NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE SHUTTLE MISSION STS-79

PRESS KIT
SEPTEMBER 1996

Fourth Shuttle-Mir Docking Mission

STS-79 INSIGNIA

STS079-S-001 -- *STS-79 is the fourth in a series of NASA docking missions to the Russian Mir space station, leading up to the construction and operation of the International Space Station (ISS). As the first flight of the Spacehab Double Module, STS-79 encompasses research, test and evaluation of ISS, as well as logistics, resupply for the Mir space station. STS-79 is also the first NASA-Mir American crew member exchange mission, with John E. Blaha (NASA-Mir-3) replacing Shannon W. Lucid (NASA-Mir-2) aboard the Mir Space Station. The lettering of their names either up or down denotes transport up to the Mir Space Station or return to Earth on STS-79. The insignia is in the shape of the Space Shuttle's airlock hatch, symbolizing the gateway to international cooperation in space. The insignia illustrates the historic cooperation between the United States and Russia in space. With the flags of Russia and the United States as a backdrop, the handshake of Extravehicular Mobility Unit (EMU)* - *suited crewmembers symbolizes mission teamwork, not only of the crewmembers but also the teamwork between both countries' space personnel in science, engineering, medicine and logistics.*

The NASA insignia design for space shuttle flights is reserved for use by the astronauts and for other official use as the NASA Administrator may authorize. Public availability has been approved only in the form of illustrations by the various news media. When and if there is any change in this policy, which we do not anticipate, it will be publicly announced.

PHOTO CREDIT: NASA or National Aeronautics and Space Administration.

NEWS MEDIA CONTACTS

For Information on the Space Shuttle

Ed Campion Johnson Space Center Houston, TX	Policy/Management	202/358-1778
Rob Navias Johnson Space Center Houston, TX	Mission Operations Astronauts	713/483-5111
Bruce Buckingham Kennedy Space Center, FL	Launch Processing KSC Landing Information	407/867-2468
June Malone Marshall Space Flight Center Huntsville, AL	External Tank Shuttle Propulsion	205/544-0034
Cam Martin Dryden Flight Research Center Edwards, CA	DFRC Landing Information	805/258-3448

For Information on STS-79 Experiments & Activities

Mike Braukus NASA Headquarters Washington, DC	202/358-1979
James Cast NASA Headquarters Washington, DC	205/544-6535

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ASTRONAUT EXCHANGE HIGHLIGHTS SHUTTLE MISSION STS-79

A rendezvous and docking with the Russian Mir Space Station and the exchange of astronauts -- including the holder of the world record for longest space flight ever by a U.S. astronaut -- will highlight the flight of Space Shuttle Atlantis on Mission STS-79.

This is the fourth of nine planned missions to Mir between 1995 and 1998 and the first exchange of astronauts. Astronaut Shannon W. Lucid, who has been on Mir since late March, will be replaced on Mir by astronaut John E. Blaha. Blaha will spend more than four months on Mir. He will return to Earth on Space Shuttle Mission STS-81, scheduled for launch in January 1997.

STS-79 is the second Shuttle-Mir mission to carry a SPACEHAB module on board, and the first to carry a double module. The forward portion of the double module will house experiments conducted by the crew before, during and after Atlantis is docked to the Russian space station. The aft portion of the double module primarily houses the logistics equipment to be transferred to the Russian space station. Logistics include food, clothing, experiment supplies, and spare equipment for Mir.

The STS-79 crew will be commanded by William F. Readdy, who will be making his third Shuttle flight. The pilot, Terrence W. Wilcutt, will be making his second. There are four mission specialists assigned to this mission. Jay Apt, serving as Mission Specialist-1, is making his fourth Shuttle flight. Also making his fourth flight and serving as Mission Specialist-2 is Thomas D. Akers. Carl E. Walz, flying on his third flight, is serving as Mission Specialist-3. Blaha, a veteran of four missions, will serve as Mission Specialist-4 from launch to docking. After the on-orbit crew exchange, Lucid will serve as Mission Specialist-4 through landing.

Launch of Atlantis is currently targeted for September 14, 1996 at approximately 5:39 a.m. EDT from Kennedy Space Center's Launch Complex 39-A. The actual launch time may vary by a few minutes based on calculations of Mir's precise location in space at the time of liftoff due to Shuttle rendezvous phasing requirements. The available launch period, or "window" to launch Atlantis, is approximately 10 minutes on September 14.

The STS-79 mission is scheduled to last 9 days, 5 hours. An on-time launch on September 14 would set up Atlantis and the STS-79 crew for a return to Kennedy Space Center on September 23 at approximately 10:48 a.m. EDT.

Atlantis' rendezvous and docking with the Mir actually begins with the precisely timed launch setting the Orbiter on a course for rendezvous with the Mir station. Over the next three days, periodic firings of Atlantis' small thruster engines will gradually bring the Shuttle to closer proximity to Mir.

The STS-79 mission is part of the NASA/Mir program which is now into the Phase 1B portion, consisting of nine Shuttle- Mir dockings and seven long-duration flights of U.S. astronauts aboard the Russian space station between early 1996 and late 1998. The U.S. astronauts will launch and land on a shuttle and serve as a Mir crew member while the Mir cosmonauts use their traditional Soyuz vehicle for launch and landing. This series of missions will expand U.S. research on Mir by providing resupply materials for experiments to be performed aboard the station as well as returning experimental samples and data to Earth.

The current Mir 21 mission began when the cosmonaut crew launched on February 21, 1996, in a Soyuz vehicle and docked with the Mir two days later. Dr. Shannon Lucid joined the Mir 21 crew with the March 1996, docking of STS-76. Lucid will complete her stay on the Mir and return with the STS-79 crew. On August 19, the Mir 21 crew was joined by the crew of Mir 22. The Mir 22 crew will remain on Mir after the Mir 21 crew returns to Earth in September.

The STS-79 mission also will include several experiments in the fields of advanced technology, Earth sciences, fundamental biology, human life sciences, microgravity, and space sciences. Data also will supply insight for the planning and development of the International Space Station, Earth-based sciences of human and biological processes, and the advancement of commercial technology.

STS-79 will mark the largest transfer of logistics to and from the Mir space station to date. During the docked phase, 4,600 pounds of water, food, and other resupply items along with research hardware and equipment will be transferred from Atlantis to the Mir. Atlantis will return to Earth with 2,200 pounds of Russian, European Space Agency, and U.S. science samples and hardware. STS-79 will mark the first transfer of powered scientific apparatus to Mir as five different experiments are powered down on the Shuttle and rapidly transferred to Mir.

STS-79 will be the 17th flight of Atlantis and the 79th mission flown since the start of the Space Shuttle program in April 1981.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS.)

MEDIA SERVICES INFORMATION

NASA Television Transmission

NASA Television is available through the Spacenet-2 satellite system. Spacenet-2 is located on Transponder 5, at 69 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, FL; Marshall Space Flight Center, Huntsville, AL; Dryden Flight Research Center, Edwards, CA; Johnson Space Center, Houston, TX; and NASA Headquarters, Washington, DC. The television schedule will be updated to reflect changes dictated by mission operations.

Television schedules also may be obtained by calling COMSTOR at 713/483-5817. COMSTOR is a computer data base service requiring the use of a telephone modem. A voice update of the television schedule is provided daily at noon Eastern time.

Status Reports

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

Briefings

A mission press briefing schedule will be issued prior to 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 on STS-79 is available through several sources on the Internet. The primary source for mission information is the NASA Shuttle Web, part of the World Wide Web. This site contains information on the crew and their mission and will be regularly updated with status reports, photos and video clips throughout the flight. The NASA Shuttle Web's address is:

http://shuttle.nasa.gov

If that address is busy or unavailable, Shuttle information is available through the Office of Space Flight Home Page:

http://www.osf.hq.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.gsfc.nasa.gov/hqpao/hqpao_home.html

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

http://www.hq.nasa.gov/office/pao/NewsRoom/today.html

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

http://www.hq.nasa.gov/office/pao/ntv.html

Status reports, TV schedules and other information are also available from the NASA Headquarters FTP (File Transfer Protocol) server, ftp.hq.nasa.gov/pub/pao. Log in as anonymous and go to the directory /pub/pao. Users should log on with the user name "anonymous" (no quotes), then enter their E-mail address as the password. Within the /pub/pao directory there will be a "readme.txt" file explaining the directory structure.

Pre-launch status reports from KSC are found under **ftp.hq.nasa.gov/pub/pao/statrpt/ksc**
Mission status reports can be found under **ftp.hq.nasa.gov/pub/pao/statrpt/jsc**
Daily TV schedules can be found under **ftp.hq.nasa.gov/pub/pao/statrpt/jsc/tvsked**.

NASA's Spacelink, a resource for educators, also provides mission information via the Internet. The system fully supports the following Internet services:

- World Wide Web: **http://spacelink.msfc.nasa.gov**
- Gopher: **spacelink.msfc.nasa.gov**
- Anonymous FTP: **spacelink.msfc.nasa.gov**
- Telnet: **spacelink.msfc.nasa.gov**

Spacelink's dial-up modem line is 205-895-0028.

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.

QUICK-LOOK FACTS

Launch Date/Site:	September 14, 1996/KSC Launch Pad 39-A
Launch Time:	Approximately 5:39 a.m. EDT
Launch Window:	Approximately 10 minutes
Orbiter:	Atlantis (OV-104), 17th flight
Orbit Altitude/Inclination:	160 nautical miles, 51.6 degrees (approx. 207 n.m. for docking)
Mission Duration:	9 days, 5 hours
Landing Date:	September 23, 1996
Landing Time:	Approximately 10:48 a.m. EDT
Primary Landing Site:	Kennedy Space Center, FL
Abort Landing Sites:	Return to Launch Site - KSC Transoceanic Abort Sites: Zaragoza, Spain Moron, Spain Ben Guerir, Morocco Abort-Once Around - Kennedy Space Center
Crew:	Bill Readdy, Commander (CDR) Terry Wilcutt, Pilot (PLT) Jay Apt, Mission Specialist 1 (MS 1) Tom Akers, Mission Specialist 2 (MS 2) Carl Walz, Mission Specialist 3 (MS 3) John Blaha, Mission Specialist 4 (MS 4) Launch-Docking Shannon Lucid, Mission Specialist 4 (MS 4) Docking-Landing
Mir 22 Crew:	Valery Korzun, Commander (CDR) Alexander Kaleri, Flight Engineer (FE) Shannon Lucid, Cosmonaut-Researcher (through docking)
EVA Crew (if required):	Carl Walz (EV 1), Jay Apt (EV 2)
Cargo Bay Payloads:	Orbiter Docking System Spacehab Double Module
In-Cabin Payloads:	IMAX Risk Mitigation Experiments SAREX Middeck Science Hardware

CREW RESPONSIBILITIES

Payloads	Prime	Backup
Orbiter Docking System	Walz	Akers
Spacehab	Apt	Walz
EVA	Walz (EV-1)	Apt (EV-2)
Intravehicular Crewmember	Akers	------
SAREX	Apt	Walz, Readdy
Rendezvous	Readdy	Wilcutt
Cargo Transfers	Akers	Wilcutt
DTOs	Akers	Walz
DSOs	Akers	Walz
Earth Observations	Apt	Walz
ARIS (RME 1313)	Walz	Apt
Biotechnology System (BTS)	Apt	Walz
Real-time Radiation Monitoring Device	Walz	Apt
Extreme Temperature Translation Furnace Apt	Walz	
Mechanics of Granular Materials	Walz	Apt
Refrigerators and Freezers	Apt	Walz
IMAX	Walz	Akers
Mir Photo Survey	Walz	Apt
Orbiter Space Vision System	Walz	-------
Russian Language	Blaha	Readdy

DEVELOPMENTAL TEST OBJECTIVES (DTOs), DETAILED SUPPLEMENTARY OBJECTIVES (DSOs) RISK MITIGATION EXPERIMENTS (RMEs)

RME 1301:	Mated Shuttle and Mir Structural Dynamics Test
RME 1302:	Mir Electric Field Characterization Test 1 and 2
RME 1303:	Shuttle/Mir Experiment Kit Transport
RME 1310:	Shuttle/Mir Alignment Stability Experiment
RME 1312:	Intra-Vehicular Radiation Environment Measurement Experiment
RME 1313:	Active Rack Isolation System (ARIS)
RME 1319:	Inventory Management System

DTO 255:	Wraparound DAP Flight Test Verification
DTO 301D:	Ascent Structural Capability Evaluation
DTO 307D:	Entry Structural Capability
DTO 312:	ET TPS Performance
DTO 700-5:	Trajectory Control Sensor
DTO 700-10:	Orbiter Space Vision System Flight Video Taping
DTO 700-14:	Single String Global Positioning System
DTO 805:	Crosswind Landing Performance
DTO 837:	Vernier RCS Reboost Demonstration
DTO 840:	Hand-Held Lidar Procedures
DTO 1118:	Photographic and Video Survey of Mir Space Station

DSO 901:	Documentary Television
DSO 902:	Documentary Motion Picture Photography
DSO 903:	Documentary Still Photography

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MISSION SUMMARY TIMELINE

Flight Day 1
Launch/Ascent
OMS-2 Burn
Spacehab Activation
Rendezvous Burn
CPCG Activation

Flight Day 2
Spacehab Operations
ARIS Setup and Checkout
Rendezvous Tool Checkout
Orbiter Docking System Checkout
Rendezvous Burns
ETTF Activation
SAMS Activation

Flight Day 3
Atlantis/Mir Docking
Hatch Opening/Welcoming Ceremony/Gift Exchange
Soyuz Seatliner Transfer
Blaha/Lucid Crew Transfer
Logistics Transfer Preparations

Flight Day 4
Blaha/Lucid Crew Transfer
Logistics Transfers
Spacehab Operations
BTS Sterile Sample

BTS Transfer to Mir
Cold Stowage Science Sample Transfer from Mir
CGBA Transfer to Mir
MEFC Operations

Flight Day 5
Spacehab Operations
Logistics Transfers
IMAX Operations
ARIS Operations
MGM Operations
Orlan Suit Transfer from Mir
STES Transfer to Mir
ETTF Operations

Flight Day 6
IMAX Operations
Spacehab Operations
Logistics Transfers
ARIS Operations
ETTF Operations

Flight Day 7
IMAX Operations
Joint Crew News Conference
Final Logistics Transfers
Farewell Ceremony
Hatch Closure
ARIS Deactivation

Flight Day 8
Atlantis/Mir Undocking
Separation Burn
IMAX Operations

ETTF Operations
MEFC Operations
SAMS Operations

Flight Day 9
Flight Control System Checkout
Reaction Control System Hot-Fire
Deorbit Preparation Briefing
Vernier Reaction Control System Boost Test for Second HST
Servicing Mission
ARIS Stowage
Spacehab Stowage
Cabin Stow
Recumbent Seat Setup for Lucid
ETTF Deactivation
SAMS Deactivation

Flight Day 10
Spacehab Deactivation
Deorbit Prep
Deorbit Burn
KSC Landing

NOTE Exact times of events for STS-79 and other Phase 1 missions will not be determined until after launch because of the rendezvous requirements needed for Atlantis to reach the Mir Space Station.

PAYLOAD AND VEHICLE WEIGHTS

	Pounds
Orbiter (Columbia) empty and 3 SSMEs	173,249
Shuttle System at SRB Ignition	4,510,959
Orbiter Weight at Landing with Cargo	249,352
Spacehab Module	15,555
Orbiter Docking System	4,016
SAREX	27

SHUTTLE ABORT MODES

Space Shuttle launch abort philosophy aims toward safe and intact recovery of the flight crew, Orbiter and its payload. Abort modes for STS-79 include:

- Abort-To-Orbit (ATO) -- Partial loss of main engine thrust late enough to permit reaching a minimal 105-nautical mile orbit with the orbital maneuvering system engines.

- Abort-Once-Around (AOA) -- Earlier main engine shutdown with the capability to allow one orbit of the Earth before landing at the Kennedy Space Center, FL.

- Transoceanic Abort Landing (TAL) -- Loss of one or more main engines midway through powered flight would force a landing at either Ben Guerir, Morocco; or Moron, Spain.

- Return-To-Launch-Site (RTLS) -- Early shutdown of one or more engines, and without enough energy to reach a TAL site, would result in a pitch around and thrust back toward Kennedy until within gliding distance of the Shuttle Landing Facility.

MIR RENDEZVOUS AND DOCKING

Atlantis' rendezvous and docking with the Russian Space Station Mir actually begins with the precisely timed launch of the shuttle on a course for the Mir, and, over the next two days, periodic small engine firings that will gradually bring Atlantis to a point eight nautical miles behind Mir on docking day, the starting point for a final approach to the station.

Mir Rendezvous -- Flight Day 3

About two hours before the scheduled docking time on Flight Day Three of the mission, Atlantis will reach a point about eight nautical miles behind the Mir Space Station and conduct a Terminal Phase Initiation burn, beginning the final phase of the rendezvous. Atlantis will close the final eight nautical miles to Mir during the next orbit. As Atlantis approaches, the shuttle's rendezvous radar system will begin tracking Mir and providing range and closing rate information to Atlantis. Atlantis' crew also will begin air-to-air communications with the Mir crew using a VHF radio.

As Atlantis reaches close proximity to Mir, the Trajectory Control Sensor, a laser ranging device mounted in the payload bay, will supplement the shuttle's onboard navigation information by supplying additional data on the range and closing rate. As Atlantis closes in on the Mir, the shuttle will have the opportunity for four small successive engine firings to fine-tune its approach using its onboard navigation information. Identical to the three prior Mir dockings, Atlantis will aim for a point directly below Mir, along the Earth radius vector (R-Bar), an imaginary line drawn between the Mir center of gravity and the center of Earth. Approaching along the R-Bar, from directly underneath the Mir, allows natural forces to brake Atlantis' approach more so than would occur along a standard shuttle approach from directly in front of Mir. During this approach, the crew will begin using a handheld laser ranging device to supplement distance and closing rate measurements made by shuttle navigational equipment.

The manual phase of the rendezvous will begin just as Atlantis reaches a point about a half-mile below Mir. Commander Bill Readdy will fly the shuttle using the aft flight deck controls as Atlantis begins moving up toward Mir. Because of the approach from underneath Mir, Readdy will have to perform very few braking firings. However, if such firings are required, the shuttle's jets will be used in a mode called "Low-Z," a technique that uses slightly offset jets on Atlantis' nose and tail to slow the spacecraft rather than firing jets pointed directly at Mir. This technique avoids contamination of the space station and its solar arrays by exhaust from the shuttle steering jets.

Readdy will center Atlantis' docking mechanism with the Docking Module mechanism on Mir, continually refining this alignment as he approaches within 300 feet of the station. At a distance of about 30 feet from docking, Readdy will stop Atlantis and stationkeep momentarily to adjust the docking mechanism alignment, if necessary. At that time, a final go or no-go decision to proceed with the docking will be made by flight control teams in both Houston and Moscow. When Atlantis proceeds with docking, the shuttle crew will use ship-to-ship communications with Mir to inform the Mir crew of the shuttle's status and to keep them updated on major events, including confirmation of contact, capture and the conclusion of damping. Damping, the halt of any relative motion between the two spacecraft after docking, is performed by shock absorber-type springs within the docking device. Mission Specialist Carl Walz will oversee the operation of the Orbiter Docking System aboard Atlantis.

Undocking, Separation and Mir Fly-Around

Once Atlantis is ready to undock from Mir, the initial separation will be performed by springs that will gently push the shuttle away from the docking module. Both the Mir and Atlantis will be in a mode called "free drift" during the undocking, a mode that has the steering jets of each spacecraft shut off to avoid any inadvertent firings.

Once the docking mechanism's springs have pushed Atlantis away to a distance of about two feet from Mir, where the docking devices will be clear of one another, Readdy will turn Atlantis' steering jets back on. Immediately, he will fire the shuttle's jets in the Low-Z mode to begin slowly moving away from Mir.

Atlantis will continue away from Mir to a distance of about 600 feet, where Readdy and Pilot Terry Wilcutt will begin a flyaround of the station. Atlantis will circle Mir twice before firing its jets again to depart. During this flyaround the crew will perform documentary photography of the Mir space station, including the newly arrived "Priroda" science module, using still and video cameras as well as the IMAX large format movie camera.

Logistics Transfers

STS-79 will mark the first flight with a double Spacehab module, increasing the amount of logistics the shuttle can carry to the Mir space station. In addition to the U.S. astronaut exchange, the STS-79 crew will transfer over 4,600 pounds of food, water, clothing, personal hygiene supplies, replacement Mir hardware components, and U.S. science experiments and supplies to the Mir, including five powered experiments (experiments requiring electrical power on the shuttle and immediately on Mir.)

The Atlantis crew will simultaneously receive over 2,100 pounds of Russian hardware, empty food and water containers, ESA return science items, and U.S. science hardware, data and specimens from Shannon Lucid's science gathering activities during her stay on Mir.

This is the largest shuttle transfer of logistics to and from the Mir to date.

SHUTTLE/MIR SCIENCE

The NASA/Mir program is now into the Phase 1B portion, which consists of nine Shuttle-Mir dockings and seven long- duration flights of U.S. astronauts aboard the Russian space station between early 1996 and late 1998. The U.S. astronauts will launch and land on a shuttle and serve as a Mir crewmember for flight durations ranging from 127 to 158 days, while the Mir cosmonauts stay approximately 180 days and use their traditional Soyuz vehicle for launch and landing. This series of missions will expand U.S. research on Mir by providing resupply materials for experiments to be performed aboard Mir as well as returning experimental samples and data to Earth.

The Mir 21 mission began when the crew launched on February 21, 1996, in a Soyuz vehicle and docked with the Mir two days later. Dr. Shannon Lucid joined the Mir 21 crew with the March 24, 1996, docking of STS-76. The return of STS-79 will conclude a mission of experiments in the fields of advanced technology, Earth sciences, fundamental biology, human life sciences, microgravity, and space sciences. Data also will supply insight for the planning and development of the ISS, Earth-based sciences of human and biological processes, and the advancement of commercial technology.

Science Overview

As scientists learn more about the effects of the space environment, they continue to develop questions from the fields of human life sciences, behavioral sciences, fundamental biology, biotechnology, material sciences, and spacecraft structural and environmental dynamics. Valuable scientific information regarding these subjects will be returned from the Shuttle Mir Science Program disciplines of advanced technology, Earth sciences, fundamental biology, human life sciences, International Space Station, microgravity and space sciences. These investigations will provide valuable information about space flight and long term exposure to the microgravity environment. This knowledge will assist researchers in developing future space stations, science programs, procedures for those facilities, and advance the knowledge base of these areas to the benefit of all people on Earth.

The commercial initiated research and technology from the advanced technology discipline will evaluate new technologies and techniques using the Mir space station as a test bed. An increased understanding of the characteristics of superconductors, protein crystal growth, and the development of biological and chemical systems through fluid processing in reduced gravity can lead to an enhanced technological base for implementation on the International Space Station and commercial processing here on Earth.

Earth sciences research in ocean biochemistry, land surface hydrology, meteorology, and atmospheric physics and chemistry also will be performed. Observation and documentation of transient natural and human-induced changes will be accomplished with the use of passive microwave radiometers, a visible region spectrometer, a side-looking radar, and hand-held photography. Earth orbit will allow for documentation of atmospheric conditions, ecological and unpredictable events, and seasonal changes over long time periods.

Fundamental biology research continues developmental investigations that study the effects of the space environment on the biological systems of plants. Prolonged exposure to microgravity provides an ideal opportunity to determine the role gravity has on cell regulation and how this affects development and growth. Investigations under this discipline will also characterize the internal radiation environment of the Mir space station.

Human life sciences research consists of investigations that focus on the crewmember's adaptation to weightlessness in terms of skeletal muscle and bone changes, psychological interactions, immune system function, and metabolism. In addition, environmental factors such as water quality, air quality, surface assessment for microbes, and crew microbiology will be assessed. The ambitious set of investigations will continue the characterization of the integrated human responses to a prolonged presence in space.

The International Space Station risk mitigation discipline consists of several technology demonstrations associated with human factors and maintenance of crew health and safety aboard the space station. In order to improve the design and operation of the International Space Station, information is gathered to fully evaluate the Mir interior and exterior environments. This discipline includes investigations of radio interference, crew force impacts to structures, particle impact on the station, docked configuration stability, water microbiological monitoring and inventory management.

Microgravity research will advance scientific understanding through research in biotechnology, fluid physics, combustion science, and materials science. The ambient acceleration and vibration environment of Mir will be characterized to support future research programs.

Space science research continues with the externally mounted Mir Sample Return Experiment (MSRE) and Particle Impact Experiment (PIE) payloads. These experiments continue to collect interstellar and interplanetary space particles to further our understanding of the origin and evolution of planetary systems and life on Earth.

Most of the Mir 22/NASA 3 research will be conducted on the Mir; however, shuttle-based experiments are conducted in the middeck and Spacehab modules of STS-79 and STS-81.

Fundamental Biology

The microgravity environment on a long duration mission provides an ideal opportunity to determine the role gravity plays in molecular mechanisms at a cellular level and in regulatory and sensory mechanisms, and how this affects development and fundamental biological growth. Fundamental biology is also responsible for characterizing the radiation of the Mir environment and determining how it may impact station-based science.

<u>Environmental Radiation Measurements:</u> Exposure of crew, equipment, and experiments to the ambient space radiation environment in low Earth orbit poses one of the most significant problems to long term space habitation. As part of the collaborative NASA/Mir Science program, a series of measurements are being compiled of the ionizing radiation levels aboard Mir. During the mission, radiation will be measured in six separate locations throughout the Mir using a variety of passive radiation detectors. This experiment will continue on later missions, where measurements will be used to map the ionizing radiation environment of Mir. These measurements will yield detailed information on spacecraft shielding in the 51.6-degree-orbit of the Mir. Comparisons will be made with predictions from space environment and radiation transport models.

<u>Greenhouse-Integrated Plant Experiments</u>**:** The microgravity environment of the Mir space station provides researchers an outstanding opportunity to study the effects of gravity on plants, specifically dwarf wheat. The greenhouse experiment determines the effects of space flight on plant growth, reproduction, metabolism, and production. By studying the chemical, biochemical, and structural changes in plant tissues, researchers hope to understand how processes such as photosynthesis, respiration, transpiration, stomatal conductance, and water use are affected by the space station environment. This study is an important area of research, due to the fact that plants could eventually be a major contributor to life support systems for space flight. Plants produce oxygen and food, while eliminating carbon dioxide and excess humidity from the environment. These functions are vital for sustaining life in a closed environment such as the Mir or the International Space Station.

Wheat is planted and grown in the "Svet," a Russian/Slovakian developed plant growth facility, where photosynthesis, transpiration, and the physiological state of the plants are monitored. The plants are observed daily, and photographs and video images are taken. Samples are also collected at certain developmental stages, fixed or dried, and returned to Earth for analysis.

Human Life Sciences: The task of safely keeping men and women in space for long durations, whether they are doing research in Earth orbit or exploring other planets in our solar system, requires continued improvement in our understanding of the effects of space flight factors on the ways humans live and work. The Human Life Sciences (HLS) project has a set of investigations planned for the Mir 22/NASA 3 mission to determine how the body adapts to weightlessness and other space flight factors, including the psychological and microbiological aspects of a confined environment and how they readapt to Earth's gravitational forces. The results of these investigations will guide the development of ways to minimize any negative effects so that crewmembers can remain healthy and efficient during long flights, as well as after their return to Earth.

Assessment of Humoral Immune Function During Long Duration Space Flight**:** Experiments concerned with the effects of space flight on the human immune system are important to protect the health of long duration crews. The human immune system involves both humoral (blood-borne) and cell-mediated responses to foreign substances known as antigens. Humoral responses include the production of antibodies, which can be measured in samples of saliva and serum (blood component). The cell-mediated response, which involves specialized white blood cells, appears to be suppressed during long duration space missions. Preflight, a baseline saliva and blood sample is collected. While on Mir, the crew is administered a subcutaneous antigen injection. In flight and postflight, follow-up blood and saliva samples are collected to measure the white blood cell activation response to the antigen.

COMMERCIAL PAYLOADS

Two commercial payloads will be transferred to Mir on STS-79 and will be retrieved by STS-81 some four months later:

Biotechnology System (BTS)**:** The Bioreactor rotating wall vessel developed at the Space Cell Biology and Biotechnology Center at NASA's Johnson Space Center is the first of a series of long-duration cell culture experiments. BTS will study the three-dimensional growth of cartilage cells during its 147-day mission.

Cartilage is the material that makes up the joints in the human body. The bioreactor enables the growth of mature cartilage from a small number of starting cells. This level of maturity is rarely achieved by other culture methods.

Dr. Lisa Freed of MIT is using BTS to study cartilage so that cartilage cells may be engineered for replacement and transplantation.

STS-79 astronauts will activate BTS and sample the culture to ensure it is viable and sterile before transferring it to Mir. Aboard Mir, John Blaha will take weekly samples of the culture, and return the entire experiment on STS-81.

Material in Devices as Superconductors (MIDAS)**:** The MIDAS experiment developed at NASA's Langley Research Center, Hampton, VA, will fly into orbit on STS-79 and be transferred over to the Russian Mir Space Station for approximately four months. While on the Mir, MIDAS will measure the electrical properties of high temperature superconductor (HTS) materials during extended space flight and compile the results in a database for commercial use. HTS materials may be used in a variety of device applications to reduce power requirements and thermal losses. In addition to the development of a database, the MIDAS experiment will demonstrate the development of a manufacturing process using integrated superconductor and conventional microelectronics. There have been no previous flights which characterize HTS material in spaceflight at cryogenic temperatures. Sample boards are provided by the Eaton Company (USA), the Moscow Institute of Electronic Equipment (Russia), and the Langley Research Center.

Commercial Generic Bioprocessing Apparatus (CGBA): The CGBA hardware has been used extensively on short duration Shuttle missions to house a great variety of biotechnology experiments of interest to commercial product development. There are many biotechnology processes which require much longer periods of time than a Shuttle mission can provide. For this reason, the commercial affiliates of BioServe Space Technologies, a NASA Commercial Space Center, are eager to take advantage of the long duration mission which the Shuttle/MIR program provides.

Among the experiments carried by the CGBA to Mir will be small, self -contained aquatic ecosystems -- complete with both plants and animals -- developed by Paragon Space Sciences of Tucson, AZ. A leading American pharmaceutical company will conduct experiments to determine the secondary metabolite production in plant tissue. In addition, a leading biotechnology concern is taking advantage of this long duration mission to conduct crystallization experiments involving proteins and oligonucleotides.

In addition, three experiments will make a round-trip voyage aboard Atlantis itself:

Extreme Temperature Translation Furnace (ETTF)**:** The ETTF, which will be integrated into the SPACEHAB module, is a new furnace design allowing space-based processing up to 1,600 degrees Centigrade and above. ETTF was developed by McDonnell Douglas Aerospace Huntsville and the Consortium for Materials Development in Space at the University of Alabama-Huntsville (UAH), a NASA Commercial Space Center.

ETTF is designed to investigate how flaws form in cast and sintered metals. Studying the basic thermodynamics and behavior of pores and metal grains will allow metallurgists to make stronger machine tools on Earth.

The furnace is integrated into a SPACEHAB single rack to demonstrate the facility's on-orbit capabilities. Major ETTF elements include the furnace assembly, a flight computer for experimental processing, a power and switching assembly for the furnace and an experiment power switching unit for control of the water cooling system. A 3-DMA gravitational measurement and recording system is embedded in the ETTF design to allow the experimenter to correlate G-loads with scientific results. The ETTF will process four ampoules containing sintered metal compositions as well as iron. Furnace melts will be made at 1,000 degrees Centigrade, 1150C, 1375-1400C and 1540 to 1600C. Teledyne Advanced Materials Systems is a partner for the sintered samples.

<u>Commercial Protein Crystal Growth (CPCG) Experiments:</u> STS-79 will include the 31st Shuttle flight of a Protein Crystal Growth payload managed by the Center for Macromolecular Crystallography, a NASA Commercial Center for the Development of Space based at the University of Alabama at Birmingham. The complement of CPCG experiments aboard this mission is comprised of 128 individual samples involving twelve different proteins. The samples will be processed at 22 degrees Centigrade using the newly developed Commercial Vapor Diffusion Apparatus (CVDA). The goal of these experiments is to produce large, well-ordered protein crystals in the microgravity environment from very small volumes of protein solutions. These crystals will be used for x-ray diffraction studies to determine the three- dimensional structures of the individual proteins singly, and as they are bonded to other key molecules.

The CVDA hardware consists of 32 "banks" of sample holders, each containing four separate experiment chambers. This hardware is an adaptation of the most common laboratory method (vapor diffusion) for growing protein crystals. Each chamber contains a double-barreled syringe which is loaded with protein and precipitant, prior to launch. The bottom of the chamber is fitted with a cylinder of polymer wicking material which holds a more concentrated reservoir solution.

After orbit is attained, a crew member activates the experiments by using a gauged mechanism to extrude the solution from the syringe barrels to form a protein droplet on each syringe tip. The droplet becomes more concentrated as water diffuses from it, through the vapor phase, to the more concentrated reservoir solution captured in the wicking material. As equilibrium is approached, protein crystals grow slowly in the protein droplet.

The samples on this mission flown for commercial development purposes include a protein responsible for causing some types of asthma and other allergic reactions. Another is an enzyme that is important for the activation of the "complement system." This system of enzymes protects humans by killing microorganisms and infected cells.

<u>Mechanics of Granular Materials:</u> This experiment seeks to develop a quantitative scientific understanding of the behavior of cohesionless granular materials in dry and saturated states at very low confining pressures and effective stresses. Cohesionless granular materials are unlike other engineering materials since their strength and stiffness properties derive entirely from friction and dilatancy. Dilatency is the change of volume associated with the application of shear stresses. The strength and stiffness of these materials are usually several orders of magnitude lower than cementious composites. Granular material properties depend on confinement. Investigators expect to see higher axial loads for a given axial displacement in microgravity. This data could help scientists to understand the behavior of the Earth's surface during earthquakes and landslides.

The MGM experiment was developed by Sandia National Laboratories, in cooperation with the University of Colorado and the Marshall Space Flight Center.

Risk Mitigation Experiments

Several experiments are planned during STS-79 to obtain data that will reduce the development risk for the International Space Station.

Mir Electric Field Characterization (RME 1302): The radio frequency interference (RFI) environment seen by the Shuttle and the International Space Station (ISS) is of increasing concern due to new ground-based transmitters for communications and radar applications. In addition, the 52 degree inclination of the ISS orbit will expose ISS and the Shuttle to larger radio-frequency radiation levels due to longer travel over populated areas. This experiment seeks to collect data on the internal and external RFI in the 40 MHz to 18 GHz frequency band. Part one of this experiment will be conducted in the Shuttle cabin only. Part two will be conducted in the Priroda module of the Mir station. Data will assist designers in the selection of frequency bands for radio-frequency components of ISS and its supporting systems.

Real-time Radiation Monitoring Device (RRMD; RME 1312): RRMD measures the elemental composition and energy spectra of cosmic radiation in real-time. It also provides information on the effect of radiation on biological samples. The detector unit contains a Linear Energy Transfer Spectrometer.

Biological samples in the dosimeters are dry E-Coli and plasmid DNA. Biological samples in the biospecimen box are E- Coli and D. radiodurans mixed with a liquid nutrient. The investigators are interested in the ability of bacteria to repair any radiation-damaged DNA.

RRMD was developed by NASDA and Mitsubishi Heavy Industries, Ltd. of Japan.

Active Rack Isolation System (ARIS; RME 1313): The Active Rack Isolation System is designed to isolate certain classes of science experiments from major mechanical disturbances that might be found on the International Space Station. Active isolation augments passive isolation, adding apparent mass and damping, thus canceling accelerations. Specifically, ARIS is expected to isolate payloads from low frequency vibrations.

The objective of the ARIS flight experiment is to expose the system to accelerations due to the Space Shuttle and also due to the Shuttle/Mir orbital complex, which will provide a low frequency vibration environment similar to that anticipated for the International Space Station. ARIS isolation performance cannot be proven by ground testing, hence the flight test on STS-79 was proposed to characterize ARIS performance, measuring its isolation capabilities from .003 to 300 Hertz.

The ARIS rack is being developed by the Boeing Defense and Space Group in Seattle, Washington. The ARIS hardware is integrated into an ISS International Standard Payload Rack (ISPR). The ISPR was then integrated into the Spacehab, placed in a double rack enclosure on the starboard side of Spacehab. ARIS weighs approximately 700 pounds, which includes 350 pounds of Russian logistics as ballast. During the flight, periods without jet firings as well as specific jet firing occasions will be required to evaluate ARIS performance.

Inventory Management System (IMS; RME 1319): This experiment seeks to determine the utility of using a bar code reader to keep track of items transferred from Shuttle to Mir and from Mir to Shuttle. Bar code tags will be attached to selected transfer items. Results of this experiment will help in determining the type of IMS required for the International Space Station. The IMS experiment was developed at the Johnson Space Center.

IMAX

During the STS-79 mission, the crew will use an onboard IMAX camera to document activities on Atlantis and Mir. After the mission, selected still images from the film will be made available to the public via the Internet. Sections of the film will be transferred to videotape and will be broadcast on NASA-TV for subsequent use by the media.

NASA is using the IMAX film medium to document its space activities and better illustrate them for the public. This system, developed by the IMAX Corp., Toronto, Canada, uses specially designed motion picture cameras and projectors to record and display high-definition, large screen pictures.

NASA has flown IMAX camera systems on many Shuttle missions. Footage from STS-79, as well as the recent STS-63, STS-71, and STS-74 missions will be incorporated in a large- format feature film about NASA's cooperation with Russia. The IMAX system consists of a space-qualified 65 mm camera, lenses, rolls of film, lights and other equipment necessary for filming. The IMAX and supporting equipment are stowed in the middeck of the orbiter. An audio tape recorder with microphones will be used in the crew compartment to record audio sounds and crew comments during camera operations.

SHUTTLE AMATEUR RADIO EXPERIMENT (SAREX)

Ham radio operators and students will attempt to make radio contacts with the orbiting Shuttle as part of the Shuttle Amateur Radio Experiment, SAREX, during STS-79. Amateur radio has been flying aboard Space Shuttles since 1983.

Amateur radio operators from around the world will point their antennas at Atlantis, hoping to find the astronauts on the air. Some of these amateurs have volunteered to assist student groups who have prepared questions to ask the astronauts during specially-scheduled contact times.

To make their radio contacts, the astronauts will use a radio on board the Shuttle, on frequencies used by ham radio operators. For the students who participate in SAREX, the contact is the culmination of months of hard work. Many of the students have studied space science and communications, and have trained to use ham radio equipment and Shuttle- tracking computer software.

To operate amateur radio from the Space Shuttle, one or more of the astronauts must have an amateur radio license. Mission Specialist Jay Apt's amateur radio call sign is N5QWL. Apt has flown on three previous Shuttle missions and has operated amateur radio during each flight.

John Blaha also will serve as a Mission Specialist, and his ham radio call sign is KC5TZQ. Astronaut Carl Walz is KC5TIE; he participated in SAREX from Columbia during STS-65 in July 1994, before earning his amateur radio license.

During SAREX missions, the astronauts will typically make the following types of amateur radio contacts:

Scheduled radio contacts with schools; Random radio contacts with the amateur radio community; Personal contacts with the astronauts' families.

SAREX is sponsored by the American Radio Relay League (ARRL), The Radio Amateur Satellite Corporation (AMSAT) and NASA. SAREX is supported by the Federal Communications Commission.

Additional Information For Amateur Radio Operators

Since this flight is a Shuttle-Mir docking mission, and SAREX and Mir amateur radio stations sometimes share the same downlink frequency (145.55 MHz), the SAREX Working Group has decided to use the following frequencies during this mission.

The crew will use separate receive and transmit frequencies. PLEASE do not transmit on the Shuttle's DOWNLINK frequency. The DOWNLINK is your receiving frequency. The UPLINK is your transmitting frequency.

FM Voice Downlink: 145.84 MHz
FM Voice Uplink: 144.45, 144.47 MHz

The crew will not favor either uplink frequency, so your ability to communicate with SAREX will be the "luck of the draw." Transmit only when the Shuttle is within range of your station, and when the Shuttle's station is on-the-air.

CALL SIGNS: FM voice call signs N5QWL, KC5TIE, and KC5TZQ

Members of the Goddard Amateur Radio Club (Greenbelt, MD) re-transmit live, Shuttle air-to-ground audio over the amateur frequencies from their club station, WA3NAN. To listen-in, tune to amateur radio high frequency (HF) bands at 3.86, 7.185, 14.295, 21.395, and 28.65 megahertz (MHz) and in the Maryland/DC area on a very high frequency (VHF) band at 147.45 MHz.

STS-79 CREWMEMBERS

STS079-S-002 -- In various venues, these seven astronauts have been in training for several months for the different phases of the STS-79 mission scheduled for launch in August, 1996. Front row, left to right, are astronauts Jerome (Jay) Apt, mission specialist; Terrence W. Wilcutt, pilot; William F. Readdy, mission commander; Thomas D. Akers and Carl E. Walz, both mission specialists. On the back row are astronauts Shannon W. Lucid and John E. Blaha, both mission specialists. Lucid is currently aboard Russia's Mir Space Station, having been delivered there by the Space Shuttle Atlantis crew of STS-76 in March, 1996. She will return to Earth with this crew, while Blaha will launch with this crew and remain onboard Mir's Space Station for a subsequent tour of duty as a cosmonaut guest researcher.

PHOTO CREDIT: NASA or National Aeronautics and Space Administration.

BIOGRAPHICAL DATA

William F. Readdy (Captain, U.S. Naval Reserve) will serve as Commander (CDR) for STS-79. Readdy was born January 24, 1952, in Quonset Point, RI, but considers McLean, VA, to be his hometown. He graduated from McLean High School in 1970 and received a bachelor of science degree in aeronautical engineering (with honors) from the U.S. Naval Academy in 1974. He graduated from the U.S. Naval Test Pilot School in the class of 1979.

Readdy was selected as an astronaut by NASA in the 1987 group. A veteran pilot astronaut with two space flights, STS-42 in 1992 and STS-51 in 1993, he has logged over 429 hours in space.

Terrence W. Wilcutt (Lieutenant Colonel, USMC) will serve as the Pilot (PLT) for STS-79. Wilcutt was born October 31, 1949, in Russellville, KY. He graduated from Southern High School, Louisville, KY, in 1967 and received a bachelor of arts degree in math from Western Kentucky University in 1974. He graduated from the U.S. Naval Test Pilot School in 1986.

Wilcutt was selected by NASA in January 1990 and became an astronaut in July 1991. Wilcutt was the pilot on Mission STS-68 in 1994 and has logged 269 hours and 46 minutes in space.

Jay Apt (Ph.D.) will serve as Mission Specialist-1 (MS-1) on STS-79. Apt was born April 28, 1949, in Springfield, MA, but considers Pittsburgh, PA, to be his hometown. He graduated from Shady Side Academy, Pittsburgh, PA, in 1967. Apt received a bachelor of arts degree in physics (magna cum laude), from Harvard College in 1971 and a doctorate in physics from the Massachusetts Institute of Technology in 1976.

Apt was selected as an astronaut candidate by NASA in June 1985, and qualified as an astronaut in July 1986. Apt has served as a mission specialist on three flights -- STS-37 in 1991, STS-47 in 1992 and STS-59 in 1994. With the completion of his third flight, Apt has logged a total of 604 hours in space, including 10 hours and 49 minutes on two space walks.

Tom Akers (Lieutenant Colonel, USAF) will serve as Mission Specialist-2 (MS-2) on STS-79. Akers was born May 20, 1951, in St. Louis, MO, but was raised and educated in his hometown of Eminence, MO. He graduated from Eminence High School in 1969. Akers received a bachelor and master of science degrees in applied mathematics from the University of Missouri-Rolla in 1973 and 1975, respectively. He graduated from the U.S. Air Force Test Pilot School in Class 82B.

Akers was selected for the astronaut program in 1987. A veteran of three space flights, STS-41 in 1990, STS-49 in 1992, and STS-61 in 1993, Akers has accumulated over 571 hours of space flight.

Carl E. Walz (Lieutenant Colonel, USAF) will serve as Mission Specialist-3 (MS-3) on STS-79. Walz was born on September 6, 1955, in Cleveland, OH. He graduated from Charles F. Brush High School, Lyndhurst, OH in 1973. He received a bachelor of science degree in physics from Kent State University, OH, in 1977, and a master of science in solid state physics from John Carroll University, OH, in 1979. He graduated from the U.S. Air Force Test Pilot School in Class 83A.

Walz was selected to be an astronaut in 1990. He is a veteran of two spaceflights, STS-51 in September 1993 and STS-65 in July 1994. Walz has accumulated 590 hours in space.

BIOGRAPHICAL DATA

John E. Blaha (Colonel, USAF, Ret.) will serve as Mission Specialist-4 (MS-4, ascent) from launch through docking with the Mir Space Station. After docking, a crew exchange will occur and Blaha will officially become a member of the Mir 22 crew. As a station crew member, Blaha will conduct material science, fluid science, and life science research for five months with the Mir 22 and Mir 23 Cosmonaut crews. In January 1997 Blaha will return to Earth on STS-81.

Blaha was born August 26, 1942, in San Antonio, TX. He graduated from Granby High School in Norfolk, VA, in 1960. Blaha received a bachelor of science in engineering science from the United States Air Force Academy in 1965 and a master of science in astronomical engineering from Purdue University in 1966. He graduated in 1971 from the U.S. Air Force Aerospace Research Pilot School.

Blaha was selected as an astronaut in May 1980. He has logged 33 days in space on four space missions. He served as commander on two flights - STS-58 in 1993 and STS-43 in 1991 and as Pilot on two flights - STS-33 and STS-29, both in 1989.

Shannon W. Lucid (Ph.D.) (MS-4, descent) is the second NASA astronaut to serve as a researcher aboard the Mir station. She has been aboard the orbiting facility since Atlantis undocked during Mission STS-76 in March. On September 7, 1996, Lucid will reach her 169th day in space, thus surpassing Elena Kondakova for the record of most time in space by any woman on a single flight. After the crew exchange with Blaha is completed, Lucid will serve as Mission Specialist-4 for the remainder of the STS-79 flight.

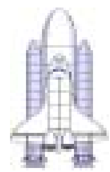
Lucid was born January 14, 1943, in Shanghai, China, but considers Bethany, OK, to be her hometown. She graduated from Bethany High School, in 1960. Lucid received a bachelor of science degree in chemistry from the University of Oklahoma in 1963 and a master of science and doctor of philosophy degrees in biochemistry from the University of Oklahoma in 1970 and 1973, respectively.

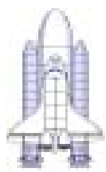
Lucid was selected by NASA in January 1978 and became an astronaut in August 1979. She served as a mission specialist on four Space Shuttle missions -- STS 51-G in 1985, STS-34 in 1989, STS-43 in 1991 and STS-58 in 1993. She has logged over 838 hours in space.

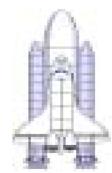
For complete biographical information on NASA astronauts, see the NASA Internet astronaut biography home page at address: http://www.jsc.nasa.gov/Bios/.

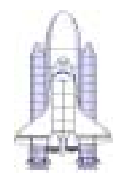
SHUTTLE FLIGHTS AS OF SEPTEMBER 1996

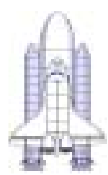
78 TOTAL FLIGHTS OF THE SHUTTLE SYSTEM -- 53 SINCE RETURN TO FLIGHT











		STS-70 07/13/95 - 07/22/95		
STS-78 000/00/96 – 00/00/96		STS-63 02/03/95 - 02/11/95		
STS-75 02/22/96 - 03/09/96		STS-64 09/09/94 - 09/20/94		
STS-73 10/20/95 - 11/05/95		STS-60 02/03/94 - -2/11/94		
STS-65 07/08/94 0 07/23/94		STS-51 09/12/93 - 09/22/93		
STS-62 03/04/94 - 03/18/94		STS-56 04/08/83 - 04/17/93	STS-76 03/22/96 - 03/31/96	
STS-58 10/18/93 - 11/01/93		STS-53 12/02/92 - 12/09/92	STS-74 11/12/95 - 11/20/95	
STS-55 04/26/93 - 05/06/93		STS-42 01/22/92 - 01/30/92	STS-71 06/27/95 - 07/07/95	
STS-52 10/22/92 - 11/01/92		STS-48 09/12/91 - 09/18/91	STS-66 11/03/94 - 11/14/94	
STS-50 06/25/92 - 07/09/92		STS-39 04/28/91 - 05/06/91	STS-46 07/31/92 - 08/08/92	
STS-40 06/05/91 - 06/14/91		STS-41 10/06/90 - 10/10/90	STS-45 03/24/92 - 04/02/92	STS-77 05/19/96 - 05/29/96
STS-35 12/02/90 - 12/10/90	STS-51L 01/28/86	STS-31 04/24/90 - 04/29/90	STS-44 11/24/91 - 12/01/91	STS-72 01/11/96 - 11/20/96
STS-32 01/09/90 - 01/20/90	STS-61A 10/30/85 - 11/06/85	STS-33 11/22/89 - 11/27/89	STS-43 08/02/91 - 08/11/91	STS-69 09/07/95 - 09/18/95
STS-28 08/08/89 - 08/13/89	STS-51F 07/29/85 - 08/06/85	STS-29 03/13/89 - 03/18/89	STS-37 04/05/91 - 04/11/91	STS-67 03/02/95 - 03/18/95
STS-61C 01/12/86 - 01/18/86	STS-51B 04/29/85 - 05/06/85	STS-26 09/29/88 - 10/03/88	STS-38 11/15/90 - 11/20/90	STS-68 09/30/94 - 10/11/94
STS-9 11/28/83 - 12/08/83	STS-41G 10/05/84 - 10/13/84	STS-51-I 08/27/85 - 09/03/85	STS-36 02/28/90 - 03/04/90	STS-59 04/09/94 – 04/20/94
STS-5 11/11/82 - 11/16/82	STS-41C 04/06/84 - 04/13/84	STS-51G 06/17/85 - 06/24/85	STS-34 10/18/89 - 10/23/89	STS-61 12/02/93 - 12/13/93
STS-4 06/27/82 - 07/04/82	STS-41B 02/03/84 - 02/11/84	STS-51D 04/12/85 - 04/19/85	STS-30 05/04/89 - 05/08/89	STS-57 06/21/93 - 07/01/93
STS-3 03/22/82 - 03/30/82	STS-8 08/30/83 - 09/05/83	STS-51C 01/24/85 - 01/27/85	STS-27 12/02/88 - 12/06/88	STS-54 01/13/93 - 01/19/93
STS-2 11/12/81 - 11/14/81	STS-7 06/18/83 - 06/24/83	STS-51A 11/08/84 - 11/16/84	STS-61B 11/26/85 - 12/03/85	STS-47 09/12/92 - 09/20/92
STS-1 04/12/81 - 04/14/81	STS-6 04/04/83 - 04/09/83	STS-41D 08/30/84 - 09/05/84	STS-51J 10/03/85 - 10/07/85	STS-49 05/07/92 - 05/16/92
OV-102 Columbia (20 flights)	**OV-099 Challenger (10 flights)**	**OV-103 Discovery (21 flights)**	**OV-104 Atlantis (16 flights)**	**OV-105 Endeavour (11 flights)**