turned on
T- :15	Second umbilical tower separates from booster
T- :10	Engine turbopumps at flight speed
T- :05	First stage engines at maximum thrust
T- :00	Fueling tower separates
	Lift off

Ascent/Insertion Timeline

T- :00	Lift off
T+ 1:10	Booster velocity is 1,640 ft/sec
T+ 1:58	Stage 1 (strap-on boosters) separation
T+ 2:00	Booster velocity is 4,921 ft/sec
T+ 2:40	Escape tower and launch shroud jettison
T+ 4:58	Core booster separates at 105.65 statute miles
	Third stage ignites
T+ 7:30	Velocity is 19,685 ft/sec
T+ 9:00	Third stage cut-off
	Soyuz separates
	Antennas and solar panels deploy
	Flight control switches to Mission Control, Korolev

Orbital Insertion to Docking Timeline

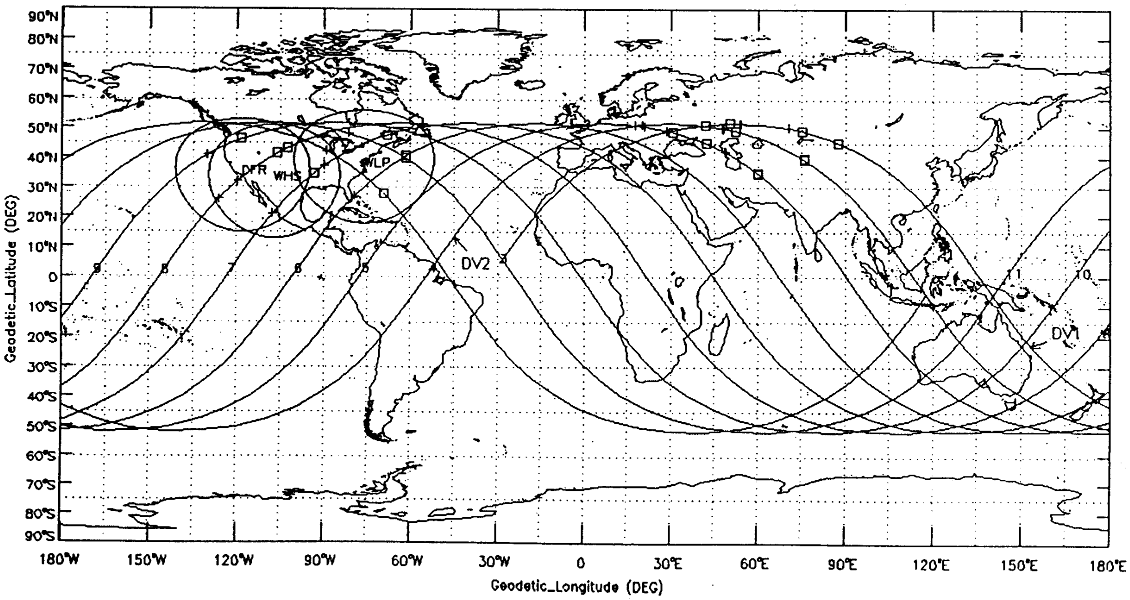
FLIGHT DAY 1 OVERVIEW	
Orbit 1	**Post insertion: Deployment of solar panels, antennas and docking probe**
	- Crew monitors all deployments
	- Crew reports on pressurization of OMS/RCS and ECLSS systems and crew health. Entry thermal sensors are manually deactivated
	- Ground provides initial orbital insertion data from tracking
Orbit 2	**Systems Checkout: IR Att Sensors, Kurs, Angular Accels, "Display" TV Downlink System, OMS engine control system, Manual Attitude Control Test**
	- Crew monitors all systems tests and confirms onboard indications
	- Crew performs manual RHC stick inputs for attitude control test
	- Ingress into HM, activate HM CO2 scrubber and doff Sokols
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
	Manual maneuver to +Y to Sun and initiate a 2 deg/sec yaw rotation. MCS is deactivated after rate is established.
Orbit 3	**Terminate +Y solar rotation, reactivate MCS and establish LVLH attitude reference (auto maneuver sequence)**
	- Crew monitors LVLH attitude reference build up
	- Burn data command upload for DV1 and DV2 (attitude, TIG Delta V's)
	- Form 14 preburn emergency deorbit pad read up
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
	Auto maneuver to DV1 burn attitude (TIG - 8 minutes) while LOS
	- Crew monitor only, no manual action nominally required
	DV1 phasing burn while LOS
	- Crew monitor only, no manual action nominally required
Orbit 4	**Auto maneuver to DV2 burn attitude (TIG - 8 minutes) while LOS**
	- Crew monitor only, no manual action nominally required
	DV2 phasing burn while LOS
	- Crew monitor only, no manual action nominally required
	Crew report on burn performance upon AOS
	- HM and DM pressure checks read down
	- Post burn Form 23 (AOS/LOS pad), Form 14 and "Globe"

	corrections voiced up
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
	Manual maneuver to +Y to Sun and initiate a 2 deg/sec yaw rotation. MCS is deactivated after rate is established.
	External boresight TV camera ops check (while LOS)
	Meal
Orbit 5	**Last pass on Russian tracking range for Flight Day 1**
	Report on TV camera test and crew health
	Sokol suit clean up
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 6-12	**Crew Sleep, off of Russian tracking range**
	- Emergency VHF2 comm available through NASA VHF Network
FLIGHT DAY 2 OVERVIEW	
Orbit 13	**Post sleep activity, report on HM/DM Pressures**
	Form 14 revisions voiced up
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 14	**Configuration of RHC-2/THC-2 work station in the HM**
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 15	**THC-2 (HM) manual control test**
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 16	**Lunch**
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 17 (1)	**Terminate +Y solar rotation, reactivate MCS and establish LVLH attitude reference (auto maneuver sequence)**
	RHC-2 (HM) Test
	- Burn data uplink (TIG, attitude, delta V)
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
	Auto maneuver to burn attitude (TIG - 8 min) while LOS
	Rendezvous burn while LOS
	Manual maneuver to +Y to Sun and initiate a 2 deg/sec yaw rotation. MCS is deactivated after rate is established.
Orbit 18 (2)	**Post burn and manual maneuver to +Y Sun report when AOS**
	- HM/DM pressures read down
	- Post burn Form 23, Form 14 and Form 2 (Globe correction) voiced up

	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 19 (3)	**CO2 scrubber cartridge change out**
	Free time
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 20 (4)	**Free time**
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 21 (5)	**Last pass on Russian tracking range for Flight Day 2**
	Free time
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 22 (6) - 27 (11)	**Crew sleep, off of Russian tracking range**
	- Emergency VHF2 comm available through NASA VHF Network
FLIGHT DAY 3 OVERVIEW	
Orbit 28 (12)	**Post sleep activity**
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 29 (13)	**Free time, report on HM/DM pressures**
	- Read up of predicted post burn Form 23 and Form 14
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 30 (14)	**Free time, read up of Form 2 "Globe Correction," lunch**
	- Uplink of auto rendezvous command timeline
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
FLIGHT DAY 3 AUTO RENDEZVOUS SEQUENCE	
Orbit 31 (15)	**Don Sokol spacesuits, ingress DM, close DM/HM hatch**
	- Active and passive vehicle state vector uplinks
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radio transponder tracking
Orbit 32 (16)	**Terminate +Y solar rotation, reactivate MCS and establish LVLH attitude reference (auto maneuver sequence)**
	Begin auto rendezvous sequence
	- Crew monitoring of LVLH reference build and auto rendezvous timeline execution
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radio transponder tracking

FLIGHT DAY 3 FINAL APPROACH AND DOCKING	
Orbit 33 (1)	**Auto Rendezvous sequence continues, flyaround and station keeping**
	- Crew monitor
	- Comm relays via SM through Altair established
	- Form 23 and Form 14 updates
	- Fly around and station keeping initiated near end of orbit
	- A/G (gnd stations and Altair), R/T TLM (gnd stations), Display TV downlink (gnd stations and Altair)
	- Radio transponder tracking
Orbit 34 (2)	**Final Approach and docking**
	- Capture to "docking sequence complete" 20 minutes, typically
	- Monitor docking interface pressure seal
	- Transfer to HM, doff Sokol suits
	- A/G (gnd stations and Altair), R/T TLM (gnd stations), Display TV downlink (gnd stations and Altair)
	- Radio transponder tracking
FLIGHT DAY 3 STATION INGRESS	
Orbit 35 (3)	**Station/Soyuz pressure equalization**
	- Report all pressures
	- Open transfer hatch, ingress station
	- A/G, R/T and playback telemetry
	- Radio transponder tracking

Typical Soyuz Ground Track



Expedition 6/Soyuz TMA-1 Landing

For the first time in history, American astronauts will return to Earth from orbit in a Russian Soyuz capsule. With Russian Flight Engineer Nikolai Budarin at the controls, Commander Ken Bowersox and NASA ISS Science Officer Don Pettit will touch down in the steppes of north central Kazakhstan in the Soyuz TMA-1 craft currently docked at the International Space Station's Pirs Docking Compartment to complete their mission.

The grounding of the space shuttle fleet following the Columbia accident on Feb.1, 2003, necessitated the landing of the Expedition 6 crew in a Soyuz capsule. The Soyuz always provides an assured crew return capability for residents aboard the ISS.

About three hours before undocking, Bowersox, Budarin and Pettit will bid farewell to the new Expedition 7 crew, Commander Yuri Malenchenko and Flight Engineer Ed Lu, and will climb into the Soyuz vehicle, closing the hatch between Soyuz and Pirs.

After activating Soyuz systems and getting approval from Russian flight controllers at the Russian Mission Control Center in Korolev, Budarin will send commands to open hooks and latches between Soyuz and Pirs which held the craft together since the Soyuz' arrival on Nov. 1, 2002.

Budarin will fire the Soyuz thrusters to back away from Pirs, and six minutes after undocking with the Soyuz about 20 meters away from the ISS, he will conduct a separation maneuver, firing the Soyuz jets for about 15 seconds to begin to move away from the ISS.

A little less than 2 ½ hours later, at a distance of about 19 kilometers from the ISS, Soyuz computers will initiate a deorbit burn braking maneuver of about 4 ½ minutes to slow the spacecraft and enable it to drop out of orbit to begin its re-entry.

Less than a half hour later, just above the first traces of the Earth's atmosphere, computers will command the separation of the three modules of the Soyuz vehicle. With the crew strapped in to the Descent Module, the forward Orbital Module containing the docking mechanism and rendezvous antennas and the rear Instrumentation and Propulsion Module, which houses the engines and avionics, will pyrotechnically separate and burn up in the atmosphere.

The Descent Module's computers will orient the capsule with its ablative heat shield pointing forward to repel the buildup of heat as it plunges into the atmosphere. The crew will feel the first effects of gravity in almost six months at the point called Entry Interface, when the module is about 400,000 feet above the Earth, about 3 minutes after module separation.

About 8 minutes later at an altitude of about 10 kilometers, traveling at about 220 meters per second, the Soyuz' computers will begin a commanded sequence for the deployment of the capsule's parachutes. First, two "pilot" parachutes will be deployed, extracting a larger drogue parachute, which stretches out over an area of 24 square meters. Within 16 seconds, the Soyuz's descent will slow to about 80 meters per second.

The initiation of the parachute deployment will create a gentle spin for the Soyuz as it dangles underneath the drogue chute, assisting in the capsule's stability in the final minutes prior to touchdown.

At this point, the drogue chute is jettisoned, allowing the main parachute to be deployed. Connected to the Descent Module by two harnesses, the main parachute covers an area of about 1,000 meters. Initially, the Descent Module will hang underneath the main parachute at a 30-degree angle with respect to the horizon for aerodynamic stability, but the bottom-most harness will be severed a few minutes before landing, allowing the Descent Module to hang vertically through touchdown. The deployment of the main parachute slows down the Descent Module to a velocity of about 7 meters per second.

Within minutes, at an altitude of a little more than 5 kilometers, the crew will monitor the jettison of the Descent Module's heat shield, which is followed by the termination of the aerodynamic spin cycle and the dumping of any residual propellant from the Soyuz. Computers also will arm the module's seat shock absorbers in preparation for landing.

With the jettisoning of the capsule's heat shield, the Soyuz altimeter is exposed to the surface of the Earth. Using a reflector system, signals are bounced to the ground from the Soyuz and reflected back, providing the capsule's computers updated information on altitude and rate of descent.

At an altitude of about 12 meters, cockpit displays will tell Budarin to prepare for the Soft Landing Engine firing. Just one meter above the surface, and just seconds before touchdown, the six solid propellant engines are fired in a final braking maneuver, enabling the Soyuz to land to complete its mission, settling down at a velocity of about 1.5 meters per second.

A recovery team, including two U.S. flight surgeons and astronaut support personnel, will be in the landing area in a convoy of Russian military helicopters awaiting the Soyuz landing. Once the capsule touches down, the helicopters will land nearby to begin the removal of the crew.

Within minutes of landing, a portable medical tent will be set up near the capsule in which the crew can change out of its launch and entry suits. Russian technicians will open the module's hatch and begin to remove the crew, one-by-one. They will be seated in special reclining chairs near the capsule for initial medical tests and to provide an opportunity to begin readapting to Earth's gravity.

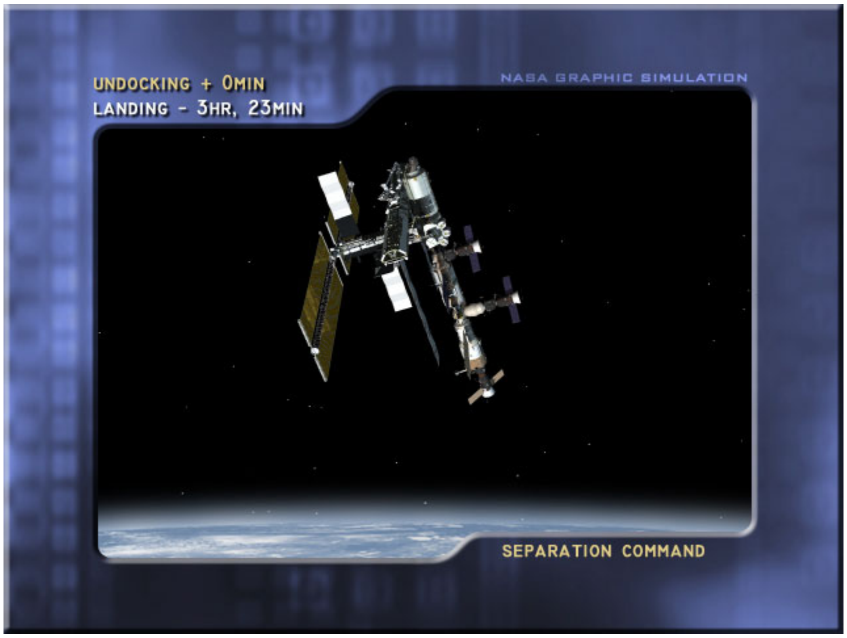
Within two hours after landing, the crew will be assisted to the helicopters for a flight back to Astana, the capital of Kazakhstan, where local officials will welcome them. The crew will then board a Russian military transport plane to be flown back to the Gagarin Cosmonaut Training Center in Star City, Russia, where their families will meet them. In all, it will take at least eight hours between landing and return to Star City.

Assisted by a team of flight surgeons, the crew will undergo at least 16 days of medical tests and physical rehabilitation before Bowersox and Pettit will return to the U.S. for additional debriefings and follow-up exams.

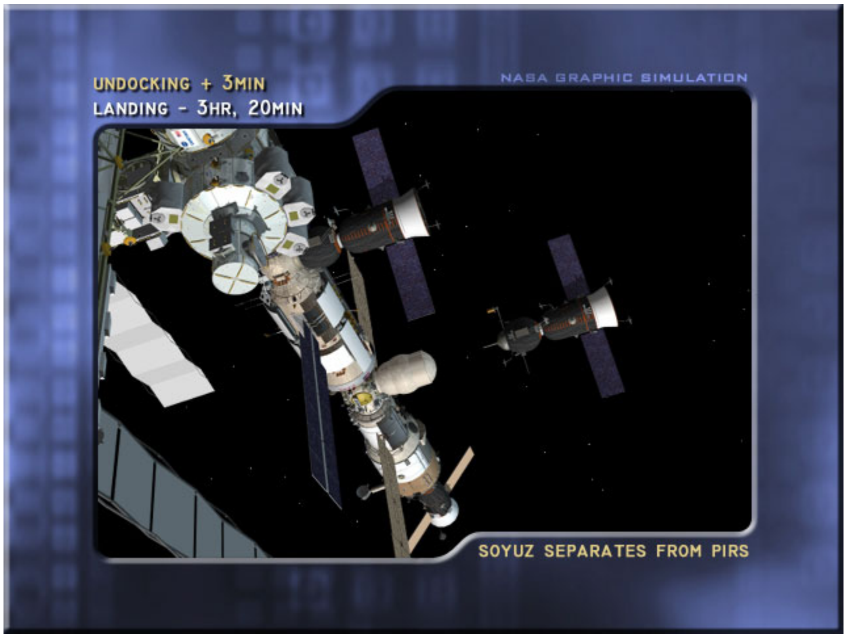
Entry Timeline for Soyuz

<u>Times are approximate. All times are keyed to elapsed time from undocking.</u>

Separation Command to Begin to Open Hooks and Latches:
Undocking + 0 minutes
Landing –3 hours
23 minutes

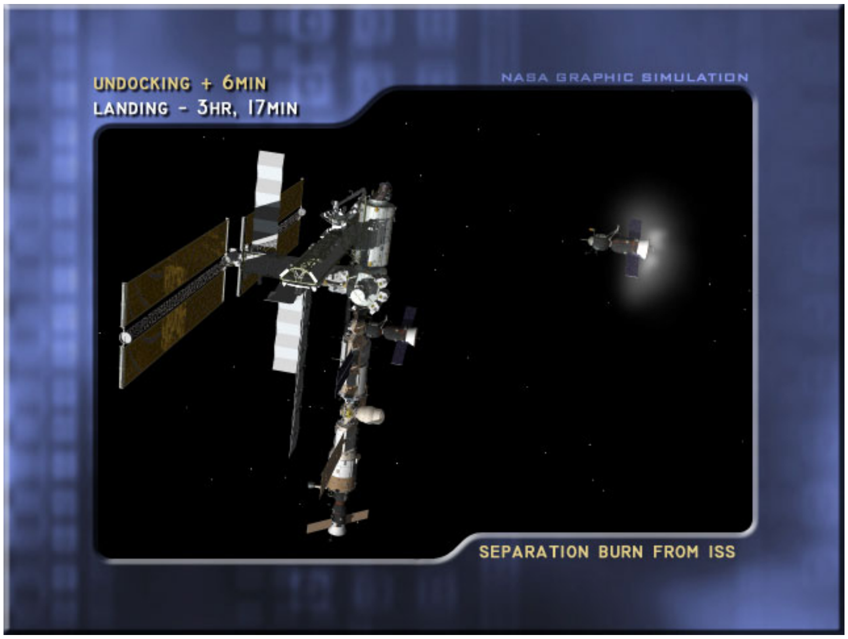


Hooks Opened / Physical Separation of Soyuz from Pirs at .1 meter/sec:
Undocking + 3 minutes
Landing – 3 hours
20 minutes



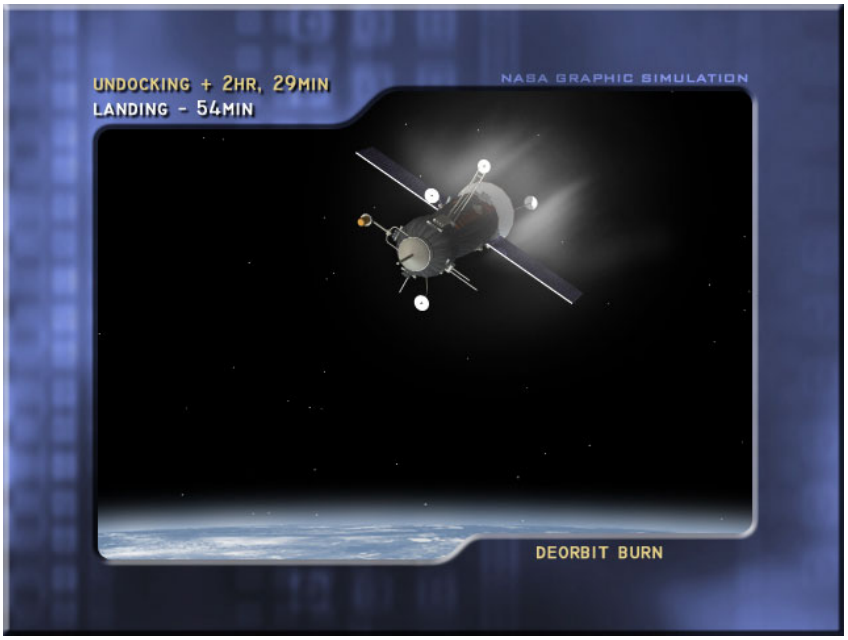
Separation Burn from ISS (15 second burn of the Soyuz engines, .57 meters/sec; Soyuz distance from the ISS is ~20 meters):

Undocking + 6 minutes
Landing – 3 hours
17 minutes



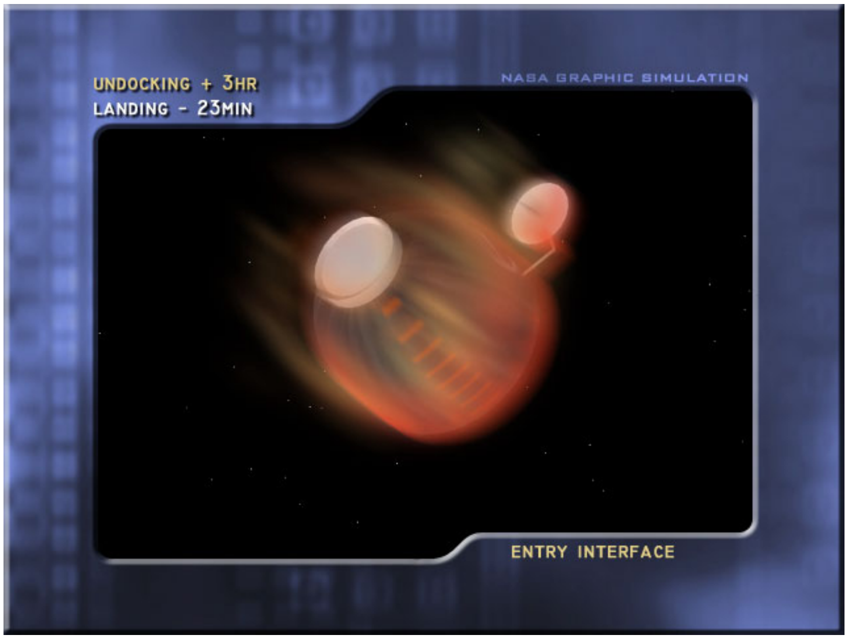
Deorbit Burn (4:21 in duration; Soyuz distance from the ISS is ~19 kilometers):

Undocking + 2 hours, 29 minutes
Landing – 54 minutes



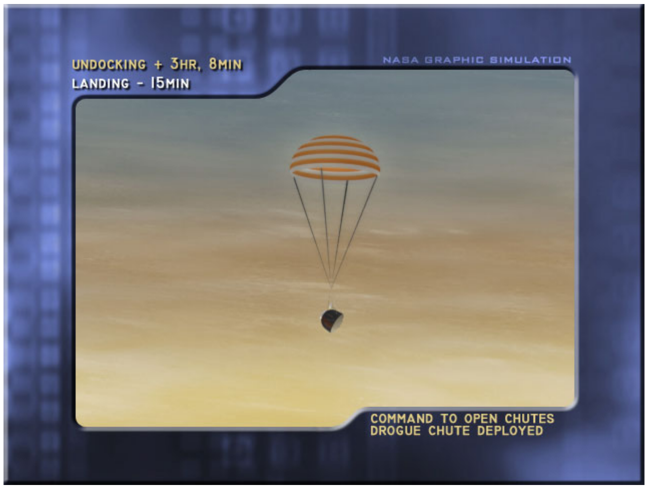
Separation of Modules (28 minutes after Deorbit Burn):
Undocking + 2 hours, 57 minutes
Landing – 26 minutes

Entry Interface (400,000 feet in altitude; 3 minutes after Module Separation; 31 minutes after Deorbit Burn):
Undocking + 3 hours
Landing – 23 minutes



Command to Open Chutes (8 minutes after Entry Interface; 39 minutes after Deorbit Burn):

Undocking + 3 hours, 8 minutes
Landing – 15 minutes

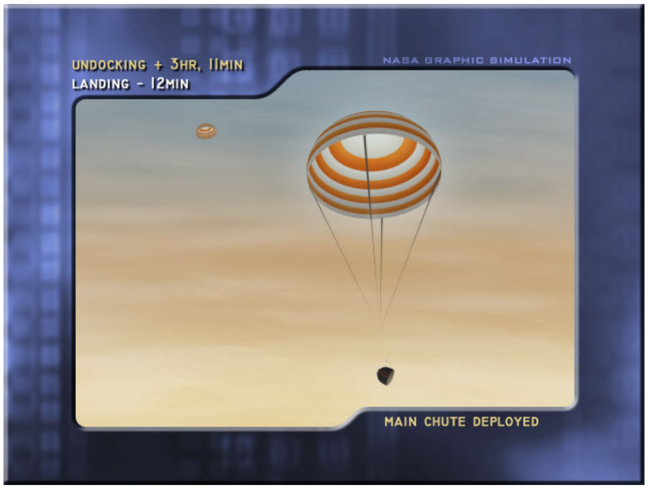


Two pilot parachutes are first deployed, the second of which extracts the drogue chute.

The drogue chute is then released, measuring 24 square meters, slowing the Soyuz down from a descent rate of 230 meters/second to 80 meters/second.

The main parachute is then released, covering an area of 1,000 meters; it slows the Soyuz to a descent rate of 7.2 meters/second; its harnesses first allow the Soyuz to descend at an angle of 30 degrees to expel heat…

Undocking + 3 hours, 11 minutes
Landing – 12 minutes



Soft Landing Engine Firing (6 engines fire to slow the Soyuz descent rate to 1.5 meters/second just .8 meter above the ground)

Landing – 2 seconds

Landing (54 minutes after Deorbit Burn):
Undocking + 3 hours, 23 minutes.

Expedition 7 Science Overview

Expedition 7 on the International Space Station is scheduled to begin in April 2003 when the station's seventh crew arrives at the station aboard a Russian Soyuz spacecraft. It is designated the 6S mission for the sixth Soyuz to visit the space station. A crew of two will replace three Expedition 6 crewmembers, who are scheduled to return home in May on another Soyuz spacecraft (5S), currently docked at the station. During Expedition 7, two Russian Progress cargo flights, called 11P and 12P for the 11th and 12th Progress vehicles, are scheduled to dock with the station. The Progress resupply ships will transport supplies to the station and also may carry scientific equipment. Another Soyuz vehicle – 7S – is scheduled to dock with the station in October.

Most of the research complement for Expedition 7 will be carried out with scientific research facilities and samples already on board the space station. Additional experiments are being evaluated and prepared to take advantage of the very limited cargo space on the Soyuz or Progress vehicles. The research agenda for the expedition remains flexible. A few perishable samples, such as urine samples and crystals, may be returned to Earth on the Soyuz, but most equipment and samples can remain on board the station without detrimental effects to the science.

The two-member crew of Expedition 7 is scheduled to devote more than 200 hours to research, while continuing to maintain the orbiting research complex. Station science also will be conducted by the ever-present additional crewmember – the team of controllers and scientists on the ground who will continue to plan, monitor and operate experiments from control centers around the country.

Expedition 7 crewmembers are Commander Yuri Malenchenko and Edward (Ed) Tsang Lu, who will serve as both the NASA International Space Station Science Officer and the Flight Engineer. They will continue maintaining the space station and work with science teams on the ground to operate experiments and collect data.

On Earth, a new cadre of controllers for Expedition 7 will replace their Expedition 6 colleagues in the International Space Station's Payload Operations Center at NASA's Marshall Space Flight Center in Huntsville, Ala. Controllers work in three shifts around the clock, seven days a week in NASA's Payload Operations Center -- the world's primary science command post for the space station. Its mission is to link earthbound researchers around the world with their experiments and the crew aboard the space 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.

Earth Knowledge Acquired by Middle School Students (EarthKAM), an education experiment, allows students to program a digital camera aboard the station to take pictures of a variety of geographical targets for study in the classroom. An observation session is scheduled for Expedition 7.

Crew Interactions will identify and characterize interpersonal and cultural factors that may affect crew and ground support personnel performance during space station missions. This experiment has been conducted on several other space station expeditions and was performed during five joint NASA/Russian Mir space station missions. Crewmembers answer a questionnaire and send data back to Earth using the station's Human Research Facility.

Extra Vehicular Activity Radiation Monitoring (EVARM) includes a set of three radiation sensors placed at various locations inside the Destiny lab to help determine radiation levels. On past expeditions, these sensors have been worn in the pockets of U.S. EVA suits during spacewalks outside the station. This radiation research, along with other station radiation studies, will help scientists mitigate this exposure.

Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions (InSPACE) seeks to obtain basic data on magnetorheological fluids -- a new class of "smart materials" that can be used to improve or develop new brake systems, seat suspensions, robotics, clutches, airplane landing gear, and vibration damper systems. The five samples for this experiment on board the station can be processed inside the Microgravity Science Glovebox facility, an enclosed work area that allows the crew to work safely with these fluids.

Pore Formation and Mobility Investigation (PFMI), another experiment performed in the Microgravity Science Glovebox, will melt samples of transparent modeling material to study how bubbles can be trapped in metal or crystal samples during space processing. Eliminating these bubbles could contribute to development of stronger materials. Several samples were processed inside the glovebox during Expedition 5 and several more can be processed during Expedition 7. These samples can be processed several times, allowing investigators to study different phenomena.

Materials 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 began growing during Expedition 6. This experiment was also flown on Expeditions 2, 4 and 5. 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 (SAMS) and **Microgravity Acceleration Measurement System (MAMS)** sensors measure vibrations caused by crew, equipment and other sources that could disturb microgravity experiments.

Pre- and Post-flight Human Physiology: Four continuing experiments will use pre- and post-flight measurements of Expedition 7 crewmembers to study changes in the body caused by exposure to the microgravity environment.

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.

Space Flight-Induced Reactivation of Latent Epstein-Barr Virus (Epstein-Barr) performs tests to study changes in human immune function.

Subregional Bone uses tests to study changes in bone density caused by long-duration spaceflight.

Experiments Requiring Transport by Soyuz or Progress Vehicles

Expedition 7 may include these experiments:

Cell Biotechnology Operations Support Systems (CBOSS) is used to grow three-dimensional tissue that retains the form and function of natural living tissue, a capability that could hold insights in studying human diseases, including various types of cancer, diabetes, heart disease and AIDS. These types of cellular experiments were conducted during Expeditions 3 and 4. A critical step in performing these cell experiments involves mixing fluids. To improve future experiments, a fluid-mixing test will be conducted using the CBOSS fluid samples transported to the station.

Two new fundamental space biology experiments may be transported to the station, if space is available on a Progress. These experiments can operate in standalone mode on battery power, or if space is available, may be transported in the Advanced Separation (ADSEP) payload facility. Both of these experiments will contain dormant living organisms that will be activated at various times on orbit. Most will be preserved before they are returned to Earth.

***C. elegans* Model Specimen in Space (CEMMS)** uses a small cassette from the ADSEP to hold 1-2 millimeter long round worms that are very common as model specimens for medical research. These worms have a short life span, which makes it possible for scientists to study multiple generations during a single space mission.

***S. pneumoniae* Expression of Genes in Space (SPEGIS)** uses two ADSEP cassettes to contain common bacteria often found in healthy humans. Scientists will observe how this organism changes in space and use the information to develop more effective treatments for infections.

Education Payload Operations (EPO) includes three educational activities: Wright Flyer, Paper Plane Activity and Pu’ili Hawaiian Instrument.

Experiments Requiring Upmass

Renal Stone collects urine samples from the crew and tests a possible countermeasure for preventing kidney stone formation (can continue only if resupply hardware is able to be launched).

Zeolite Crystal Growth Furnace (ZCG) is a commercial furnace used to grow larger zeolite crystals in microgravity. The furnace remains on board, and new samples may be delivered to the station on a Russian Progress or Soyuz. These crystals have possible applications in chemical processes, electronic device manufacturing and other uses on Earth.

Experiments Not Requiring Upmass

Earth Science Toward Exploration Research (ESTER), an Earth observation experiment, records images revealing surface changes on Earth, with particular emphasis on ephemeral events, such as hurricanes, plankton blooms and volcanic eruptions. This experiment uses on-board hand-held cameras and the station’s high-quality optical window. Digital images are sent to scientists on the ground.

Destiny Laboratory Facilities

Several research facilities are in place aboard the station to support Expedition 7 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 facility’s hardware is now undergoing repair and should be available for Expedition 7 operations.

The Destiny lab also is outfitted with five **EXPRESS** Racks. EXPRESS, or 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.

On the Internet:

For fact sheets, imagery and more on Expedition 7 experiments and payload operations, click on

http://www.scipoc.msfc.nasa.gov

The Payload Operations Center

The Payload Operations Center (POC) at NASA's Marshall Space Flight Center in Huntsville, Ala., is the world's primary science command post for the International Space Station.

The Payload Operations team is responsible for managing all science research experiments aboard the station. The center also is home for coordination of the mission-planning work of a variety of international sources, all science payload deliveries and retrieval, and payload training and payload safety programs for the station crew and all ground personnel.

State-of-the-art computers and communications equipment deliver round-the-clock reports from science outposts around the planet to systems controllers and science experts staffing numerous consoles beneath the glow of wall-sized video screens. Other computers stream information to and from the space station itself, linking the orbiting research facility with the science command post on Earth.

The International Space Station will accommodate dozens of experiments in fields as diverse as medicine, human life sciences, biotechnology, agriculture, manufacturing, Earth observation, and more.

Managing these science assets -- as well as the time and space required to accommodate experiments and programs from a host of private, commercial, industry and government agencies worldwide -- makes the job of coordinating space station research a critical one.

The POC continues the role Marshall has played in management and operation of NASA's on-orbit science research. In the 1970s, Marshall managed the science program for Skylab, the first American space station. Spacelab -- the international science laboratory carried to orbit in the early '80s by the space shuttle for more than a dozen missions -- was the prototype for Marshall's space station science operations.

The POC is the focal point for incorporating research and experiment requirements from all international partners into an integrated space station payload mission plan.

Four international partner control centers -- in the United States, Japan, Russia and one representing the 11 participating countries of Europe -- prepare independent science plans for the POC. Each partner's plan is based on submissions from its participating universities, science institutes and commercial companies.

The U.S. partner control center incorporates submissions from Italy, Brazil and Canada until those nations develop partner centers of their own. The U.S. center's plan also includes payloads commissioned by NASA from the four Telescience Support Centers in the United States. Each support center is responsible for integrating specific disciplines of study with commercial payload operations. They are:

- Marshall Space Flight Center, managing microgravity (materials sciences, biotechnology research, microgravity research, space product development)
- Ames Research Center in Moffett Field, Calif., managing gravitational biology and ecology (research on plants and animals)
- John Glenn Research Center in Cleveland, managing microgravity (fluids and combustion research)
- Johnson Space Center in Houston, managing human life sciences (physiological and behavioral studies, crew health and performance)

The POC combines inputs from all the partners into a Science Payload Operations master plan, delivered to the Space Station Control Center at Johnson Space Center to be integrated into a weekly work schedule. All necessary resources are then allocated, available time and rack space are determined, and key personnel are assigned to oversee the execution of science experiments and operations in orbit.

Once payload schedules are finalized, the POC oversees delivery of experiments to the space station. These will be constantly in cycle: new payloads will be delivered by the space shuttle, or aboard launch vehicles provided by international partners; completed experiments and samples will be returned to Earth via the shuttle. This dynamic environment provides the true excitement and challenge of science operations aboard the space station.

Housed in a two-story complex at Marshall, the POC is staffed around the clock by three shifts of 13 to 19 systems controllers -- essentially the same number of controllers that staffed the operations center for Spacelab more than a decade earlier.

During space station operations, however, center personnel will routinely manage three to four times the number of experiments as were conducted aboard Spacelab, and also will be responsible for station-wide payload safety, planning, execution and troubleshooting.

The POC's main flight control team, or the "cadre," is headed by the payload operations director, who approves all science plans in coordination with Mission Control at Johnson, the station crew and various outside research facilities.

The payload communications manager, the voice of the POC, coordinates and delivers messages and project data to the station. The systems configuration manager monitors station life support systems. The operations controller oversees station science operations resources such as tools and supplies. The photo and TV operations manager is responsible for station video systems and links to the POC.

The timeline maintenance manager maintains the daily calendar of station work assignments, based on the plan generated at Johnson Space Center, as well as daily status reports from the station crew. The payload rack officer monitors rack integrity, temperature control and the proper working conditions of station experiments.

Additional systems and support controllers routinely monitor payload data systems, provide research and science expertise during experiments, and evaluate and modify timelines and safety procedures as payload schedules are revised.

The international partner control centers include Mission Control Center, Moscow; the Columbus Orbital Facility Control Center, Oberpfaffenhoffen, Germany; Tsukuba Space Center, Tsukuba, Japan; and the Space Station Control Center at Johnson Space Center. NASA’s primary Space Station Control Center, Johnson, is also home to the U.S. partner control center, which prepares the science plan on behalf of the United States, Brazil, Canada and Italy.

For updates to this fact sheet, visit the Marshall News Center at:

http://www.msfc.nasa.gov/news

http://www.scipoc.msfc.nasa.gov

Russian Increment 7 Research

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Commercial	KHT-1 (TBD)	GTS (TBD)	Electronics unit; Antenna assembly with attachment mechanism	Global time system test development	Unattended
Commercial	KHT-2	MPAC&SEED	Equipment for catching microparticles and for exposing MPAC&SEED materials Special returnable cassette Transfer rack with interface	Study of meteoroid and man-made environment and of the outer space factor effects on exposed materials	Unattended
Commercial	KHT-21	STARMAIL	*Nominal hardware:* Nikon D1 Sony PD 150P Laptop TP1 CD-disk	Downlink of messages (private congratulations, wishes) with images and text records from ISS RS board	The first session during ISS-6, ISS-7 crews rotation
Geophysical	ГФИ-1	Relaksatsiya	“Fialka-MB-Kosmos”; Spectrozonal ultraviolet system	Study of chemiluminescent chemical reactions and atmospheric light phenomena that occur during high-velocity interaction between the exhaust products from spacecraft propulsion systems and the Earth atmosphere at orbital altitudes and during the entry of space vehicles into the Earth upper atmosphere	Using OCA
Geophysical	ГФИ-8	Uragan	“Rubinar” telescope *Nominal hardware:* Kodak 460 camera; LIV video system	Experimental verification of the ground and space-based system for predicting natural and man-made disasters, mitigating the damage caused, and facilitating recovery	Using OCA
Geophysical	ГФИ-10	Molniya-SM	ВФС-3М videophotometric system	Study of the electrodynamic interaction between the Earth atmosphere, ionosphere, and magnetosphere associated with thunderstorm or seismic activity using a video photometric system	

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Biomedical	МБИ-1	Sprut-MBI	Sprut-K kit *Nominal Hardware:* Tsentr power supply; Central Post Computer laptop	Study of human bodily fluids during long-duration space flight	US astronaut assistance
Biomedical	МБИ-2	Diurez	Urine receptacle kit; KB-03 container; *Nominal Hardware:* Kriogem-03/1 freezer; Plazma-03 kit; Hematocrit kit;	Study of fluid-electrolyte metabolism and hormonal regulation of blood volume in microgravity	During ISS-7, ISS-8 crews rotation
Biomedical	МБИ-3	Parodont	Saliva-A Parodont kit; Parodont test tube kit; *Nominal Hardware:* Kriogem-03/1 freezer	Study of the effects of space flight on human parodontium tissue	
Biomedical	МБИ-4	Farma	Saliva-F kit	Study of specific pharmacological effects under long-duration space flight conditions	
Biomedical	МБИ-5	Kardio-ODNT	*Nominal Hardware:* Gamma-1M equipment; Chibis countermeasures vacuum suit	Comprehensive study of the cardiac activity and blood circulation primary parameter dynamics	US astronaut assistance
Biomedical	МБИ-7	Biotest	*Nominal Hardware:* Gamma-1M equipment; Hematocrit kit	Biochemical mechanisms of metabolic adaptation to space flight environment	During ISS-7, ISS-8 crews rotation
Biomedical	МБИ-8	Profilaktika	Laktat kit; TEEM-100M gas analyzer; Accusport device; *Nominal Hardware:* Reflotron-4 kit; TVIS treadmill; ВБ-3 cycle ergometer; Set of bungee cords; Computer; Tsentr equipment power supply	Study of the action mechanism and efficacy of various countermeasures aimed at preventing locomotor system disorders in weightlessness	Time required for the experiment should be counted toward physical exercise time. US astronaut assistance

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Biomedical	МБИ-9	Pulse	Pulse set, Pulse kit; *Nominal Hardware:* Computer	Study of the autonomic regulation of the human cardiorespiratory system in weightlessness	
Biomedical	МБИ-11	Gematologia	Erythrocyte kit *Nominal hardware:* Kriogem-03/1 freezer Plazma-03 kit Hematocrit kit	New data obtaining of the outer space factor effects on human blood system in order to extend its diagnostic and prognostic capabilities, studying the mechanism of appearance of changes in hematological values (space anemia, lymphocytosis)	
Biomedical	МБИ-15	Pilot	Right Control Handle Left Control Handle Synchronizer Unit (БС) ULTRABIY-2000 Unit *Nominal hardware:* Laptop №3	Researching for individual features of psychophysiological regulation of cosmonauts' state and crewmembers professional activities during long space flights.	The first session during ISS-6, ISS-7 crews rotation
Biomedical	БИО-2	Biorisk	Biorisk-KM set (4 units) Biorisk-MSV conteiners (6 units) Biorisk-MSN set	Study of space flight impact on microorganisms-substrates systems state related to space technique ecological safety and planetary quarantine problem	Unattended
Biomedical	БИО-5	Rasteniya-2	Lada greenhouse; Water container; *Nominal Hardware:* BVP-70P video camera from the LIV video system; Computer	Study of the space flight effect on the growth and development of higher plants	
Biomedical	БИО-10	Mezhkletochnoe vzaimodeistvie (Intercellular interaction)	Fibroblast-1 kit Aquarius hardware (+37°C during 24 hours) Glovebox КВ-03 container	Study of microgravity influence on cells surface behavior and intercellular interaction	During ISS-6, ISS-7 crews rotation
Biomedical	РБО-1	Prognoz	*Nominal Hardware for the radiation monitoring system:* Р-16 dosimeter; ДБ-8 dosimeters (4 each)	Development of a method for real-time prediction of dose loads on the crews of manned spacecraft	Unattended

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Biomedical	РБО-2	Bradoz	Bradoz kit	Bioradiation dosimetry in space flight	Unattended
Study of Earth natural resources and ecological monitoring	ДЗЗ-2	Diatomea	Nikon F5 camera; DSR-PD1P video camera; Dictophone; Laptop No. 3; Diatomea kit;	Study of the stability of the geographic position and form of the boundaries of the World Ocean biologically active water areas observed by space station crews	
Biotechnology	БТХ-10	Kon'yugatsiya (Conjugation)	Rekomb-K hardware Biocont-T hardware Aquarius hardware (+37°C during 4 hours)	Working through the process of genetic material transmission using bacteria conjugation method	During ISS-6, ISS-7 crews rotation
Biotechnology	БТХ-11	Biodegradatsiya	Bioproby kit Biodegradatsiya-ГО1 kit; Biodegradatsiya-ГО2 kit	Assessment of the initial stages of biodegradation and biodeterioration of the surfaces of structural materials	Assembling – during ISS-6, ISS-7 crews rotation; Disassembling - ISS-7, ISS-8 crews rotation
Biotechnology	БТХ-32	MSC (Mesenchymal stem cells)	Embrion kit with accessories Aquarius hardware (+37oC during 4 hours)	Study of behavior of mesenchymal stem cells from bone marrow under space flight conditions	During ISS-6, ISS-7 crews rotation
Technical Studies	ТЕХ-3	Akustika-M (Phase 1)	Akustika-M kit	Acoustic studies of the conditions of ISS crew voice and audio communications	
Technical Studies	ТЕХ-5 (SDTO 16002-R)	Meteoroid	Nominal micrometeoroid monitoring system: MMK-2 electronics unit; Stationary electrostatic sensors КД1, КД2, КД3, and КД4; Removable electrostatic sensor КДС	Recording of meteoroid and man-made particles on the ISS RS Service Module exterior surface	Unattended
Technical Studies	ТЕХ-13 (SDTO 12001-R)	Tenzor	*Nominal Hardware:* ISS RS motion control and navigation system (СУДН) sensors; Star tracker; SM TV systems	Determination of ISS dynamic characteristics	Unattended

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Technical Studies	TEX-14 (SDTO 12002-R)	Vektor-T	*Nominal Hardware:* ISS RS СУДН sensors; ISS RS orbit radio tracking [PKO] system; Satellite navigation; equipment [ACH] system GPS/GLONASS satellite systems	Study of a high-precision system for ISS motion prediction	Unattended
Technical Studies	TEX-15 (SDTO 13002-R)	Izgib	*Nominal Hardware:* ISS RS onboard measurement system (СБИ) accelerometers; ISS RS motion control and navigation system GIVUS (ГИВУС СУДН)	Study of the relationship between the onboard systems operating modes and ISS flight conditions	Unattended
Technical Studies	TEX-16 (SDTO 12003-R)	Privyazka	*Nominal Hardware:* ISS RS СУДН SM-8M sensors and magnetometer	High-precision orientation of science instruments in space with consideration given to ISS hull deformation	Unattended
Technical Studies	TEX-17 (SDTO 16001-R)	Iskazhenie	*Nominal Hardware:* ISS RS СУДН SM-8M sensors and magnetometer	Determination and analysis of magnetic disturbance on the ISS	Unattended
Technical Studies	TEX-20	Plazmennyi Kristall	*Plazmennyi kristall* equipment Telescience flight equipment	Study of the plasma-dust crystals and fluids under microgravity	US astronaut assistance
Technical Studies	TEX-22 (SDTO 13001-R)	Identifikatsiya	Nominal Hardware: ISS RS СБИ accelerometers	Identification of disturbance sources when the microgravity conditions on the ISS are disrupted	Unattended
Technical Studies	TEX-25	Skorpion	Skorpion equipment	Development, testing, and verification of a multi-functional instrument to monitor the science experiment conditions inside ISS pressurized compartments	
Study of cosmic rays	ИКЛ-1В	Platan	Platan-M equipment	Search for low-energy heavy nuclei of solar and galactic origin	Unattended
Space energy systems	ПКЭ-1В	Kromka	Tray with materials to be exposed	Study of the dynamics of contamination from liquid-fuel thruster jets during burns, and verification of the efficacy of devices designed to protect the ISS exterior surfaces from contamination	Unattended

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Pre/Post Flight		Motor control	Electromiograph, control unit, tensometric pedal, miotometer «Miotonus», «GAZE» equipment	Study of hypo-gravitational ataxia syndrome;	Pre-flight data collection is on L-60 and L-30 days; Post-flight: on 1, 3, 7, 11 days Total time for all 4 tests is 2.5 hours
Pre/Post Flight		MION		Impact of microgravity on muscular characteristics.	Pre-flight biopsy (60 min) on L-60, and L-30 days; Post-flight: 3-5 days
Pre/Post Flight		Izokinez	Isokinetic ergometer «LIDO», electromiograph, reflotron-4, cardiac reader, scarifier	Microgravity impact on voluntary muscular contraction; human motor system re-adaptation to gravitation.	Pre-flight: L-30; Post-flight: 3-5, 7-9, 14-16, and 70 days. 1.5 hours for one session
Pre/Post Flight		Tendometria	Universal electrostimulator (ЭСУ-1);bio-potential amplifier (УБП-1-02); tensometric amplifier; osciloscop with memory; oscillograph	Microgravity impact on induced muscular contraction; long duration space flight impact on muscular and peripheral nervous apparatus	Pre-flight: L-30; Post-flight: 3, 11, 21, 70 days; 1.5 hours for one session
Pre/Post Flight		Ravnovesie	"Ravnovesie" ("”Equilibrium") equipment	Sensory and motor mechanisms in vertical pose control after long duration exposure to microgravity.	Pre-flight: L-60, L-30 days; Post-flight: 3, 7, 11 days, and if necessary on 42 or 70 days; Sessions: pre-flight data collection 2x45 min, post-flight: 3x45 min
Pre/Post Flight		Sensory adaptation	IBM PC, Pentium 11 with 32-bit s/w for Windows API Microsoft.	Countermeasures and correction of adaptation to space syndrome and of motion sickness.	Pre-flight: L-30, L-10; Post-flight: 1, 4, and 8 days, then up to 14 days if necessary; 45 min for one session.
Pre/Post Flight		Lokomotsii	Bi-lateral video filming, tensometry, miography, pose metric equipment.	Kinematic and dynamic locomotion characteristics prior and after space flight.	Pre-flight: L-20-30 days; Post-flight: 1, 5, and 20 days; 45 min for one session.

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Pre/Post Flight		Peregruzki	Medical monitoring nominal equipment: Alfa-06, Mir 3A7 used during descent phase.	G-forces on Soyuz and recommendations for anti-g-force countermeasures development	In-flight: 60 min; instructions and questionnaire familiarization: 15 min; Post-flight: cosmonauts checkup – 5 min; debrief and questionnaire – 30 min for each cosmonauts.
Pre/Post Flight		Polymorphism	No hardware is used in-flight	Genotype parameters related to human individual tolerance to space flight conditions.	Pre-flight: blood samples, questionnaire, anthropometrical and anthroposcopic measurements – on early stages if possible; blood samples could be taken during preflight medical checkups on L-60, L-30 days. 30 min for one session.
Pre/Post Flight		Thermographia	Thermograph «IRTIS-200»	Human peripheral thermoregulation during re-adaptation after long duration space flight.	Pre-flight: 2 times (BDC); Post-flight: daily for the first 3 days, then each 1-2 days until the end of rehabilitation period. 30 min for one session.
Pre/Post Flight		Khemoluminomer	Khemoluminomer «ХЛ-003»	Space flight factors impact on free-radical oxidation level, as well as changes in human organism during re-adaptation to Earth conditions.	Pre-flight: 2 times; Post-flight: blood samples are taken on 1(2), 5(7) days; 15-20 min for one session.

Experiments

Cellular Biotechnology Operations Support System-Fluid Dynamics Investigation (CBOSS-FDI)

Project Manager:
John Love, Cellular Biotechnology Program, Biological Systems Office, NASA Johnson Space Center, Houston

Principal Investigators:
Joshua Zimmerberg, National Institutes of Health, Bethesda, Md.
J. Milburn Jessup, Georgetown University, Washington

Overview

The near-weightless (microgravity) environment of orbital spaceflight affords unprecedented opportunities in biomedical research and biotechnology. Adherent mammalian cells cultured on Earth, under the persistent influence of unit gravity characteristic of terrestrial ecosystems, typically proliferate into a two-dimensional monolayer array. In contrast, previous space shuttle and Mir experiments demonstrated that adherent mammalian cells, cultured *in vitro* in space, grow into three-dimensional tissue assemblies that are similar to their natural counterparts in some of their molecular, structural, and functional characteristics.

For more than a decade the goal of the NASA Cellular Biotechnology Program at Johnson Space Center has been to develop and utilize microgravity technology to support the scientific community's research in cell biology and tissue engineering. Previous Cellular Biotechnology investigations included the longest duration continuous cell culture in space (Mir NASA 3) and mapping of the genetic signatures of cells in microgravity (STS-90, STS-106). In addition, the program developed the NASA rotating bioreactor, which is employed for ground-based propagation of cells in a suspended state with minimal stress.

The Cellular Biotechnology Operations Support System (CBOSS) is a stationary bioreactor system developed by the Cellular Biotechnology Program for the cultivation of cells aboard the International Space Station (ISS). The CBOSS payload complement consists of the following hardware elements: Cell cultures are incubated in the Biotechnology Specimen Temperature Controller (BSTC), which contains an isothermal chamber with carbon dioxide concentration control. The Gas Supply Module (GSM) provides pressurized gases to the incubator unit, while the Biotechnology Refrigerator (BTR) serves for cold storage of labile experiment components. The Biotechnology Cell Science Stowage (BCSS) is comprised of caddies containing experiment supplies and cryodewars for the transport of cryopreserved cells for on-orbit inoculation and the return of frozen biospecimen samples. Cellular Biotechnology Program experiments conducted in the ISS with this system during Expeditions 3, 4, and 5 involved human kidney cells, human colon cancer cells, rat adrenal gland tumor cells, ovarian cancer cells, mouse blood cancer cells, human immune system tissue, and human liver cells. The experiments represented the work of principal investigators from various institutions and industry.

Typically CBOSS is used to provide a controlled environment for the cultivation of cells into healthy, functional three-dimensional tissues. A critical step in performing these experiments involves complete mixing of cells and fluids during various tissue culture procedures. The CBOSS - Fluid Dynamics Investigation (FDI) is comprised of a series of experiments aimed at optimizing CBOSS operations while contributing to the characterization of the CBOSS stationary bioreactor vessel (the Tissue Culture Module or TCM) in terms of fluid dynamics in microgravity. These experiments will also validate the most efficient fluid mixing techniques on orbit, which are essential to conduct cellular research in that environment. In addition, some experiments may examine microgravity biotechnology processes with applications to future cell science research in space.

Background/Flight History

The first cellular biotechnology experiments flew aboard the space shuttle in the mid-1990s, such as in the STS-70 and STS-85 missions. Long-duration cellular biotechnology experiments were conducted in the Biotechnology System Facility on the Russian space station Mir from 1996 through 1998. Cellular biotechnology experiments were also performed on board the International Space Station during Expeditions 3, 4, and 5.

In the future, the Biotechnology Facility (BTF) is expected to maximize utilization of the ISS microgravity environment by enhancing cellular biotechnology research capabilities and increasing scientific output. Because of its continuous operation, BTF research will generate a critical threshold of data that the cell science community may use to advance research in human tissue engineering and gravitational biology, which could have significant impact in science and medicine.

Benefits

Bioreactor cell culture in microgravity permits *in vitro* cultivation of cells into tissue constructs of size and quality not possible on Earth. Such a capability provides unprecedented opportunities for research in human diseases, including various types of cancer, diabetes, heart disease, and AIDS. This approach to tissue engineering and modeling has potential applications in areas such as tissue transplantation, drug testing, and the production of biopharmacological therapeutic agents, and may yield insight into the fundamental effects of gravity on biological systems.

More information on NASA biotechnology research and other Expedition 7 experiments is available at:

http://microgravity.msfc.nasa.gov
http://scipoc.msfc.nasa.gov

Chromosomal Aberrations in Blood Lymphocytes of Astronauts

Principal Investigator: Günter Obe, Ph.D., University of Essen, Germany

Research Objectives

Cosmic radiation is a major risk factor in human spaceflight. This study will assess the mutagenic impact of ionizing radiations in crewmembers by analyzing chromosomal aberrations in blood lymphocytes, from pre- and post-flight blood samples.

Previous investigations studying chromosomal aberrations were conducted using conventional block stained Giemsa preparations. A disadvantage of this method is that only unstable aberrations, which are of less biological significance, can be detected.

In the past few years, new methods of chromosome recognition were developed, such as fluorescence *in situ* hybridization (FISH), multi-color FISH (mFISH), and multi-color banding FISH (mBAND), which enable researchers to mark all chromosome pairs and allow detection of almost all aberration types in the genome, including stable and unstable ones. These new methods will provide new information about the effects of space radiation on humans.

Flight Operations Summary

The investigation requires 10-15 ml of venous blood to be collected preflight and postflight from each participating crewmember. Preflight, the blood draw is scheduled together with the L-10 physical; the postflight blood draw is performed within a week of landing.

Flight History/Background

Dr. Obe and his investigator team conducted chromosomal aberration studies on 18 astronauts and cosmonauts flown on board the space shuttle and the Mir Space Station between 1993 and 1997.

The study will include blood samples from 20 astronauts: 10 short-duration shuttle crewmembers, and 10 long-duration Expedition crewmembers, living on board the International Space Station. The investigation is part of the experiment complement of ISS Increment 6 through 10, and part of the experiment complement for the STS-115, STS-116 and STS-117 shuttle flights.

Benefits

The expected results will provide a better knowledge of the genetic risk of astronauts in space and in consequence can help to optimize radiation shielding. The data will allow calculation of aberration frequencies expected during deep-space missions.

Crew Earth Observations (CEO)

Principal Investigator: Kamlesh Lulla, NASA Johnson Space Center, Houston

Payload Developer: Sue Runco, NASA Johnson Space Center, Houston

Overview

By allowing photographs to be taken from space, the Crew Earth Observations (CEO) experiment provides people on Earth with data needed to better understand our planet. The photographs—taken by crewmembers using handheld cameras—record observable Earth surface changes over a period of time, as well as more fleeting events such as storms, floods, fires and volcanic eruptions.

Orbiting 220 miles or more above the Earth, the International Space Station offers an ideal vantage point for crewmembers to continue observational efforts that began in the early 1960s when space crews first photographed the Earth. This experiment on the space station began during Expedition 1, STS-97 (ISS Assembly Flight 4A), and is planned to continue through the life of the space station.

History/Background

This experiment has flown on every crewed NASA space mission beginning with Gemini in 1961. Since that time, astronauts have photographed the Earth, observing the world's geography and documenting events such as hurricanes and other natural phenomena. Over the years, space crews also have documented human impacts on Earth -- city growth, agricultural expansion and reservoir construction. The CEO experiment aboard the ISS will build on that knowledge.

Benefits

Today, images of the world from 10, 20 or 30 years ago provide valuable insight into Earth processes and the effects of human developments. Photographic images taken by space crews serve as both primary data on the state of the Earth and as secondary data to be combined with images from other satellites in orbit. Worldwide more than one million users log on to the Astronaut Earth Photography database each year. Through their photography of the Earth, space station crewmembers will build on the time series of imagery started 35 years ago -- ensuring this record of Earth remains unbroken.

Earth Knowledge Acquired by Middle School Students

Experiment Location on ISS: The U.S. Laboratory Window

Principal Investigator: Dr. Sally Ride, University of California, San Diego

Project Manager: Brion J. Au, NASA Johnson Space Center, Houston

Overview

EarthKAM (Earth Knowledge Acquired by Middle school students) is a NASA education payload that enables students to photograph and examine Earth from a space crew's perspective.

Using the Internet, working through the EarthKAM Mission Operations Center located at the University of California at San Diego (UCSD), middle school students direct a camera mounted in the Window Observational Research Facility (WORF) located in the station's Destiny science module to capture high-resolution digital images of features around the globe. Students use these images to enhance their study of geography, geology, botany, earth science, and to identify changes occurring on the Earth's surface, all from the unique vantage point of space. Utilizing the high-speed digital communications capabilities of the ISS, the images are downlinked in near real-time and posted on the EarthKAM web site for the public and participating classrooms around the world to view.

Experiment Operations

Funded by NASA, EarthKAM is operated by UCSD and NASA field centers. It is an educational payload that allows middle school students to conduct research from the International Space Station as it orbits 220 miles above the Earth. Using the tools of modern technology – computers, the Internet and a digital camera mounted at the space station's laboratory window – EarthKAM students are able to take stunning, high-quality digital photographs of our planet.

The EarthKAM camera is periodically set up in the International Space Station, typically for a four-day data gathering session. Beginning with the Expedition 2 crew, in May 2001, the payload is scheduled for operations that coincide with the traditional school year. When the ISS crew mounts the camera at the window, the payload requires no further crew interaction for nominal operations.

EarthKAM photographs are taken by remote operation from the ground. When the middle school students target the images of terrestrial features they choose to acquire, they submit the image request to the Mission Operation Center at UCSD. Image requests are collected and compiled into a “Camera Control File” for each ISS orbit that the payload is operational. This camera control file is then uplinked to a Station Support Computer aboard the space station that controls when the digital camera captures the image. The Station Support Computer activates the camera at the specified times and immediately transfers these images to a file server, storing them until they are downlinked to Earth. With all systems performing nominally, the entire cycle takes about five hours.

EarthKAM is monitored from console positions at the Tele-Science Support Center (Mission Control) at Johnson Space Center in Houston, and operated from the EarthKAM Mission Operations Center at the UCSD. Because EarthKAM is classified as a payload, its space station operations are coordinated through the Payload Operations Integration Center (POIC) at NASA’s Marshall Space Flight Center in Huntsville, Ala. EarthKAM is a long-term payload that will operate on the space station for several Increments.

Flight History/Background

In 1994, Dr. Sally Ride, a physics professor and former NASA astronaut, started what is now EarthKAM with the goal of integrating education with the space program. EarthKAM has flown on five shuttle flights. Its first flight was aboard space shuttle Atlantis in 1996, with three participating schools taking a total of 325 photographs. Since 1996, EarthKAM students have taken thousands of photographs of Earth.

EarthKAM invites schools from all around the world to take advantage of this educational opportunity. Previous participants include schools from the United States, Japan, Germany and France.

Benefits

EarthKAM brings education out of textbooks and into real life. By integrating Earth images with inquiry-based learning, EarthKAM offers students and educators the opportunity to participate in a space mission, develop teamwork, communication and problem-solving skills.

Long after the photographs are taken, students and educators continue to reap the benefits of EarthKAM. Educators are able to use the images alongside suggested curriculum plans for studies in physics, computers, geography, math, earth science, botany, biology, art, history, cultural studies and more.

More information on EarthKAM and the International Space Station can be found at:

www.earthkam.ucsd.edu
www.spaceflight.nasa.gov

Education Payload Operations (EPO)

Overview

Education Payload Operations (EPO) is an education payload designed to support the NASA Mission to inspire the next generation of explorers. Generally, these activities will focus on demonstrating science, mathematics, technology, engineering or geography principles. Video recording of the demonstrations and/or still photographic documentation of a crewmember operating EPO hardware while on orbit will achieve EPO goals and objectives. Overall goal for every expedition is to facilitate education opportunities that use the unique environment of human spaceflight.

EP0-8

Through an agreement with NASA Headquarters, five museums and science centers from around the country provided the hardware and procedures for EPO-8. These organizations form the Museum Aerospace Education Alliance (MAEA). Members of the group are the Bishop Museum, Honolulu, Hawaii; St. Louis Science Center, St. Louis, Mo.; Denver Museum of Nature and Science, Denver, Colo.; Maryland Science Center, Baltimore, Md.; Center of Science and Industry (COSI), Columbus and Toledo, Ohio.

The overall objectives of the payload are to help students discover how familiar objects may perform differently in the microgravity environment on board the ISS. Students will also learn ways that humans must adapt to use these familiar objects in space.

During Increment 7, three education payload items will be demonstrated. Additional EPO-8 hardware will be used during subsequent increments.

Payload

The payload for Increment 7 consists of three items: Wright Flyer, Paper Airplane Activity, and Pu’ili Hawaiian Instrument. Two crewmembers are required to perform and videotape educational demonstrations using these items.

Wright Flyer

Sixth-grade students at Orono Middle School, Orono, Maine, constructed the scale model of the Wright Flyer. As part of Centennial of Flight activities in 2003, NASA plans to provide educators around the country with plans to construct a similar scale model Wright Flyer. Students will have the opportunity to use the plans to build a model out of balsa wood and tissue paper.

On orbit, the Wright Flyer will be used to enhance discussions about the basic elements of flight, including lift, thrust, and control. In addition, the flyer will be used in a comparison and contrast of the concepts of flight and orbit. Crewmembers will use rubber band-powered propellers to fly the model on orbit. Discussions and demonstrations will be videotaped for use in future educational products.

Paper Airplane Activity

The paper airplane is a universal toy that can be used to assist students in understanding basic principles of flight, including drag, lift, and propulsion. Crewmembers will use paper airplanes to examine Newton's Third Law of Motion and flight characteristics in a microgravity environment. Students will use similar paper airplanes on Earth to compare and contrast flight performance.

Using a paper airplane with wingtips, crewmembers will launch it with an elastic band propulsion system. The plane will be launched three times using a different stretch (8", 10", and 12") of the elastic band. Flight characteristics and the length of the flight path will be noted after each flight. A paper airplane without wingtips will also be flown three times. Crewmembers will adjust the position of wingtips for each flight. Length of flight path and flight characteristics will be noted after each flight. Crewmembers will also choose one of the airplanes to compare its performance using a short or long stretch of the elastic band. Flight characteristics and length of flight path will be noted after each flight. Demonstrations will be videotaped for future educational products.

Pu'ili

The Pu'ili is a bamboo musical instrument unique to Hawaii. A piece of bamboo is split into narrow strips that vibrate when the instrument is tapped against a surface. The Pu'ili can be played individually or as a pair. Traditionally, dancers use the Pu'ili to tap against the floor, their shoulder or arm, the shoulder or arm of a partner, or against another Pu'ili.

On orbit, crewmembers will be asked to play the Pu'ili to determine if the vibrations and sound produced are similar to vibrations and sound produced on Earth. Crewmembers will also demonstrate the effect of tapping the Pu'ili against stable and floating crewmembers. Demonstrations will be videotaped for use in future educational products.

Benefits

At MAEA locations, students and educators will participate in lessons and activities related to payload operations. Video of on-orbit demonstrations will be distributed to member organizations for use in lessons and also for future use in museum exhibits. Students at these locations will also have the opportunity to participate in live in-flight education programs during which the crew will demonstrate and answer questions about the payload. Video and information will also be distributed to NASA's education programs for use in educational resources, multimedia products and Web sites.

Spaceflight-Induced Reactivation of Latent Epstein-Barr Virus (Epstein-Barr)

Principal Investigator: Dr. Alan D.T. Barrett, University of Texas Medical Branch, Galveston, Texas

Overview

As shuttle mission duration increases, the potential development of infectious illness in crewmembers during flight also increases. This is especially true with latent viruses, and infections caused by these viruses are not mitigated by a quarantine period. An example of a latent infection is Epstein-Barr virus (EBV), of which about 90 percent of the adult population is infected. Stress and other acute/chronic events reactivate this virus from latency, which results in increased virus replication. This investigation will assess the immune system function using blood and urine samples collected before and after spaceflight.

Flight Operations Summary

Blood and 24-hour urine samples will be collected from crewmembers both pre-flight and post-flight. Data collections will occur on or around L-180, L-60, L-10 and L-3 for pre-flight and R+0, R+3, R+14 and R+180 for post-flight. The L-180, L-60 and L-10 data collections pre-flight and the R+0, R+3, R+180 data collections post-flight will be coordinated to data share with MedOps if possible.

Flight History/Background

Flown as a Detailed Supplementary Objective on STS-108.

Benefits

This research will provide new insights into the mechanisms of EBV reactivation during spaceflight. In addition, this research may provide important information that may lead to a better understanding of latent herpes virus reactivation in humans living on Earth. Potential applications of this research also include the development of rapid and sensitive diagnostic methods for identifying station crewmembers who may be at increased risk of illness.

Researchers must understand how the body's immune system adjusts to long stays in microgravity, both for continuing space station missions and for any future long-duration missions within our own solar system.

For more information on any Expedition 7 science experiment, visit the Web at:

www.scipoc.msfc.nasa.gov
http://spaceflight.nasa.gov/station/science/index.html

Earth Science Toward Exploration Research (ESTER)

Principal Investigator: Kamlesh Lulla, Ph.D., NASA-Johnson Space Center, Houston

Overview

Earth Science Toward Exploration Research (ESTER) is a continuation of handheld photography of weekly uplinked selected sites to record observable Earth surface changes and image ephemeral events such as hurricanes, volcanic eruptions and plankton blooms.

Orbiting 220 miles or more above the Earth, the International Space Station offers an ideal vantage point for crewmembers to continue observational efforts that began in the early 1960s when space crews first photographed the Earth. Every ISS crew will conduct this experiment. The imagery collected will be added into a database of human observations of Earth from space that spans more than 30 years.

Flight History/Background

This experiment has flown on every crewed NASA space mission beginning with Gemini in 1961. Since that time, astronauts have photographed the Earth, observing the world’s geography and documenting events such as hurricanes and other natural phenomena. Over the years, space crews also have documented human impacts on Earth -- city growth, agricultural expansion and reservoir construction. The ESTER experiment aboard the ISS will build on that knowledge.

Benefits

Today, images of the world from 10, 20 or 30 years ago provide valuable insight into Earth processes and the effects of human developments. Photographic images taken by space crews serve as both primary data on the state of the Earth and as secondary data to be combined with images from other satellites in orbit. Worldwide more than one million users log on to the Astronaut Earth Photography database each year. Through their photography of the Earth, space station crewmembers will build on the time series of imagery started 35 years ago -- ensuring this record of Earth remains unbroken.

Additional Information

For more information visit:

http://www.earth.jsc.nasa.gov/
http://www.eol.jsc.nasa.gov/

A Study of Radiation Doses Experienced by Astronauts in EVA (EVARM)

Principal Investigator: Ian Thomson, Thomson & Nielsen Electronics, Ltd., Ottawa, Canada

NASA Project Manager: Michelle Kamman, Johnson Space Center, Houston, Texas

CSA Project Manager: Ron Wilkinson, Canadian Space Agency, Ottawa, Canada

Overview

Space travel can be dangerous for humans because of the large amounts of radiation to which they can be adversely exposed. This concern is particularly true for spacewalkers who venture outside the shielded walls of spacecraft protected by only a spacesuit. Construction and maintenance of the space station will require hundreds of hours of space-walking time over the life of the program. Very high doses of radiation can kill cells and damage tissue, leading to cancer, cataracts and even injury to the central nervous system.

Monitoring devices have been flown on many space shuttle missions and Russia's space station Mir to learn more about how to protect crews from the effects of radiation. But these devices were not specifically designed to study radiation dosages encountered during spacewalks. The space station crewmembers in the EVA Radiation Monitoring (EVARM) study will be the first to measure radiation dosage encountered by the eyes, internal organs and skin during specific spacewalks, relating the measurements to the type of activity, location and other factors. Thus far Expeditions 4 thru 6 have taken part in the EVARM experiment. In addition, the EVARM dosimeters are used to gather extensive background radiation inside the station.

Flight History/Background

Scientists have been measuring radiation in the Earth's upper atmosphere and beyond since balloon launches in the 1940s. Radiation experiments have been part of many human space missions, measuring radiation exposure to spacecraft and space travelers. The Canadian Space Agency and the principal investigator for the experiment flew a similar radiation monitoring experiment on three missions aboard Russia's space station Mir in the mid-1990s. That experiment used passive dosimeters that were read after they were returned to Earth. The dosimeters were placed in the cosmonauts' sleeping quarters but were not carried on spacewalks.

Benefits

EVARM will help scientists better understand and predict radiation exposure encountered by astronauts during spacewalks and compare that to specific activities. For instance, scientists believe that spacewalkers who work close to the massive structure of the station will receive a lower radiation dosage than spacewalkers working at the end of the shuttle or station robot arms. The results of the investigation may offer ways to reduce exposure to radiation during spacewalks. In addition, this space experiment will help further the technology used for radiation sensors on Earth.

More information on the EVARM and other Expedition 7 experiments is available at:

http://www.scipoc.msfc.nasa.gov/factchron.html
http://www.thomson-elec.com

Crewmember and Crew-Ground Interactions During ISS Missions (Interactions)

Principal Investigator: Dr. Nick Kanas, Veterans Administration Medical Center, San Francisco, Calif.

Overview

Spaceflight places humans in an environment unlike any found on Earth. The nearly complete absence of gravity is perhaps the most prominent obstacle that astronauts face. It requires a significant modification of living and working habits by the astronauts. Not only do they have to learn to adapt to the way they perform routine operations, such as eating, moving and operating equipment, but they must also learn to adjust to the internal changes that their bodies experience and to the psychosocial stressors that result from working under isolated and confined conditions.

The Interactions experiment seeks to identify and characterize important interpersonal and cultural factors that may impact the performance of the crew and ground support personnel during International Space Station missions. The study will examine — as it did in similar experiments on the Russian space station Mir— issues involving tension, cohesion and leadership roles in the crew in orbit and in the ground support crews. The study will have both the crewmembers and ground control personnel complete a standard questionnaire. The survey will be conducted by the crews of Expeditions 2 through 9.

History/Background

NASA performed similar “interaction” studies during the Shuttle/Mir Program in the late 1990s. That experiment examined the crewmembers’ and mission control personnel’s perception of tension, cohesion, leadership and the crew-ground relationship.

Benefits

Because interpersonal relationships can affect crewmembers in the complicated day-to-day activities they must complete, studies such as this are important to crew health and safety on future long-duration space missions. Findings from this study will allow researchers to develop actions and methods to reduce negative changes in behavior and reverse gradual decreases in mood and interpersonal interactions during the ISS missions—and even longer missions, such as an expedition to Mars.

Acceleration Measurements Aboard the International Space Station

Acceleration Measurement Discipline Program Manager: David Francisco, NASA Glenn Research Center, Cleveland, Ohio

Acceleration Measurement Discipline Scientist: Richard DeLombard, NASA Glenn Research Center

Overview

Providing a quiescent microgravity, or low-gravity, environment for fundamental scientific research is one of the major goals of the International Space Station Program. However, tiny disturbances aboard the space station mimic the effects of gravity, and scientists need to understand, track and measure these potential disruptions. Two accelerometer systems developed by the Glenn Research Center will be used aboard the station. Operation of these systems began with Expedition 2 and will continue throughout the life of the station.

The Space Acceleration Measurement System II (SAMS-II) will measure accelerations caused by vehicle, crew and equipment disturbances. To complement the SAMS-II measurements, the Microgravity Acceleration Measurement System (MAMS) will record accelerations caused by the aerodynamic drag created as the station moves through space. It also will measure accelerations created as the vehicle rotates and vents water. These small, quasi-steady accelerations occur in the frequency range below 1 Hertz.

Using data from both accelerometer systems, the Principal Investigator Microgravity Services project at the Glenn Research Center will help investigators characterize accelerations that influence their station experiments. The acceleration data will be available to researchers during the mission via the World Wide Web. It will be updated nominally every two minutes as new data is transmitted from the station to Glenn's Telescience Support Center. A catalog of acceleration sources also will be maintained.

Space Acceleration Measurement System II (SAMS-II)

Project Manager: Richard DeLombard, NASA Glenn Research Center, Cleveland, Ohio

The Space Acceleration Measurement System II (SAMS-II) began operations on ISS Mission 6A. It measures vibrations that affect nearby experiments. SAMS-II uses small remote triaxial sensor systems that are placed directly next to experiments throughout the laboratory module. In EXPRESS (Expedite the Processing of Experiments to the Space Station) Racks 1 and 4, it will remain on board the station permanently.

As the sensors measure accelerations electronically, they transmit the measurements to the interim control unit located in an EXPRESS rack drawer. SAMS-II is designed to record accelerations for the lifetime of the space station. As larger, facility-size experiments fill entire space station racks in the future, the interim control unit will be replaced with a more sophisticated computer control unit. It will allow on-board data analysis and direct dissemination of data to the investigators' telescience centers located at university laboratories and other locations around the world. Special sensors are being designed to support future experiments that will be mounted on the exterior of the space station.

Microgravity Acceleration Measurement System (MAMS)

Project Manager: Richard DeLombard, NASA Glenn Research Center, Cleveland, Ohio

The Microgravity Acceleration Measurement System (MAMS) measures accelerations that affect the entire space station, including experiments inside the laboratory. It fits in a double middeck locker, in the U.S. Laboratory Destiny in EXPRESS Rack No.1. It was preinstalled in the rack, which was placed in the laboratory during Expedition 2, ISS Flight 6A. It will remain on board the station permanently.

The MAMS accelerometer sensor is a spare flight sensor from the Orbital Acceleration Research Experiment program that characterizes similar accelerations aboard the space shuttle. Unlike SAMS-II, MAMS measures more subtle accelerations that only affect certain types of experiments, such as crystal growth. Therefore MAMS will not have to be on all the time. During early expeditions, MAMS will require a minimum operational period of 48 or 96 hours to characterize the performance of the sensors and collect baseline data. During later increments, MAMS can be activated for time periods sufficient to satisfy payload or space station requirements for acceleration data.

MAMS is commanded on and off from the Telescience Support Center at Glenn. MAMS is activated when the crew switches on the power switch for the EXPRESS Rack No. 1, and the MAMS computer is powered up from the ground control center. When MAMS is powered on, data is sent to Glenn Research Center's Telescience Support Center where it is processed and displayed on the Principal Investigator Microgravity Services Space Station Web site to be viewed by investigators.

History/Background

The Space Acceleration Measurement System (SAMS) – on which SAMS-II is based -- first flew in June 1991 and has flown on nearly every major microgravity science mission. SAMS was used for four years aboard the Russian space station Mir where it collected data to support science experiments.

Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions (InSPACE)

Payload Name: Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions (InSPACE)

Mission: Hardware was delivered on Expedition 5, ISS Flight UF2, Space Shuttle Flight STS-111; Samples were delivered on Flight 11A, STS-113; experiment operations began in December 2002 during Expedition 6. The hardware and samples are scheduled to be returned to Earth on STS-116, ISS Flight 12A.1.

Payload Location: Microgravity Science Glovebox (MSG) inside the U.S. Destiny Laboratory Module

Glovebox Investigator: Dr. Alice Gast, Massachusetts Institute of Technology, Cambridge, with support from graduate students.

Project Scientist: Dr. Juan Agui, NASA Glenn Research Center, Cleveland, Ohio

Project Manager: Jack Lekan, NASA Glenn Research Center

Payload Developer: NASA Glenn Research Center

Overview

This fluid physics experiment will be performed in the Microgravity Science Glovebox, which has an enclosed workspace that provides power, computer interfaces and other resources for experiment operations. It is also equipped with glove ports that enable the crew access to operate the experiment. The purpose of this experiment is to obtain basic data on magnetorheological (MR) fluids -- a new class of "smart materials" or controllable fluids. Due to the quiet, rapid-response interface that they provide between mechanical components and electronic controls, MR fluids can be used to improve or develop new brake systems, seat suspensions, robotics, clutches, airplane landing gear and vibration damping systems.

In the low-gravity environment created as the International Space Station orbits Earth, it is possible to study the way small magnetic particles interact in these fluids. On Earth, gravity causes sedimentation, which means heavier, or larger groups of particles sink while lighter ones remain suspended. On board the space station, the small magnetic particles will form three-dimensional microstructures that are unaffected by sedimentation. A pulsed magnetic field will be used to mimic the forces applied to these fluids in real applications, such as in active feedback systems. A pulsed field also tends to produce intricate, thick structures with different properties than structures produced by a constant magnetic field. These structures can provide stiffness or rigidity to the fluid.

Benefits

This experiment will provide fundamental data on the way the particles and aggregate structure in the fluid respond to an external magnetic field that is repeatedly switched on and off. When these fluids are used in braking systems and for other electromechanical devices, they are often exposed to such fields that affect their operations.

The data from the experiment can be used to test theoretical models of the structure of suspensions of small particles in applied fields. By understanding the complex properties of these fluids and learning the way the particles interact, scientists can develop more sophisticated methods for controlling these fluids and using them in a variety of devices.

Then, scientists can improve the types of fluids used in existing braking and vibration damping systems. They may even be able to design new robotics systems and use the fluids for novel applications such as seismic dampers to make high-rise structures more resistant to earthquakes.

Materials on International Space Station Experiment (MISSE)

Overview

The Materials on International Space Station Experiment (MISSE) Project is a NASA/Langley Research Center-managed cooperative endeavor to fly materials and other types of space exposure experiments on the space station. The objective is to develop early, low-cost, non-intrusive opportunities to conduct critical space exposure tests of space materials and components planned for use on future spacecraft.

The Boeing Co., the Air Force Research Laboratory and Lewis Research Center are participants with Langley in the project.

History/Background

Flown to the space station in 2001, the MISSE experiments were the first externally mounted experiments conducted on the ISS. The experiments are in four Passive Experiment Containers (PECs) that were initially developed and used for an experiment on Mir in 1996 during the Shuttle-Mir Program. The PECs were transported to Mir on STS-76. After an 18-month exposure in space, they were retrieved on STS-86.

PECs are suitcase-like containers for transporting experiments via the space shuttle to and from an orbiting spacecraft. Once on orbit and clamped to the host spacecraft, the PECs are opened and serve as racks to expose experiments to the space environment.

The first two MISSE PECs were transported to the ISS on STS-105 (ISS Assembly Flight 7A.1) in August 2001. Samples deployed on 7A.1 will be retrieved and replaced with new samples on STS-114 (ULF-1).

Examples of tests to be performed in MISSE include: new generations of solar cells with longer expected lifetimes to power communications satellites; advanced optical components planned for future Earth observational satellites; new, longer-lasting coatings that better control heat absorption and emissions and thereby the temperature of satellites; new concepts for lightweight shields to protect crews from energetic cosmic rays found in interplanetary space; and the effects of micrometeoroid impacts on materials planned for use in the development of ultra-light membrane structures for solar sails, large inflatable mirrors and lenses.

Benefits

New affordable materials will enable the development of advanced reusable launch systems and advanced spacecraft systems.

Pore Formation and Mobility Investigation (PFMI)

Experiment Name: Pore Formation and Mobility During Controlled Directional Solidification in a Microgravity Environment Investigation (PFMI)

Mission: Begun on Expedition 5, ISS Flight UF2, STS-111 Space Shuttle Flight; samples will be returned on 12A.1 (STS-116).

Payload Location: Microgravity Science Glovebox inside U.S. Destiny Laboratory Module

Principal Investigator: Dr. Richard Grugel, NASA Marshall Space Flight Center, Huntsville, Ala.

Project Scientist: Dr. Martin Volz, NASA Marshall Space Flight Center

Project Manager: Linda B. Jeter, NASA Marshall Space Flight Center

Project Engineer: Paul Luz, NASA Marshall Space Flight Center

Payload Developer: NASA Marshall Space Flight Center

Overview

On Earth when scientists melt metals, bubbles that form in the molten material can rise to the surface, pop and disappear. In microgravity, in the near-weightless environment created as the International Space Station orbits the Earth, the lighter bubbles do not rise and disappear. Prior space experiments have shown that bubbles often become trapped in the final metal or crystal sample. In the solid, these bubbles, or porosity, are defects that diminish both the material's strength and usefulness.

The Pore Formation and Mobility Investigation will melt samples of a transparent modeling material, succinonitrile and succinonitrile water mixtures. Investigators will be able to observe how bubbles form in the samples and study their movements and interactions.

Benefits

This investigation gives scientists an opportunity to observe bubble dynamics in a sample being processed in a way similar to industrial methods. The intent of the experiment is to gain insights that will improve solidification processing in a microgravity environment. The generated data also may promote better understanding of processes on Earth.

For more information on this experiment, the Microgravity Science Glovebox and other space station investigations visit:

www.scipoc.msfc.nasa.gov
http://www.microgravity.nasa.gov
www.spaceflight.nasa.gov
http://www.spaceresearch.nasa.gov

Promoting Sensorimotor Response Generalizability: A Countermeasure to Mitigate Locomotor Dysfunction After Long-duration Spaceflight (MOBILITY)

Principal Investigator: Dr. Jacob Bloomberg, Johnson Space Center, Houston

Overview

Astronauts returning from spaceflight can experience difficulty walking, as the brain must readapt to programming body movements in a gravity environment. The MOBILITY experiment will use tests taken before and after a long-duration spaceflight to determine whether a specific training regimen using the station's treadmill can help astronauts recover more quickly when they return to Earth. Specifically, do astronauts who use this unique treadmill workout in space readjust more quickly when once again exposed to the effects of gravity?

Two tests, the Treadmill Locomotion Test and the Functional Mobility Test, will be performed by each participating crewmember both before and after their mission (pre- and post-flight). The pre-flight data will be collected on or around six months, four months and 60 days before launch. Post-flight data will be collected on the day of landing and on post-landing days 1, 3, 6, 12, 24 and 48.

Benefits

How quickly an astronaut's body readjusts to gravity after a long-duration spaceflight is very important, both for space station missions and for any future long-duration missions within our own solar system.

Researchers are continuing to search for the best exercise program that will keep astronauts fit while in space and ensure a quick return to their pre-flight physical conditions once they re-encounter the effects of Earth's gravity.

For more information on any Expedition 7 science experiment, visit the Web at:

www.scipoc.msfc.nasa.gov
http://spaceflight.nasa.gov/station/science/index.html

Protein Crystal Growth (PCG) Single-locker Thermal Enclosure System (STES) Housing the Protein Crystallization Apparatus for Microgravity (PCAM)

Missions: Expedition 7. The STES on orbit went up on 11A (STS-113) and will return on ULF1 (STS-114).

Experiment Location on ISS: U.S. Lab EXPRESS Rack No. 4

Project Manager: Clark Darty, NASA's Marshall Space Flight Center, Huntsville, Ala.

Overview

Structural biological experiments conducted in the Single-locker Thermal Enclosure System (STES) may provide a basis for understanding the function and structure of macromolecules. The scope of biological macromolecules includes proteins, polysaccharides and other carbohydrates, lipids and nucleic acids of biological origin, or those expressed in plant, animal, fungal or bacteria systems.

The fundamental goal for growing biological macromolecular crystals is to determine their three-dimensional structure in order to understand the biological processes in which they are involved. Scientists select macromolecules, crystallize them, and analyze the atomic details -- often by using X-ray crystallography. By sending an intense X-ray beam through a crystal, scientists try to determine the three-dimensional atomic structure of the macromolecule. Understanding these structures may impact the studies of medicine, agriculture, the environment and other biosciences. Every chemical reaction essential to life depends on the function of these compounds.

Microgravity – the near weightlessness condition created inside a spacecraft as it orbits the Earth – offers an environment which sometimes allows the growth of macromolecular structures – crystals – that show greater detail when exposed to X-ray diffraction (the pattern showing the structure of crystals when exposed to X-ray beams) than those crystals grown on Earth.

The International Space Station provides for longer-duration experiments in a more research-friendly, acceleration-free (no change in the rate of speed, or velocity, of the spacecraft that could affect the experiments), dedicated laboratory, than provided by the space shuttle. Mission ULF-1 will be a continuation of similar structural biology experiments to characterize the use of the space station for this type of research.

Benefits

With science being performed on the International Space Station, scientists are no longer restricted to relatively short-duration flights to conduct structural biology experiments. This research will enable the more accurate mapping of the three-dimensional structure of macromolecules. Once the structure of a particular macromolecule is known, it may become much easier to determine how these compounds function. Every chemical reaction essential to life depends on the function of these compounds.

Additional Information/Photos

Additional information on structural biology crystal growth in microgravity is available at:

http://crystal.nasa.gov
http://crystal.nasa.gov/technical/pcam.html
http://www.microgravity.nasa.gov/
http://www.scipoc.msfc.nasa.gov
http://www.spaceflight.nasa.gov
http://spaceresearch.nasa.gov/
http://mix.msfc.nasa.gov/ABSTRACTS/MSFC-9807368.html

Renal Stone Risk During Spaceflight: Assessment and Countermeasure Validation

Principal Investigator: Dr. Peggy A. Whitson, Johnson Space Center, Houston

Overview

Exposure to microgravity results in a number of physiological changes in the human body, including alterations in kidney function, fluid redistribution, bone loss and muscle atrophy. Previous data have shown that human exposure to microgravity increases the risk of kidney stone development during and immediately after spaceflight. Potassium citrate, a proven Earth-based therapy to minimize calcium-containing kidney stone development, will be tested during Expeditions 4 through 12 as a countermeasure to reduce the risk of kidney stone formation. This study also will assess the kidney stone-forming potential in humans based on mission duration, and determine how long after spaceflight the increased risk exists.

Beginning three days before launch and continuing through 14 days after landing, each crewmember will either ingest two potassium citrate pills or two placebos daily with the last meal of the day. Urine will be collected for later study over several 24-hour periods before, during and after flight. Food, fluid, exercise and medications also will be monitored before and during the urine collection period to assess any environmental influences other than microgravity.

(Renal Stone is a candidate experiment on a Russian vehicle on this increment).

Benefits

The formation of kidney stones could have severe health consequences for ISS crewmembers and negatively impact the success of a mission. This study will provide a better understanding of the risk factors associated with kidney stone development both during and after a spaceflight, as well as test the effectiveness of potassium citrate as a countermeasure to reduce this risk. Understanding how the disease may form in otherwise healthy crewmembers under varying environmental conditions also may provide insight into kidney stone-forming diseases on Earth.

For more information on Expedition 7 science experiments, visit the Web at:

scipoc.msfc.nasa.gov
http://spaceflight.nasa.gov/station/science/index.html

Sub-regional Assessment of Bone Loss in the Axial Skeleton in Long-term Spaceflight (Sub-regional Bone)

Principal Investigator: Dr. Thomas F. Lang, U. of California, San Francisco

Project Manager: David K. Baumann, NASA Johnson Space Center, Houston

Overview

As demonstrated by Skylab and Russian space station Mir missions, bone loss is an established medical risk in long-duration spaceflight. There is little information about the extent to which lost bone is recovered after spaceflight. This experiment is designed to measure bone loss and recovery experienced by crewmembers on the International Space Station.

Expeditions 2 through 8 are scheduled to participate in this study.

Experiment Operations

Bone loss in the spine and hip will be determined by comparing pre-flight and post-flight measurements of crewmembers' spine and hipbones using Quantitative Computed Tomography -- a three-dimensional technique that examines the inner and outer portions of a bone separately. It can determine if the loss was localized in a small sub-region of the bone or over a larger area.

Bone recovery will be assessed by comparing tomography data taken before and after flight and one year later. Results will be compared with ultrasound measurements and Dual X-Ray Absorptiometry taken at the same times. The measurements will include Dual X-Ray Absorptiometry of the spine, hip and heel, and ultrasound of the heel. To determine how the bone loss in space compares to the range of bone density in a normal adult population, crewmember bone measurements in the spine and hip will be compared to measurements of 120 healthy people of different genders and races between ages 35 and 45.

Benefits

This study will provide the first detailed information on the distribution of spaceflight-related bone loss between the trabecular and cortical compartments of the axial skeleton, as well as the extent to which lost bone is recovered in the year following return. The study will provide information that could be used in determining the frequency of crewmember assignments to long-duration missions, and for studying their health in older age. It also may be of use in the design of exercise or pharmacological countermeasures to prevent bone loss. Finally, comparison of bone mineral density in the hip and spine in the control population will help to improve understanding of the prevalence of osteoporosis between different race and gender subgroups.

Zeolite Crystal Growth Furnace

Principal Investigator: Dr. Al Sacco, Jr., Center for Advanced Microgravity Materials Processing, Northeastern University, Boston, Mass.

CSC Manager: Jeneene Sams, NASA Space Product Development Program, Marshall Space Flight Center, Huntsville, Ala.

Overview

Zeolites have a rigid crystalline structure with a network of interconnected tunnels and cages, similar to a honeycomb. While a sponge needs to be squeezed to release water, zeolites give up their contents when they are heated or under reduced pressure. Zeolites have the ability to absorb liquids and gases such as petroleum or hydrogen but remain as hard as a rock. Zeolites form the backbone of the chemical processes industry, and virtually all the world’s gasoline is produced or upgraded using zeolites. Industry wants to improve zeolite crystals so that more gasoline can be produced from a barrel of oil, making the industry more efficient and reducing America’s dependence on foreign oil.

(Zeolite Crystal Growth is a candidate experiment on a Russian vehicle on this increment).

Operations

The Zeolite Crystal Growth Furnace is designed for relatively low-temperature growth of crystals in solutions. The furnace was delivered to the International Space Station during STS-108/UF-1 in December 2001. The crew installed the hardware into a double middeck locker in EXPRESS Rack 2. The hardware was checked out during UF-1. The shuttle delivered the first experimental samples during STS-110/8A in March 2002. When the autoclaves containing the sample solutions arrived, the crew unstowed them and loaded them into the furnace. At the end of the specified processing time, the crew powered down the furnace, unloaded the autoclaves containing the crystals and stowed them for return to Earth. Four batches of samples have been processed aboard the ISS. New samples are scheduled to be delivered to the station for subsequent processing.

Flight History/Background

A simpler version of this experiment has flown successfully on three space shuttle missions: STS-50 in 1992, STS-57 in 1993 and STS-73 in1995. During these earlier flights, zeolite crystals grown in space were larger and of better quality than crystals grown in a similar facility on the ground. In addition, experiments in zeolite crystal growth have been conducted on the ISS. Thus far four batches of samples have been processed; three batches have been returned to scientists on Earth and are being analyzed.

Benefits

Research with zeolites has the potential to reduce our dependence on foreign oil and the pollution associated with producing gasoline and other petroleum products. In the future, zeolites may even be used for storing new fuels that are cheaper and cleaner. Hydrogen is one candidate fuel that might be stored and transported safely using zeolites. Since hydrogen is the most abundant element in the universe, and it’s pollution-free, it is an ideal fuel. Scientists are seeking a solution to the efficient storage of hydrogen, and zeolites and zeo-type materials are being tested as possible storage media.

Media Assistance

NASA Television Transmission

NASA Television is available through the AMC-2 satellite system which is located on Transponder 9C, at 85 degrees west longitude, frequency 3880.0 MHz, audio 6.8 MHz.

The schedule for television transmissions from the orbiter and for mission briefings will be available during the mission at Kennedy Space Center, Fla.; Marshall Space Flight Center, Huntsville, Ala.; Dryden Flight Research Center, Edwards, Calif.; Johnson Space Center, Houston, Texas; and NASA Headquarters, Washington, DC. The television schedule will be updated to reflect changes dictated by mission operations.

Status Reports

Status reports on countdown and mission progress, on-orbit activities and landing operations will be produced by the appropriate NASA news center.

Briefings

A mission press briefing schedule will be issued before launch. During the mission, status briefings by a flight director or mission operations representative and when appropriate, representatives from the payload team, will occur at least once each day. The updated NASA television schedule will indicate when mission briefings are planned.

Internet Information

Information is available through several sources on the Internet. The primary source for mission information is the NASA Human Space Flight Web, part of the World Wide Web. This site contains information on the crew and its mission and will be updated regularly with status reports, photos and video clips throughout the flight. The NASA Shuttle Web's address is:

http://spaceflight.nasa.gov

General information on NASA and its programs is available through the NASA Home Page and the NASA Public Affairs Home Page:

http://www.nasa.gov

or

http://www.nasa.gov/newsinfo/index.html

Shuttle Pre-Launch Status Reports

http://www-pao.ksc.nasa.gov/kscpao/status/stsstat/current.htm

Information on other current NASA activities is available through the Today@NASA page:

http://www.nasa.gov/today/index.html

The NASA TV schedule is available from the NTV Home Page:

http://spaceflight.nasa.gov/realdata/nasatv/schedule.html

Resources for educators can be found at the following address:

http://education.nasa.gov

Access by CompuServe

Users with CompuServe accounts can access NASA press releases by typing "GO NASA" (no quotes) and making a selection from the categories offered.

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