STS-113 Shuttle Press Kit

Station Crew Exchange, Port Truss Segment Installation Highlight Endeavour's Mission

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Updated October 25, 2002

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Mission Overview

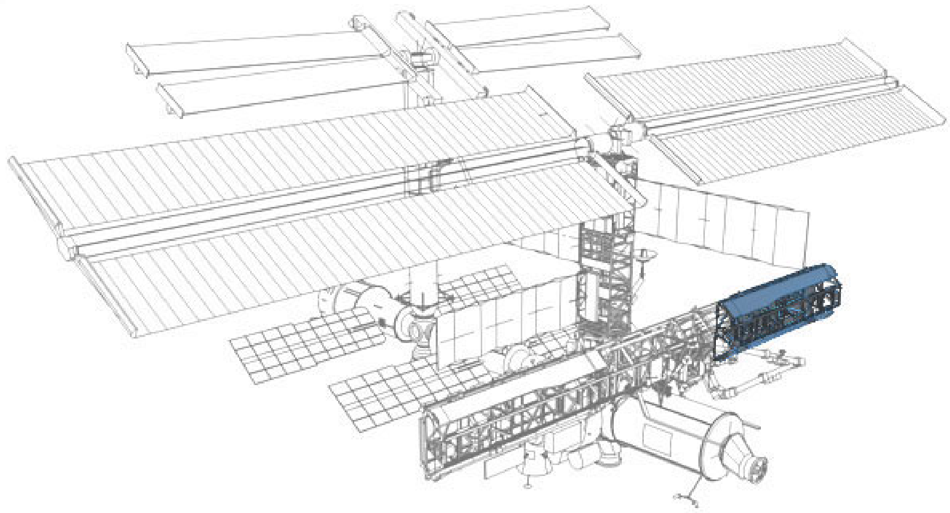
STS-113 will be the 16th American (11A) assembly flight to the International Space Station (ISS). The primary mission will be to bring the Expedition 6 crew to the ISS and return the Expedition 5 crew to the Earth. In addition to the crew exchange, STS-113 will be the next flight in the assembly sequence to install a major component, the Port 1 (P1) Integrated Truss Assembly.

If one held a giant mirror in front of the ISS during space shuttle Atlantis' mission in October, that image could be replayed to demonstrate the primary assembly task of Endeavour's crew to mount the next truss segment onto the station. The P1 Truss is virtually identical to the S1, which now is attached to the opposite side of the central truss piece.

Space shuttle Endeavour is rolled to the Kennedy Space Center Launch Pad 39A on top of the Mobile Launch Platform, moved by the crawler-transporter underneath.

Endeavour is set to depart for the station from Launch Complex 39-A no earlier than Nov. 10 to install that P1 Truss element to the station and deliver the Expedition 6 crew to replace the Expedition 5 crew, which will return home after more than five months in space.

Known as STS-113 (station assembly flight 11A), Endeavour's mission is the fifth providing expedition crew rotation services.

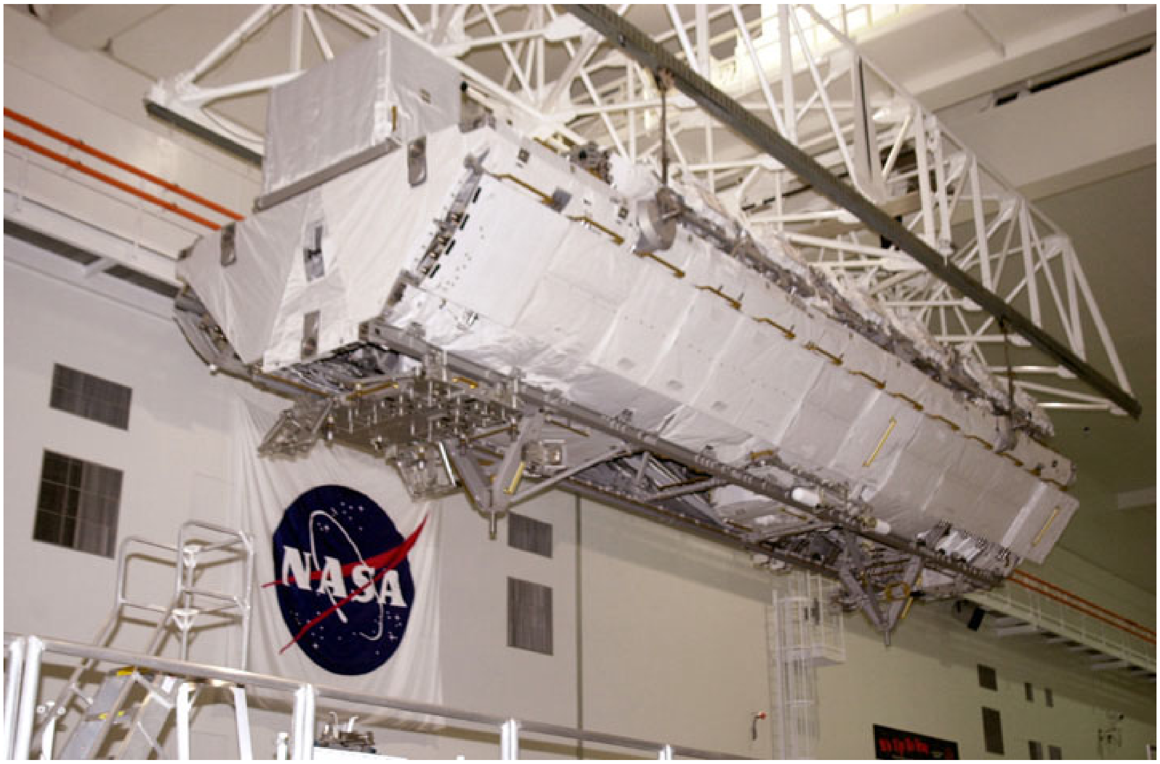


The P1 Truss, highlighted in blue, will be attached to the International Space Station during STS-113/11A.

The major objective of the planned 11-day mission is delivery of the 45-foot-long, 14-ton P1 to the ISS. The segment, identical to the one delivered on the recent STS-112/9A flight, will be attached to the port side of the centerpiece truss, the S-Zero (S0), which is home to the Mobile Transporter (MT), Mobile Base System (MBS) and the Canadarm2 robotic arm. P1 continues the outboard expansion of the station's rail system in preparation for the addition of new power and international science modules in the years to come. With the addition of P1, the station's truss spans 134 feet.

P1 contains the Active Thermal Control System (ATCS) for the station that will be activated next year. This system serves a similar purpose to an automobile's radiator except this system uses 99.9 percent pure ammonia. Additionally, the P1 houses a second Ultra High Frequency (UHF) communications system to provide enhanced and extended voice and data capability, and a second mobile work platform for spacewalkers called the Crew and Equipment Translation Aid (CETA) cart. Like the S1, the P1 includes a Thermal Radiator Rotary Joint (TRRJ), which will provide the mechanical and electrical energy for rotating the station's heat-rejecting radiators.

Three spacewalks will be carried out to install and activate the truss and its associated equipment.



Inside the KSC Space Station Processing Facility, the P1 Truss segment is moved by overhead crane through the highbay toward the payload canister.

P1 is the fourth of 11 truss structures that ultimately will expand the ISS to the length of a football field and increase its power through the addition of new photovoltaic modules and solar arrays.

Future assembly missions will include additional truss elements and relocation in late 2003 of the P6 Truss with the first set of U.S. solar arrays, which was delivered to the ISS as part of the STS-97/4A mission in December 2000.

The STS-113 and Expedition 6 crews exit the Operations and Checkout Building on their way to Launch Pad 39A for a simulated launch countdown. On the left, front to back, are Ken Bowersox, commander of Expedition 6, Mission Specialist John Herrington, astronaut Donald Pettit, and Mission Specialist Michael Lopez-Alegria. On the right, front to back, are STS-113 Commander James Wetherbee, Pilot Paul Lockhart, and cosmonaut Nikolai Budarin. The countdown is part of Terminal Countdown Demonstration Test activities prior to launch.

Endeavour will be commanded by veteran Astronaut Jim Wetherbee (Capt., USN), who will be making his sixth flight into space, most recently on STS-102 in 2001 – the first station crew rotation mission. He will be joined on the flight deck by Pilot Paul Lockhart (Lt. Col., USAF), making his second flight to the ISS this year after piloting the STS-111 mission that delivered the station's Mobile Base System along with the Expedition 5 crew and returned Expedition 4 home.

First-time shuttle crewmember John Herrington (Cmdr., USN) will serve as Endeavour's flight engineer and will be one of the two astronauts conducting three spacewalks during the docked phase of the mission to connect power and data cables between truss sections along with other external hardware.

Joining Herrington on the spacewalks (known as Extravehicular Activity, or EVA) is veteran Astronaut Mike Lopez-Alegria (Capt., USN) who conducted spacewalks during his last mission to the station on the STS-92 flight to install the Z1 Truss and huge gyroscopes to the station two years ago. In addition to his outside work, Lopez-Alegria will oversee the transfer of equipment and supplies inside the station.

The Expedition 6 crew of Commander Ken Bowersox and Flight Engineers Nikolai Budarin and Don Pettit will join Endeavour's four astronauts heading to the station for about a four-month stay. They will replace the Expedition 5 crew of Commander Valery Korzun and Flight Engineers Sergei Treschev and Peggy Whitson, also serving as the first NASA ISS Science Officer. That crew returns after more than five months on the station that included the conduct of some 25 science experiments. Pettit will serve as ISS Science Officer for Expedition 6.

The International Space Station, photographed by Atlantis crewmembers after undocking, clearly shows the newly installed S1 Truss (illuminated in center).

Two days after Endeavour is launched, Wetherbee will guide the shuttle to a gentle linkup with a docking port on the U.S. Destiny laboratory, setting the stage for the opening of the hatches and the start of seven days of joint operations, including the fifth transition of one station crew to another.

The following day, Lopez-Alegria and Herrington will begin spacewalk preparations while Wetherbee uses the shuttle's robotic arm to lift the huge P1 Truss out of Endeavour's payload bay to hand it to the station's Canadarm2 under control of Whitson inside Destiny. She then will carefully install it on the port side of the S0 Truss. Capture bolts will structurally mate the two trusses after a claw-like device on the S0 grabs a fixture on the P1 segment. The procedure will be timed so that the two spacewalkers do not exit the station's Quest Airlock until the mating process is complete.

As part of Crew Equipment Interface Test activities, STS-113 Mission Specialists Michael Lopez-Alegria (left) and John Herrington (right) practice working with flight equipment in Endeavour's payload bay.

Once outside, Lopez-Alegria and Herrington begin the connection of power, data and fluid umbilicals between the newly attached trusses. They also will release launch restraints on the truss' crew platform cart and install a wireless video system transceiver on the Unity module.

The next day – Flight Day 5 – is highlighted by the formal handover of station command from Expedition 5 to Expedition 6. The day includes inside transfer work and some off duty time before the second spacewalk begins on Flight Day 6 to continue the connection of fluid lines between the P1 and the S0 segments, the installation of another wireless video system transceiver on the P1, and the relocation of the CETA cart in preparation for the relocation of the Mobile Transporter. Also in preparation for the MT relocation, the station's Canadarm2 will be temporarily moved to a grapple fixture on the outside of Destiny.

Another day of transfer work will take place on the seventh day followed by the third and final spacewalk of the mission during which Lopez-Alegria and Herrington will focus on the installation of small devices called Spool Positioning Devices, which are being retrofitted on all of the quick disconnect fluid line fittings between modules and truss sections on the outside of the station. They are being installed as a precautionary step to ensure the lines can be disconnected even if pressure builds up due to an internal leak. Fifty-one SPDs are being installed during this mission – more than 40 during the third EVA. Additionally, Lopez-Alegria and Herrington will install a pump used to transfer ammonia through the P1 and also connect ammonia and nitrogen lines to its Ammonia Tank Assembly.
All three spacewalks are budgeted to last about 6½ hours and will be conducted from the station's Quest Airlock.

The next day, Flight Day 9, the shuttle and station crews will complete transfer work and get-ahead tasks for future assembly flights. The Expedition 5 Crew bids farewell to its home for five months and the shuttle crew bids its Expedition 6 replacements bon voyage as the hatches are closed on Flight Day 10.

Lockhart will be at the controls as Endeavour undocks from the ISS and conducts a 400-foot radial fly around of the complex for photo and television documentation of the newly expanded facility.

After a day devoted to packing up gear, Endeavour's six crewmembers will glide to a landing at the Kennedy Space Center to wrap up the orbiter's 19th mission and the 112th in shuttle program history

Timeline Overview

Flight Day 1—Ascent:

- Standard Flight Day 1 activities will be completed [Aft Controller C/O, Elevon Park, Auxiliary Power Unit (APU) Heater reconfiguration].

Flight Day 2—Prep for Mission:

- The ergometer will be set up early in the day to support exercise for International Space Station crewmembers.
- Checkout of two suits on shuttle to be used by STS-113 spacewalkers and other spacewalk setup and reconfiguration tasks will be performed in support of 11A.
- The Shuttle Remote Manipulator System (SRMS) and Orbital Space Vision System (OSVS) will be checked out.
- Rendezvous activities including rendezvous tools setup and checkout, handheld laser checkout, centerline camera installation and Orbiter Docking System ring extension will be performed before docking with the ISS.
- Rendezvous burns will be performed.
- Sequential Still Video will be set up, if not already from Flight Day 1.
- Status of powered payloads will be verified.

Flight Day 3—Rendezvous and Docking:

- The ISS crew will set up the ISS Wireless Information System (IWIS) to observe loads caused by orbiter docking. After docking, the ISS crew will terminate the IWIS operations and will later downlink the data.
- The ISS crew will perform an initial reading of the EVA Radiation Monitoring equipment to establish a baseline for future readings performed after EVAs.
- The spacewalkers' spacesuits will be removed from the shuttle airlock to facilitate hatch opening and transfers after docking.
- The orbiter will rendezvous and dock with the ISS.

- After docking, leak checks will be performed on the PMA and ODS; the ODS will be prepared for ingress and hatches will be opened. A short ISS safety briefing will be given to the arriving shuttle crewmembers.

- The SRMS will be powered and uncradled. A P1 install prep will check camera connectivity and views.

- Spacewalkers' spacesuits (Extravehicular Mobility Units or EMUs) and EVA equipment will be transferred to the ISS. The EMUs will be checked out with airlock interfaces. Rechargeable EVA Battery Assembly (REBA) batteries will be installed into the EMUs and REBA-powered equipment will be verified operational on both EMUs. EVA tools will be transferred to the ISS and prepared for EVA 1 the next day. The Pistol Grip Tool (PGT) will be checked out. All crewmembers involved in the first spacewalk will participate in an EVA 1 Procedure Review.

- Large items in the shuttle middeck will be transferred to the ISS to clear space in the middeck.

Flight Day 4—First Spacewalk:

- The crew will grapple the P1 with the SRMS and remove it from the Orbiter Payload Bay. A 10-hour thermal clock begins when the truss clears the payload bay sill and ends when the survival heaters are activated. The P1 Truss will then be handed over to the SSRMS and installed on the Segment-to-Segment Attach System using an auto sequence.

- Once bolting is completed, the SSRMS is no longer needed until EVA 2, so it will be maneuvered to the lab PDGF. Following this, the SSRMS will maneuver to the Mobile Base System and be powered down in preparation for EVA 2. Once the SRMS has completed Photo/TV Ops, it will be stowed and powered down. It will not be needed again for the docked phase.

- The ISS Exercise EVA protocol will be used to support the EVA. The two EVA crewmembers will perform the required 10-minute Cycle/Ergometer Vibration Isolation System (CVIS) exercise while breathing pure oxygen to purge nitrogen from the EVA crewmembers' blood. IV crewmembers will ingress the ISS airlock with the two EVA crewmembers and close the Node hatch. The EVA crewmembers will continue to pre-breathe pure oxygen for a total of 80 minutes.

- Once Crew Lock depress is complete, EVA crewmembers will egress the Crew lock and begin EVA setup.

- EVA 1 takes place. (See the section on spacewalks for details.)

- When EVA cleanup is complete, EVA crewmembers will enter the ISS Crew Lock and perform pre-repress, close the EVA hatch, and repress the Crew Lock. Post-EVA procedures and EVA preparation activities for the next EVA will be performed. EMUs will be transferred to STS airlock for recharging overnight.

Flight Day 5—Transfer:

- Transfer of nitrogen from the orbiter to the Airlock High-Pressure Gas Tanks will be initiated. Nitrogen transfer is performed by equalizing the higher pressure orbiter nitrogen tanks with the ISS nitrogen tanks.

- Reboost No. 1 will be performed.

- A shuttle supply water will be performed.

- Equipment Lock preparation, EVA tool configuration and preparation of spacesuits and equipment for the second spacewalk will be performed.

- Logistics stowed in the shuttle middeck will be transferred to the ISS.

- All shuttle crewmembers will participate in a joint PAO event.

Flight Day 6—Second Spacewalk:

- EVA 2 will be conducted. (See the section on spacewalks for details.)

- The SSRMS will be stowed after the EVA is complete.

Flight Day 7—Transfer:

- Reboost No. 2 will be performed.

- Preparation and configuration of suits and tools for the third spacewalk will be the order of the day.

- A joint crew news conference will be conducted and a joint crew photo will be taken.

- Remaining transfer items in the shuttle middeck will be delivered to the ISS. Return items in ISS will be taken to the orbiter and stowed.

Flight Day 8—Third Spacewalk:

- The Mobile Transporter will translate from worksite No. 4 to No. 7. The SSRMS will then walk off the lab onto the MT.

- The third EVA will be conducted. (See the section on spacewalks for details.)

Flight Day 9—Undock Preparations:

- Oxygen transfer will be terminated and equipment will be disassembled.
- Reboost No. 3 takes place.
- Final still imagery photos of the final 11A configuration will be taken.
- Oxygen and nitrogen transfer will be terminated and transfer equipment will be disassembled.
- Remaining logistics will be transferred between the ISS and shuttle. EMU and EVA equipment is transferred. An inventory check will be performed to verify that all equipment transferred between vehicles is returned to the correct vehicle.
- Change of command ceremony takes place.
- Off duty time for shuttle crewmembers is scheduled in the afternoon.

Flight Day 10—Undock/MEPSI:

- ISS and shuttle crews will bid farewell, close the hatch between vehicles, and perform an ODS leak check and Centerline Camera Setup.
- Undocking, flyaround and final departure from the ISS takes place.
- MEPSI will be deployed at a safe distance from ISS out of plane.
- Any remaining crew time will be used to begin stowing the cabin.

Flight Day 11—Entry Preparations:

- Standard day before entry shuttle activities will be performed (Flight Control System checkout, Reaction Control System hot-fire, Deorbit Briefing, Landing -1 communications check, cabin stow, pilot ops, entry video setup, ergometer stowed, and Ku stow).
- SRMS will be powered down.
- Any remaining crew time will be used to finish stowing the cabin.
- Recumbent seats will be set up in the middeck.

Flight Day 12—Entry and Landing:

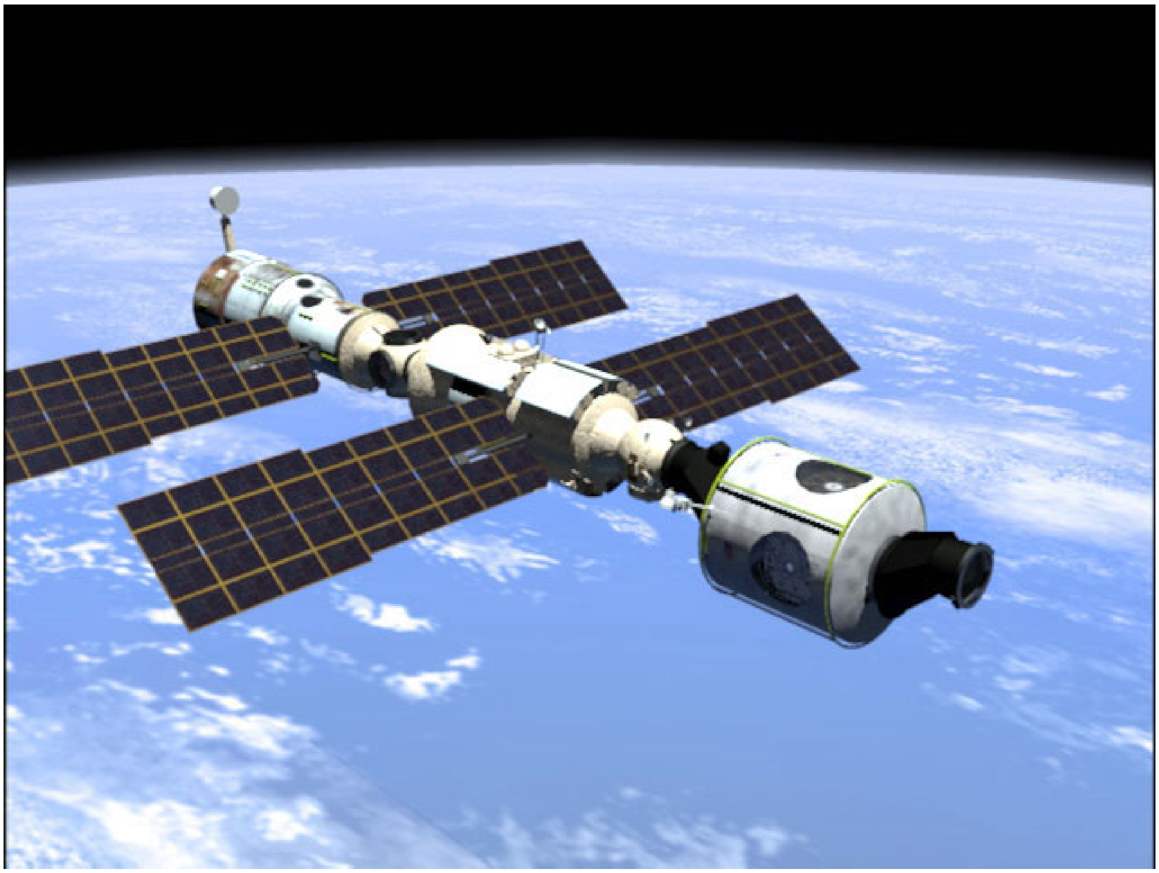
- Standard activities before de-orbit prep will be performed.
- Kennedy Space Center, Fla., is the preferred landing site.

Mission Objectives

International Space Station Program list of major tasks in order of priority

1. Rotate the Expedition 5 crew with Expedition 6 crew.
2. Install and safe the Integrated Truss Structure P1 to the existing central truss using both the shuttle and station robotic arms.
3. Transfer critical items per Flight 11A Transfer Priority List.
4. Perform mandatory crew activities to support powered payload maintenance operations.
5. Complete P1 activation and check out, including connection of the remaining P1/S0 nadir and zenith tray umbilicals.
6. Install and check out two Wireless Video System External Transceiver Assemblies (WETA).
7. Deploy P1 central radiator.
8. Disconnect the Squib Firing Unit harness, reposition it to the radiator beam line heaters and activate the P1 fluid line secondary heaters.
9. Configure Mobile Transporter/Crew and Equipment Translation Aid (CETA) cart to starboard side of the MT.
10. Release P1/P3 utility line clamps.
11. Checkout P1/P3 Segment-to-Segment Attach System (SSAS).
12. Perform Thermal Radiator Rotary Joint check out.
13. Connect S0 to P1 ammonia lines.
14. Connect Ammonia Tank Assembly nitrogen and ammonia lines.
15. Deploy P1 Ultra High Frequency (UHF) antenna.
16. Transfer oxygen and nitrogen to the Quest Airlock's High-Pressure Gas Tanks.
17. Activate and check out the P1 UHF antenna.
18. Perform ISS reboost to maintain altitude and rendezvous requirements.

Mission Factoids



Just over two years ago the International Space Station consisted of three modules and one small supporting truss structure upon which the station's first solar arrays were mounted. In the fall of 2000, the ISS weighed 62 tons, was about 120 feet long and had an equivalent habitable volume to fill the average home garage.

Today, the fifth resident crew aboard the ISS is wrapping up a 4½-month stay aboard an orbiting outpost with habitable volume equal to that of a three-bedroom house. It consists of six modules, two airlocks for spacewalk activity, the world's most complex robotic arm for assembly and a railcar system which soon will span the 360-foot length of the station's truss system in the years to come.

The fifth crew rotation occurs during Endeavour's week of docked operations at the station, providing a near seamless transition from one crew to the next since Expedition 1's pathfinding flight that began in October 2000.

As the International Space Station enters its third year of continuous occupancy and fifth since the first segment was launched Nov. 20, 1998, it features the following:

- With the addition of the P1 Truss and the second of two small translation carts to help with moving spacewalkers and equipment to worksites, 19 different elements will have been delivered to the station, representing contributions from all of the International Partners involved in the global project.

- The ISS is 171 feet long, 240 feet wide and 90 feet high.
- With the addition of the P1 Truss and the Crew and Equipment Translation Aid (CETA) cart, the ISS will weigh more than 197 tons.
- Five scientific experiment racks are housed in the Destiny laboratory of the ISS.
- Eleven experiments representing life sciences, material sciences and Earth observation studies are currently yielding reams of data for researchers back on Earth.
- The three spacewalks on STS-113 are designed to install and activate the P1 Truss, and will bring to 49 the number of spacewalks conducted for ISS assembly and maintenance.
- More than 300 hours in spacewalking time will have been devoted to ISS assembly and maintenance by the time STS-113 is completed.

Acknowledged as the most complex engineering project in history, the ISS is rapidly expanding to accommodate new scientific modules and solar arrays to provide the power needed to run tens of thousands of systems and scientific research from every corner of the Earth.

Mission Profile

Crew

Commander:	Jim Wetherbee
Pilot:	Paul Lockhart
Mission Specialist 1:	Michael Lopez-Alegria
Mission Specialist 2:	John Herrington
ISS Expedition 6 (Up):	Ken Bowersox
ISS Expedition 6 (Up):	Nikolai Budarin
ISS Expedition 6 (Up):	Donald Pettit
ISS Expedition 5 (Down):	Valery Korzun
ISS Expedition 5 (Down):	Peggy Whitson
ISS Expedition 5 (Down):	Sergei Treschev

Launch

Orbiter:	Endeavour (OV-105)
Launch Site:	Kennedy Space Center Launch Pad 39A
Launch Date:	Nov. 10, 2002
Launch Window:	5 Minutes
Altitude:	122 Nautical Miles (Orbital Insertion); 210 NM (Rendezvous)
Inclination:	51.6 Degrees
Duration:	10 Days 19 Hrs. 10 Min.

Vehicle Data

Shuttle Liftoff Weight:	4,521,127 lbs.
Orbiter/Payload Liftoff Weight:	256,747 lbs.
Orbiter/Payload Landing Weight:	201,715 lbs.

Software Version: OI-29

Space Shuttle Main Engines:

SSME 1: 2050 **SSME 2:** 2044 **SSME 3:** 2045

External Tank: ET-116A (Super Light Weight Tank)

SRB Set: BI114PF

Shuttle Aborts

Abort Landing Sites

RTLS: Kennedy Space Center Shuttle Landing Facility
TAL: Primary – Zaragoza; Alternates Ben Guerir, Moron
AOA: Kennedy Space Center Shuttle Landing Facility

Landing

Landing Date:	11/20/02
Primary Landing Site:	Kennedy Space Center Shuttle Landing Facility

Crewmembers

Jim Wetherbee, Commander, 49 (Capt., USN)

***Seating*:** Flight deck for launch and landing.

Responsibilities: Wetherbee is responsible for the overall safety and success of the mission and will oversee orbiter operations for the rendezvous and docking of Endeavour to the International Space Station. He will be the prime operator of the shuttle's robotic arm during the removal of the P1 Truss from Endeavour's payload bay. He then will hand it off to the station's robotic arm under control of Expedition Five Flight Engineer Peggy Whitson. Wetherbee then serves as the backup to Pilot Paul Lockhart throughout the fly around of the station after undocking and will act as 'camera operator' during the three spacewalks conducted by Michael Lopez-Alegria and John Herrington.

PERSONAL DATA

Born Nov. 27, 1952, in Flushing, N.Y. Considers his hometown to be Huntington Station, N.Y. Married to the former Robin DeVore Platt of Jacksonville, Fla. They have two children. He enjoys tennis, skiing, softball, running, and music. His parents, Mr. and Mrs. Dana A. Wetherbee, reside in Huntington Station, N.Y. Her parents, Mr. and Mrs. Harry T. Platt, Jr., reside in Jacksonville, Fla.

EDUCATION

Graduated from Holy Family Diocesan High School, South Huntington, N.Y., in 1970; received a bachelor of science degree in aerospace engineering from the University of Notre Dame in 1974.

ORGANIZATIONS

Member of the Society of Experimental Test Pilots.

SPECIAL HONORS

Distinguished Flying Cross; Navy Achievement Medal; two Meritorious Unit Commendations.

EXPERIENCE

Wetherbee received his commission in the United States Navy in 1975 and was designated a naval aviator in December 1976. After training in the A-7E, he was assigned to Attack Squadron 72 (VA-72) from August 1977 to November 1980 aboard the USS John F. Kennedy and logged 125 night carrier landings. After attending the U.S. Naval Test Pilot School, Patuxent River, Md., in 1981 he was assigned to the Systems Engineering Test Directorate. He was a project officer and test pilot for the weapons delivery system and avionics integration for the F/A-18 aircraft. Subsequently assigned to Strike Fighter Squadron 132 (VFA-132), he flew operationally in the F/A-18 from January 1984 until his selection for the astronaut candidate program. He has logged over 5,000 hours flying time and 345 carrier landings in 20 different types of aircraft.

NASA EXPERIENCE

Selected by NASA in May 1984, Wetherbee became an astronaut in June 1985. Most recently, he served as director of the Flight Crew Operations Directorate. A veteran of five spaceflights, Wetherbee has logged over 1,262 hours in space. He was the pilot on STS-32 in 1990, and was the mission commander on STS-52 in 1992, STS-63 in 1995, STS-86 in 1997, and STS-102 in 2001. Wetherbee will serve as commander of STS-113.

SPACEFLIGHT EXPERIENCE

STS-32 Columbia (Jan. 9-20, 1990) included the successful deployment of the Syncom IV-F5 satellite, and retrieval of the 21,400-pound Long Duration Exposure Facility (LDEF) using the remote manipulator system (RMS). The crew also operated a variety of middeck experiments and conducted numerous medical test objectives, including in-flight aerobic exercise and muscle performance to evaluate human adaptation to extended duration missions. Mission duration was 173 orbits in 261 hours and 1 minute.

STS-52 Columbia (Oct. 22 to Nov. 1, 1992) successfully deployed the Laser Geodynamic Satellite (LAGEOS), a joint Italian-American project. The crew also operated the first U.S. Microgravity Payload (USMP) with French and American experiments, and successfully completed the initial flight tests of the Canadian-built Space Vision System (SVS). Mission duration was 236 hours and 56 minutes.

STS-63 Discovery (Feb. 2-11, 1995), was the first joint flight of the new Russian-American Space Program. Mission highlights included the rendezvous with the Russian Space Station, Mir, operation of Spacehab, and the deployment and retrieval of Spartan 204. The mission was accomplished in 129 orbits in 198 hours and 29 minutes.

STS-86 Atlantis (Sept. 25 to Oct. 6, 1997) was the seventh mission to rendezvous and dock with the Russian Space Station Mir. Highlights included the delivery of a Mir attitude control computer, the exchange of U.S. crew members Mike Foale and David Wolf, a spacewalk by Scott Parazynski and Vladimir Titov to retrieve four experiments first deployed on Mir during the STS-76 docking mission, the transfer to Mir of 10,400 pounds of science and logistics, and the return of experiment hardware and results to Earth. Mission duration was 169 orbits in 259 hours and 21 minutes.

STS-102 Discovery (March 8-21, 2001) was the eighth shuttle mission to visit the International Space Station. Mission accomplishments included the delivery of the Expedition 2 crew and the contents of the Leonardo Multi-Purpose Logistics Module, the completion of two successful space walks, the return to earth of the Expedition 1 crew, as well as the return of Leonardo, the reusable cargo carrier built by the Italian Space Agency. Mission duration was 307 hours and 49 minutes.

Paul Lockhart, Pilot, 46 (Lt. Col., USAF)

Seating: Flight deck for launch and landing.

Responsibilities: Lockhart is the in-cabin choreographer throughout the three planned spacewalks by Lopez-Alegria and Herrington and will be in charge of undocking Endeavour from the ISS and conducting a fly around of the station for photo and television documentation.

PERSONAL DATA

Born April 28, 1956, in Amarillo, Texas, to Mr. and Mrs. Charles W. Lockhart. Married to the former Mary Theresa Germaine of Boston, Mass., where her parents, Mr. and Mrs. Joseph R. Germaine, still reside. His mother and stepfather, Joy and Leo Wiley, continue to reside in Amarillo. He enjoys all outdoor sports, including hunting and camping.

EDUCATION

Graduated from Tascosa High School, Amarillo, Texas, in 1974; received a bachelor of arts degree in mathematics from Texas Tech University in 1978, and a master of science degree in aerospace engineering from the University of Texas in 1981. Studied at the University of Innsbruck and the University of Vienna Summer School from 1978-79 on a Rotarian Fellowship. Has also completed aerospace-related courses from Syracuse University and the University of Florida.

ORGANIZATIONS

Society of Experimental Test Pilots, Order of Daedalians (Fraternal Order of Military Pilots).

AWARDS

Recipient of Air Force Aerial Achievement Medal, Commendation Medal, Outstanding Unit Award with Valor, National Defense Service Medal, Achievement Medal, and numerous other service recognitions and ribbons. A distinguished graduate of both ROTC and the Air Force Squadron Officer School, Lockhart is also a member of Outstanding Young Men of America and Who's Who in American Colleges.

EXPERIENCE

Lockhart was commissioned a 2nd Lieutenant in the USAF in 1981. Upon graduation from pilot training in 1983, he was assigned to the 49th Fighter Interceptor Squadron flying T-33s. In 1986, he transitioned to the F-4 and flew operationally with U.S. Air Forces, Europe (in Germany) from 1987-1990 as an instructor pilot for F-4 and F-16 aircrew in the tactics of surface-to-air missile suppression. In 1991 he reported to Edwards Air Force Base for year-long training as a test pilot in high-performance military aircraft. Upon graduation, he was assigned to the Test Wing at the Air Force Developmental Test Center at Eglin Air Force Base, Fla., performing weapons testing for the F-16 aircraft. During his 4-1/2 year tour at Eglin, he was selected as the Operations Officer for the 39th Flight Test Squadron. Much of America's state-of-the-art weaponry was first tested under his guidance at the 39th Flight Test Squadron.

He has logged over 4,000 hours in more than 30 different aircraft.

NASA EXPERIENCE

Selected by NASA in April 1996, Lockhart reported to the Johnson Space Center in August 1996. After completion of initial astronaut training, Lockhart was assigned to the Astronaut Office Spacecraft Systems/Operations Branch where he worked various technical issues including the Space Shuttle Main Engine (SSME) and redesign of the orbiter's flight display. Lockhart served as pilot on STS-111 (2002) and has logged over 332 hours in space.

SPACEFLIGHT EXPERIENCE

STS-111 Endeavour (June 5-19, 2002). The STS-111 mission delivered a new ISS resident crew and a Canadian-built mobile base for the orbiting outpost's robotic arm. The crew also performed late-notice repair of the station's robot arm by replacing one of the arm's joints. It was the second space shuttle mission dedicated to delivering research equipment to the space platform. STS-111 also brought home the Expedition 4 crew from their 6-1/2 month stay aboard the station. Mission duration was 13 days, 20 hours and 35 minutes. Unacceptable weather conditions in Florida necessitated a landing at Edwards Air Force Base, Calif.

Michael Lopez-Alegria, Mission Specialist 1, 44 (Capt., USN)

Seating: Flight deck for launch, middeck for landing.

Responsibilities: Lopez-Alegria will serve as extravehicular crewmember 1 (EV1) for the three spacewalks and will wear the spacesuit bearing red stripes. He will assist in handling rendezvous tools during Endeavour's approach for docking to the ISS and oversee the operation of the orbiter docking system and will direct the transfer of equipment and supplies to the station from the shuttle.

PERSONAL DATA

Born May 30, 1958, in Madrid, Spain, and grew up in Mission Viejo, Calif. Married to the former Daria Robinson of Geneva, Switzerland. They have one son. Michael enjoys sports, traveling and cooking, and is interested in national and international political, economic and security affairs. His father, Eladio Lopez-Alegria, resides in Madrid. His mother, Louise Lopez-Alegria, is deceased. Daria's parents, Professor Stuart and Margareta Robinson, reside in Geneva.

EDUCATION

Graduated from Mission Viejo High School, Mission Viejo, Calif., in 1976; received a bachelor of science degree in systems engineering from the U.S. Naval Academy in 1980; and a master of science degree in aeronautical engineering from the U.S. Naval Postgraduate School in 1988. Graduate of Harvard University's Kennedy School of Government Program for Senior Executives in National and International Security.

ORGANIZATIONS

Member, Society of Experimental Test Pilots; Association of Naval Aviation and Association of Space Explorers.

EXPERIENCE

Following flight training, Lopez-Alegria was designated a Naval Aviator on Sept. 4, 1981. He served as a flight instructor in Pensacola, Fla., until March 1983 and then as a pilot and mission commander of EP-3E aircraft, flying electronic reconnaissance missions in the Mediterranean Sea, North Atlantic, Baltic Sea and Central America. In 1986 he was assigned to a two-year cooperative program between the Naval Postgraduate School in Monterey, Calif., and the U.S. Naval Test Pilot School in Patuxent River, Md. His final tour before being assigned to NASA was at the Naval Air Test Center as an engineering test pilot and program manager. He has accumulated more than 4,500 pilot hours in over 30 different aircraft types.

NASA EXPERIENCE

Selected by NASA in March 1992, Lopez-Alegria reported for training to the Johnson Space Center in August 1992. Following one year of training and designation as an astronaut, he was assigned to be the Astronaut Office technical point of contact to various space shuttle project elements. He was subsequently assigned to the Kennedy Space Center where he provided crew representation on orbiter processing issues and provided direct crew support during launches and landings. Following his first spaceflight he served as NASA Director of Operations at the Yuri Gagarin Cosmonaut Training Center, Star City, Russia. After his second mission, he led the newly formed ISS Crew Operations branch of the Astronaut Office.

SPACEFLIGHT EXPERIENCE

STS-73 Columbia (Oct. 20 to Nov. 5, 1995) was launched from and returned to land at the Kennedy Space Center, Fla. STS-73 was the second United States Microgravity Laboratory mission and focused on materials science, biotechnology, combustion science, the physics of fluids, and numerous scientific experiments housed in the pressurized Spacelab module. Lopez-Alegria served as the flight engineer during the ascent and entry phases of flight, and was responsible for all operations of the “blue” shift on orbit. The STS-73 mission was completed in 15 days, 21 hours, 52 minutes and 21 seconds and traveled over 6 million miles in 256 Earth orbits.

STS-92 Discovery (Oct. 11-24, 2000) was launched from the Kennedy Space Center, Fla., and returned to land at Edwards Air Force Base, Calif. During the 13-day flight, the seven-member crew attached the Z1 Truss and Pressurized Mating Adapter 3 to the International Space Station using Discovery’s robotic arm and performed four spacewalks to configure these elements. This expansion of the ISS opened the door for future assembly missions and prepared the station for its first resident crew. Lopez-Alegria totaled 14 hours and 3 minutes of EVA time in two spacewalks. The STS-92 mission was accomplished in 202 orbits of the Earth, traveling 5.3 million miles in 12 days, 21 hours, 40 minutes and 25 seconds.

John Bennett Herrington, Mission Specialist 2, 44 (Cmdr., USN)

Seating: Flight deck for launch and landing.

Responsibilities: Herrington will serve as flight engineer during Endeavour's launch and landing, assisting Wetherbee and Lockhart. He also will serve as extravehicular activity crewmember 2 (EV2) for the three spacewalks and will wear a suit with no markings.

PERSONAL DATA

Born Sept. 14, 1958, in Wetumka, Okla. He grew up in Colorado Springs, Colo., Riverton, Wyo., and Plano, Texas. Married to the former Debra Ann Farmer of Colorado Springs, Colo. They have two children. He enjoys rock climbing, snow skiing, running, cycling. His parents, Mr. and Mrs. James E. Herrington, reside in Spicewood, Texas. His brother, James E. Herrington, Jr., resides in Sandy Spring, Md. His sister, Jennifer D. Monshaugen, resides in Spicewood, Texas.

EDUCATION

Graduated from Plano Senior High School, Plano, Texas, in 1976; received a bachelor of science degree in applied mathematics from the University of Colorado at Colorado Springs, in 1983, and a master of science degree in aeronautical engineering from the U.S. Naval Postgraduate School in 1995.

ORGANIZATIONS

Life member of the Association of Naval Aviation, University of Colorado at Colorado Springs Alumni Association. Sequoyah Fellow, American Indian Science and Engineering Society.

SPECIAL HONORS

Distinguished Naval Graduate from Aviation Officer Candidate School, Pensacola, Fla., in 1984. Awarded Navy Commendation Medal, Navy Meritorious Unit Commendation, Coast Guard Meritorious Unit Commendation, Coast Guard Special Operations Service Ribbon, National Defense Medal, Sea Service Deployment Ribbons (3), and various other service awards.

EXPERIENCE

Herrington received his commission from Aviation Officer Candidate School in March 1984 and was designated a Naval Aviator in March 1985. He reported to Patrol Squadron Thirty-One (VP-31) at the Moffett Field Naval Air Station, Mountain View, Calif., for initial training in the P-3C Orion. His first operational assignment was with Patrol Squadron Forty-Eight (VP-48) where he made three operational deployments, two to the Northern Pacific based from Naval Air Station Adak, Alaska, and one to the Western Pacific based from the Naval Air Station Cubi Point, Republic of the Philippines. While assigned to VP-48, Herrington was designated a Patrol Plane Commander, Mission Commander, and Patrol Plane Instructor Pilot. Following completion of his first operational tour, Herrington then returned to VP-31 as a Fleet Replacement Squadron Instructor Pilot. While assigned to VP-31 he was selected to attend the U.S. Naval Test Pilot School in Patuxent River, Md., in January 1990. After graduation in December 1990, he reported to the Force Warfare Aircraft Test Directorate as a project test pilot for the Joint Primary Aircraft Training System. Herrington conducted additional flight test assignments flying numerous variants of the P-3 Orion as well as the T-34C and the DeHavilland Dash 7. Following his selection as an Aeronautical Engineering Duty Officer, Herrington reported to the U.S. Naval Postgraduate School where he completed a master of science degree in aeronautical engineering in June 1995. Herrington was assigned as a special projects officer to the Bureau of Naval Personnel Sea Duty Component when selected for the astronaut program.

He has logged over 3,000 flight hours in over 30 different types of aircraft.

NASA EXPERIENCE

Selected by NASA in April 1996, Herrington reported to the Johnson Space Center in August 1996. Having completed two years of training and evaluation, he is qualified for flight assignment as a mission specialist. Initially, Herrington was assigned to the Flight Support Branch of the Astronaut Office where he served as a member of the Astronaut Support Personnel team responsible for shuttle launch preparations and post-landing operations.

Ken Bowersox, Mission Specialist 3 (Up), 45 (Capt., USN)

Seating: Middeck for launch.

Responsibilities: Bowersox will serve as commander of the Expedition 6 crew aboard the International Space Station. In that role, he will oversee the day-to-day operations aboard the complex, taking the reins from current commander Valery Korzun. During the docked phase of Endeavour's mission, Bowersox will serve as the prime operator of the station's robotic arm (Canadarm2) on spacewalks two and three and back up station Flight Engineer Peggy Whitson on the first.

PERSONAL DATA

Born Nov. 14, 1956, in Portsmouth, Va., but considers Bedford, Ind., to be his hometown.

EDUCATION

Graduated from Bedford High School, Bedford, Ind., in 1974; received a bachelor of science degree in aerospace engineering from the United States Naval Academy in 1978, and a master of science degree in mechanical engineering from Columbia University in 1979.

EXPERIENCE

Bowersox received his commission in the United States Navy in 1978 and was designated a Naval Aviator in 1981. He was then assigned to Attack Squadron 22, aboard the USS Enterprise, where he served as a Fleet A-7E pilot, logging over 300 carrier arrested landings. Following graduation from the United States Air Force Test Pilot School at Edwards Air Force Base, Calif., in 1985, he moved to the Naval Weapon Center at China Lake, Calif., where he spent the next year and a half as a test pilot flying A-7E and F/A-18 aircraft until advised of his selection to the astronaut program.

NASA EXPERIENCE

Selected as an astronaut candidate by NASA in June 1987, Bowersox completed a one-year training and evaluation program in August 1988. He has held a variety of assignments since then including: flight software testing in the Shuttle Avionics Integration Laboratory (SAIL); Technical Assistant to the Director of Flight Crew Operations; Astronaut Office representative for orbiter landing and rollout issues; Chief of the Astronaut Office Safety Branch; Chairman of the Spaceflight Safety Panel; during several shuttle missions he served as a spacecraft communicator (CAPCOM) in the Houston Mission Control Center. He also served as backup to the first International Space Station crew. A four-flight veteran, Bowersox has logged over 50 days in space. He flew as pilot on STS-50 in 1992 and STS-61 in 1993, and was the spacecraft commander on STS-73 in 1995 and STS-82 in 1997.

SPACEFLIGHT EXPERIENCE

STS-50, June 25-July 9, 1992, was the first flight of the United States Microgravity Laboratory and the first Extended Duration Orbiter flight. Over a two-week period, the STS-50 flight crew aboard space shuttle Columbia conducted a wide variety of experiments relating to materials processing and fluid physics in a microgravity environment.

STS-61, Dec. 2-13, 1993, was the Hubble Space Telescope (HST) servicing and repair mission. During the 11-day flight, the HST was captured and restored to full capacity through a record five spacewalks by four astronauts.

STS-73, Oct. 20 to Nov. 5, 1995, was the second flight of the United States Microgravity Laboratory. The mission focused on materials science, biotechnology, combustion science, the physics of fluids, and numerous scientific experiments housed in the pressurized Spacelab module.

STS-82, Feb. 11-21, 1997, was the second Hubble Space Telescope (HST) maintenance mission. During the flight, the crew retrieved and secured the HST in Discovery's payload bay. In five spacewalks, two teams installed two new spectrometers and eight replacement instruments, as well as replacing insulation patches over three compartments containing key data processing, electronics and scientific instrument telemetry packages. Following completion of upgrades and repairs, HST was boosted to a higher orbit and redeployed.

Nikolai Budarin, Mission Specialist 4 (Up), 49 (RSC-Energia)

Seating: Middeck for launch.

Responsibilities: Budarin will serve as flight engineer 1 (FE1) of Expedition 6 and initially oversee the transfer and installation of the seat liners in the Soyuz spacecraft, which serves as the emergency rescue vehicle when the shuttle is not present. Budarin would pilot the Soyuz, if needed, and manages the equipment and operation of the Russian segment.

PERSONAL DATA

Born April 29, 1953, in Kirya, Chuvashia (Russia). Married to Marina Lvovna Budarina (nee Sidorenko). There are two sons in the family, Dmitry and Vladislav. His hobbies include fishing, skiing, picking mushrooms. His father, Mikhail Romanovich Budarin, died in 1984. His mother, Alexandra Mikhailovna Budarina, died in 1986.

EDUCATION

Graduated from the S.Ordzhonikidze Moscow Aviation Institute in 1979 with a mechanical engineering diploma.

SPECIAL HONORS

Awarded the titles of Hero of Russia, and a Pilot-Cosmonaut of the Russian Federation

EXPERIENCE

Since 1976 Budarin has occupied the positions of engineer and leading engineer at the RSC ENERGIA. In February 1989 he was enrolled in the ENERGIA cosmonaut detachment as a candidate test cosmonaut.

From September 1989 to January 1991, he underwent a complete basic space training course at the Gagarin Cosmonaut Training Center and passed a State examination. Budarin is qualified as a Test Cosmonaut.

From February 1991 to December 1993, he took an advanced training course for the Soyuz-TM transport vehicle and the Mir Station flight.

From June 27 to Sept. 11, 1995, Budarin participated in a space mission as a board engineer of the 19th long-term expedition launched by the space shuttle and landed by the Soyuz TM-21 transport vehicle.

From Jan. 28 to Aug. 25, 1998, he participated in a space mission as a board engineer of the 25th long-term expedition aboard the Mir Orbital Station.

Don Pettit, Mission Specialist 5 (Up), 47 (Ph.D.)

Seating: Middeck for launch.

Responsibilities: Pettit serves as flight engineer 2 (FE2) of Expedition 6 and will back up Whitson, if needed, during station robotic arm operations during the early stages of the P1 Truss' handoff from the shuttle's robot arm to the station's. During his four-month stay on the ISS, Pettit will serve as NASA ISS Science Officer and prime operator of the ISS robotic arm.

PERSONAL DATA

Born April 20, 1955, in Silverton, Ore. Married. Two children.

EDUCATION

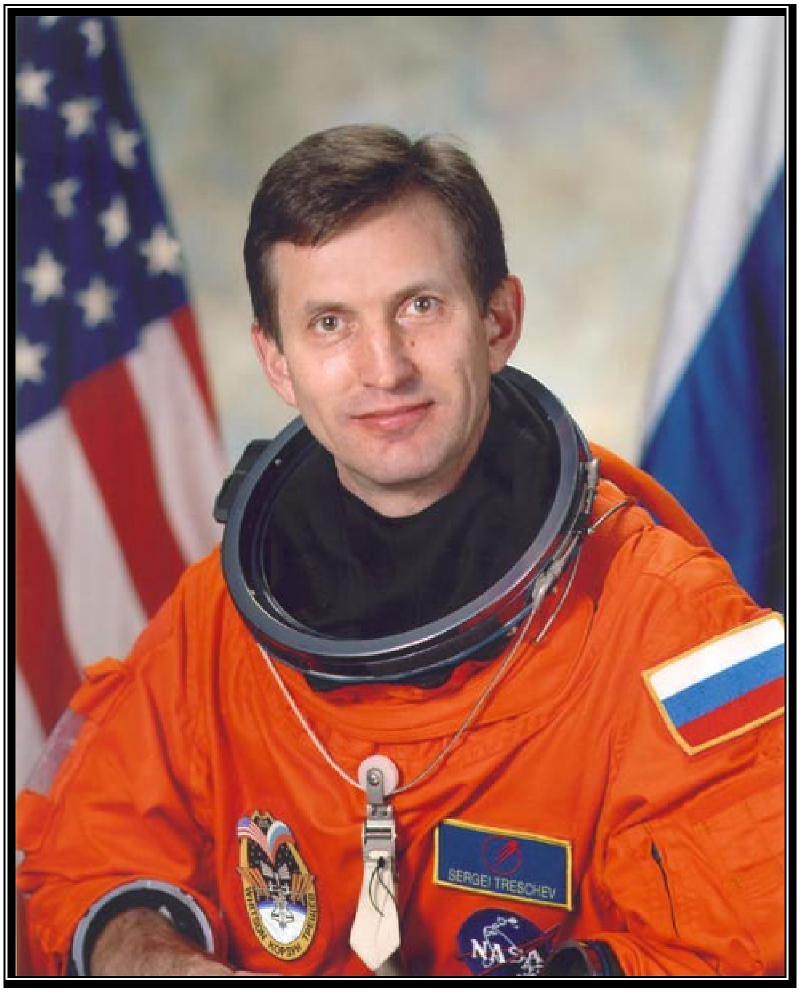
Graduated from Silverton Union High School, Silverton, Ore., in 1973; received a bachelor of science degree in chemical engineering from Oregon State University in 1978 and a doctorate in chemical engineering from the University of Arizona in 1983.

EXPERIENCE

Staff scientist at Los Alamos National Laboratory, Los Alamos, N.M., from 1984-1996. Projects included reduced gravity fluid flow and materials processing experiments on board the NASA KC-135 airplane, atmospheric spectroscopy measurements on noctolucent clouds seeded from sounding rocket payloads, volcano fumarole gas sampling on active volcanos, and problems in detonation physics applied to weapon systems. He was a member of the Synthesis Group, slated with assembling the technology to return to the moon and explore Mars (1990), and the Space Station Freedom Redesign Team (1993).

NASA EXPERIENCE

Selected by NASA in April 1996, Pettit reported to the Johnson Space Center in August 1996. Having completed two years of training and evaluation, he is qualified for flight selection as a mission specialist. Initially, he was assigned technical duties in the Astronaut Office Computer Support Branch.



Sergei Treschev, Mission Specialist 3 (Down), 44 (RSC-Energia)

Seating: Middeck for landing.

Responsibilities: Treschev served as the Expedition 5 Flight Engineer 2 during his five-month stay on the International Space Station.

PERSONAL DATA

Born Aug. 18, 1958, in Volynsky District, Lipetsk Region (Russia). Married to Elvira Victorovna Trescheva. They have two sons, Dmitry and Alexy. His father is Yevgeny Georgievich Treschev, and his mother is Nina Davydovna Trescheva. His hobbies include soccer, volleyball, ice hockey, hiking, tennis, music, photography, and video.

EDUCATION

Graduated from the Moscow Energy Institute in 1982.

EXPERIENCE

From 1982 to 1984, Treschev served as a group leader in an Air Force regiment. He worked as a foreman and as an engineer at the RSC ENERGIA from 1984 to 1986. His responsibilities included the analysis and planning of cosmonaut activities aboard the Mir and their in-flight technical training. He also developed technical documentation and, together with the Yuri Gagarin Cosmonaut Training Center, coordinated all facets of cosmonaut training. His duties also included crew support and training for descent and emergency escape scenarios aboard the Mir. He also participated as a test operator during tests of the ground-based complex (transport vehicle/*Mir* core module/*KVANT*-2 module docked configuration) to optimize the Life Support System of ЭУ367/734.

In 1992, he enrolled in the RSC ENERGIA cosmonaut detachment, and from 1992 to 1994 he completed the basic cosmonaut training course. Treschev spent the next three years (1994 to 1996) in advanced test cosmonaut training.

From June 1997 to February 1998, Treschev trained as a flight engineer for the Mir station backup Exp-25 crew.

From June 1999 to July 2000 he trained as a flight engineer for the Soyuz-TM backup ISS contingency crew.

Initially, he trained as backup to the ISS Expedition 3 crew.

Since June 7, 2002, Treschev has served as International Space Station (ISS) Increment 5 flight engineer.

**Valery Korzun, Mission Specialist 4 (Down),
49 (Col., Russian Air Force)**

Seating: Middeck for landing.

Responsibilities: Korzun served as the Expedition 5 commander during his five-month stay on the International Space Station. He will oversee the leak checks and hatch operations after Endeavour's docking. Korzun also will serve as the backup choreographer during the first of the three spacewalks by Lopez-Alegria and Herrington.

PERSONAL DATA

Born March 5, 1953, in Krasny Sulin. Korzun and his wife Elana have one son, Nikita. His father is Korzun Grigori Andreevich, and his mother, Korzun Maria Arsentievna.

EDUCATION

1974 graduate of the Kachin Military Aviation College; Commander Department of the Gagarin Air Force Academy, 1987.

SPECIAL HONORS

Awarded six Air Force Medals.

EXPERIENCE

After graduation from the Military College in 1974, he served as pilot, senior pilot, flight section leader, and ultimately commander of a Russian Air Force squadron. In 1987, after a successful tour as commander of the Gagarin Military Air-Force Academy, he was selected as a cosmonaut for training at the Gagarin Cosmonaut Training Center.

In December 1987 he began cosmonaut training and was certified as a test-cosmonaut in June 1989.

From September 1989 through September 1992, he trained for spaceflight as part of the test-cosmonauts group and from October 1992 to March 1994 he underwent extensive training as commander of the "Soyuz TM" rescue spacecraft. He also trained as a group member for flight on board the orbital complex Mir from March 1994 to June 1995.

Korzun also served as deputy director of the 27KC crew flight training complex as crew communication supervisor from March 1994 to January 1995.

Korzun is a 1st class military pilot and has logged 1,473 hours, primarily in four aircraft types. He is also an instructor of parachute training, and has completed 377 parachute jumps.

In August 1996 Korzun completed training as commander for the Mir-22/ NASA-3 and "Cassiopia" (sponsored by CNES) programs.

On March 2, 1997 Korzun returned to Earth after completing a 197-day flight on board the Mir. The program included joint flights with NASA/Mir 2, 3 and 4 astronauts, as well as astronauts from France and Germany. During the mission, Korzun performed two spacewalks totaling 12 hours and 33 minutes.

Since June 7, 2002, Korzun has served as International Space Station Increment 5 commander.

Peggy Whitson, Mission Specialist 5 (Down), 42 (Ph.D.)

Seating: Middeck for landing.

Responsibilities: Whitson served as the Expedition 5 Flight Engineer 1 and NASA ISS Science Officer during her five-month stay on the International Space Station. She is the primary station robotic arm operator throughout the installation of the P1 Truss onto the station and the first spacewalk, and will back up Bowersox throughout the second and third spacewalks.

PERSONAL DATA

Born Feb. 9, 1960, in Mt. Ayr, Iowa. Hometown is Beaconsfield, Iowa. Married to Clarence F. Sams, Ph.D. She enjoys windsurfing, biking, basketball, water skiing.

EDUCATION

Graduated from Mt. Ayr Community High School in 1978; received a bachelor of science degree in biology/chemistry from Iowa Wesleyan College in 1981, and a doctorate in biochemistry from Rice University in 1985.

AWARDS/HONORS

Two patents approved (1997, 1998); Group Achievement Award for Shuttle-Mir Program (1996); American Astronautical Society Randolph Lovelace II Award (1995); NASA Tech Brief Award (1995); NASA Space Act Board Award (1995, 1998); NASA Silver Snoopy Award (1995); NASA Exceptional Service Medal (1995); NASA Space Act Award for Patent Application; NASA Certificate of Commendation (1994); Submission of Patent Disclosure for "Method and Apparatus for the Collection, Storage, and Real Time Analysis of Blood and Other Bodily Fluids" (1993); Selected for Space Station Redesign Team (March-June 1993); NASA Sustained Superior Performance Award (1990); Krug International Merit Award (1989); NASA-JSC National Research Council Resident Research Associate (1986-1988); Robert A. Welch Postdoctoral Fellowship (1985-1986); Robert A. Welch Predoctoral Fellowship (1982-1985), Summa Cum Laude from Iowa Wesleyan College (1981); President's Honor Roll (1978-81); Orange van Calhoun Scholarship (1980); State of Iowa Scholar (1979); Academic Excellence Award (1978).

EXPERIENCE

From 1981 to 1985, Whitson conducted her graduate work in biochemistry at Rice University as a Robert A. Welch Predoctoral Fellow. Following completion of her graduate work she continued at Rice as a Robert A. Welch Postdoctoral Fellow until October 1986. Following this position, she began her studies at NASA Johnson Space Center as a National Research Council Resident Research Associate. From April 1988 until September 1989, Whitson served as the Supervisor for the Biochemistry Research Group at KRUG International, a medical sciences contractor at NASA-JSC. In 1991-1997, Whitson was also invited to be an Adjunct Assistant Professor in the Department of Internal Medicine and Department of Human Biological Chemistry and Genetics at University of Texas Medical Branch, Galveston, Texas. In 1997, Whitson began a position as Adjunct Assistant Professor at Rice University in the Maybee Laboratory for Biochemical and Genetic Engineering.

NASA EXPERIENCE

From 1989 to 1993, Whitson worked as a research biochemist in the Biomedical Operations and Research Branch at NASA-JSC. In 1990, she gained the additional duties of research advisor for the National Research Council Resident Research Associate. From 1991-1993, she served as technical monitor of the Biochemistry Research Laboratories in the Biomedical Operations and Research Branch. From 1991-1992 she was the payload element developer for Bone Cell Research Experiment (E10) aboard SL-J (STS-47), and was a member of the US-USSR Joint Working Group in Space Medicine and Biology. In 1992, she was named the project scientist of the Shuttle-Mir Program (STS-60, STS-63, STS-71, Mir 18, Mir 19) and served in this capacity until the conclusion of the Phase 1A Program in 1995. From 1993-1996 Whitson held the additional responsibilities of the deputy division chief of the Medical Sciences Division at NASA-JSC. From 1995-1996 she served as co-chair of the U.S.-Russian Mission Science Working Group. In April 1996, she was selected as an astronaut candidate and started training, in August 1996. Upon completing two years of training and evaluation, she was assigned technical duties in the Astronaut Office Operations Planning Branch and served as the lead for the Crew Test Support Team in Russia from 1998-99.

Since June 7, 2002, Whitson has been living and working aboard the International Space Station.

Rendezvous and Docking

Endeavour's rendezvous and docking with the International Space Station begins with the precisely timed launch of the shuttle on a course for the station. During the first two days of the mission, periodic engine firings will gradually bring Endeavour to a point about 9½ statute miles behind the station, the starting point for a final approach to the station.

About 2½ hours before the scheduled docking time on Flight Day 3, Endeavour will reach that point, about 50,000 feet behind the ISS. There Endeavour's jets will be fired in a Terminal Intercept (TI) burn to begin the final phase of the rendezvous. Endeavour will close the final miles to the station during the next orbit.

ISS005E16516

This view of the space shuttle Atlantis was photographed by an Expedition 5 crewmember on board the International Space Station (ISS) during STS-112 rendezvous and docking operations. The S-One (S1) Truss, similar to this mission's P-One (P1) Truss, can be seen in Atlantis' cargo bay.

As Endeavour closes in, the shuttle's rendezvous radar system will begin tracking the station and providing range and closing rate information to the crew. During the final approach, Endeavour can do as many as four small mid-course corrections at regular intervals. Just after the fourth correction is completed, Endeavour will reach a point about half a mile below the station. There, about an hour before the scheduled docking, Commander Jim Wetherbee will take over manual control of the approach.

He will slow Endeavour's approach and fly to a point about 600 feet directly below the station, from which he will begin a quarter-circle of the ISS, slowly moving to a position in front of the complex, in line with its direction of travel. Pilot Paul Lockhart will help Wetherbee in controlling Endeavour's approach**.** Mission Specialist John Herrington also will play key roles in the rendezvous, using a handheld laser ranging device and acting as a backup in operation of the docking mechanism to latch the station and Endeavour together after the two spacecraft make contact. Mission Specialist Michael Lopez-Alegria will operate the docking system and back up Herrington on the handheld laser.

Wetherbee will fly the quarter-circle of the station while slowly closing in on the complex, stopping at a point a little more than 300 feet directly in front of the station. From there, he will begin slowly moving Endeavour toward the station at about a tenth of a mile per hour. Using a view from a camera mounted in the center of Endeavour's docking mechanism as a key alignment aid, Wetherbee will precisely center the docking ports of the two spacecraft. He will fly to a point where the docking mechanisms are 30 feet apart, and pause to check the alignment.

S112E05779

A close-up view of the ISS docking adapter

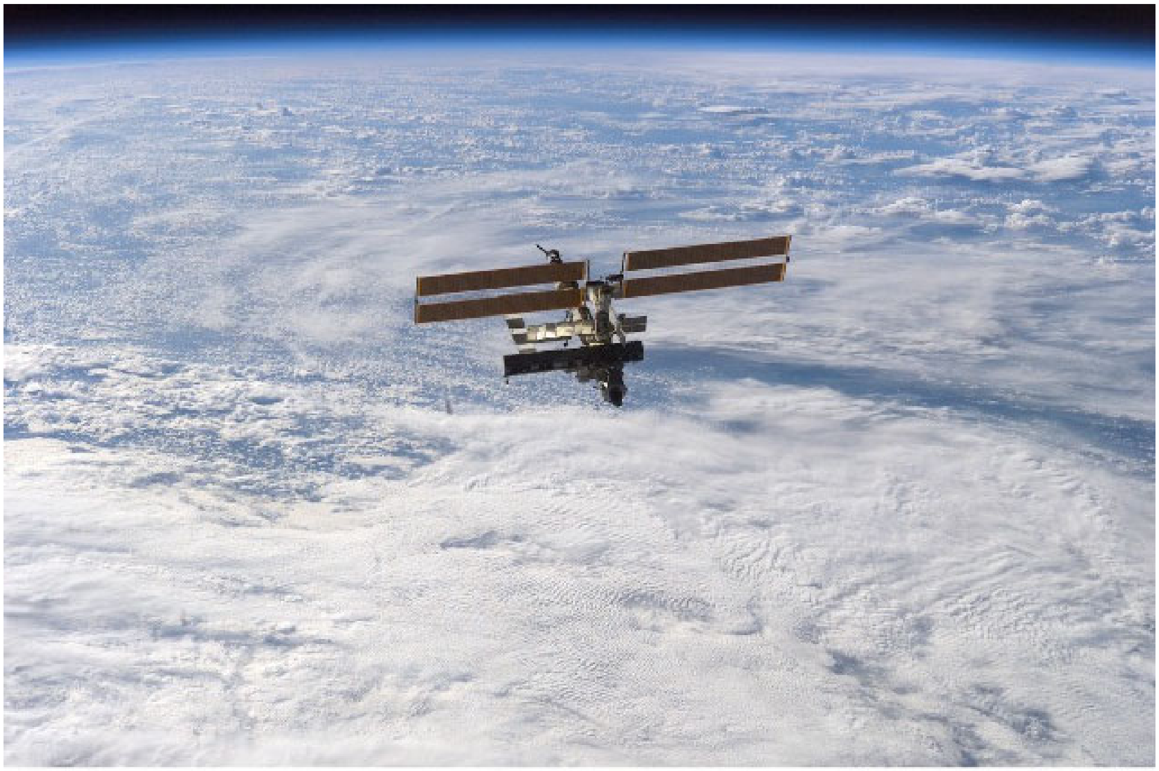
For Endeavour's docking, Wetherbee will maintain the shuttle's speed relative to the station at about one-tenth of a foot per second (while both Endeavour and the space station are traveling at about five miles a second), and keep the docking mechanisms aligned to within a tolerance of three inches. When Endeavour makes contact with the station, preliminary latches will automatically attach the two spacecraft. Immediately after Endeavour docks, the shuttle's steering jets will be deactivated to reduce the forces acting at the docking interface. Shock absorber-like springs in the docking mechanism will dampen any relative motion between the shuttle and the station.

Once that motion between the spacecraft has been stopped, Lopez-Alegria will secure the docking mechanism, sending commands for Endeavour's docking ring to retract and to close a final set of latches between the shuttle and station.

Undocking, Separation and Flyaround

Once Endeavour is ready to undock, Lopez-Alegria will send a command to release the docking mechanism. At initial separation of the spacecraft, springs in the docking mechanism will push the shuttle away from the station. Endeavour's steering jets will be shut off to avoid any inadvertent firings during this initial separation.

Once Endeavour is about two feet from the station, with the docking devices clear of one another, Lockhart will turn the steering jets back on and fire them to very slowly move away. From the aft flight deck, Lockhart will manually control Endeavour within a tight corridor as she separates from the ISS, essentially the reverse of the task performed by Wetherbee just before Endeavour docked.



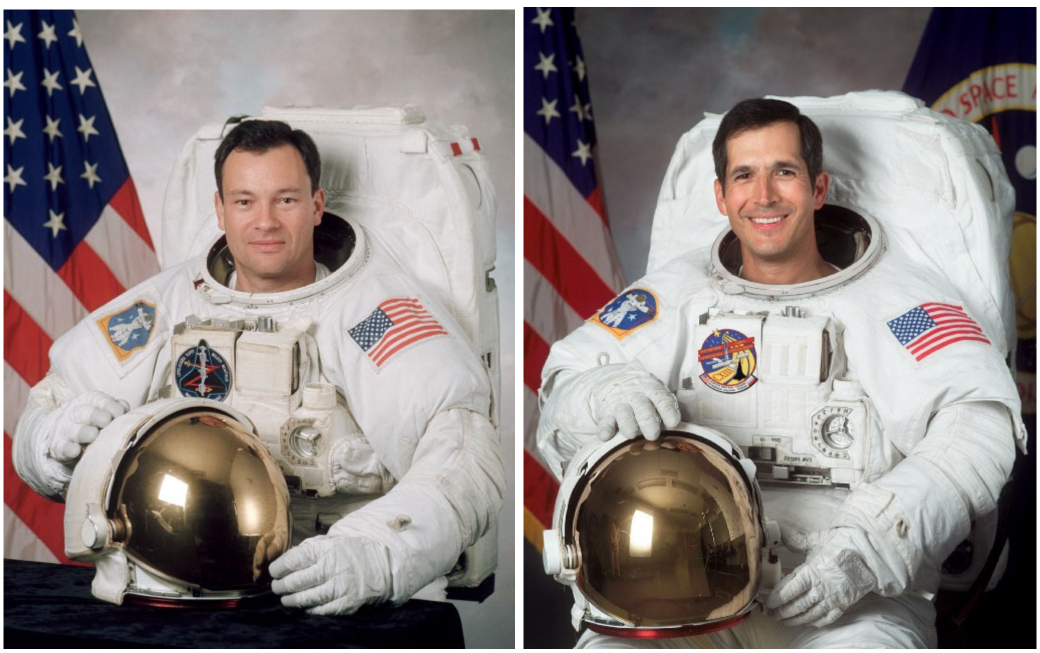
S112E05868

Endeavour will continue away to a distance of about 450 feet, where Lockhart will begin a close flyaround of the station, much like the one he did on STS-111 in June, circling the complex about one and a quarter times. Lockhart will pass a point directly above the station, then behind, then underneath, then in front and then reach a point directly above the station for a second time. At that point, passing above the orbiting laboratory, Lockhart will fire Endeavour’s jets for final separation from the station. The flyaround should take about an hour and 20 minutes after undocking.

Spacewalks

STS-113 Extravehicular Activity

Three spacewalks are scheduled for the STS-113 (11A) mission of Endeavour to the International Space Station. The spacewalks will be performed on alternate days, on the crew's flight days four, six and eight. Endeavour Mission Specialists Michael Lopez-Alegria and John Herrington will perform all three.



STS-113 Spacewalkers Michael Lopez-Alegria (left) and John Herrington (right)

Lopez-Alegria, EV1 (EV stands for Extravehicular Activity) will wear the spacesuit marked with solid red stripes, while Herrington, EV2, will wear an all-white spacesuit. Each spacewalk will last about 6½ hours. Lopez-Alegria has conducted two previous spacewalks. This will mark the first spacewalks for Herrington.

The spacewalks focus on installation and hookup of the Port 1 (P1) Truss, the 45-foot-long third part of the station's Integrated Truss Structure (ITS) to the Starboard 0 (S0) Truss, the center of the ITS. The ITS eventually will have 11 segments and stretch 356 feet from end to end. It will support four virtually identical solar array assemblies, including the one now atop the P6 Truss of the ISS, and radiators to cool the station. The truss, the backbone of the station, also will support experiments. It already boasts a railroad track with a mobile base for the station's robotic arm, Canadarm2.

Astronaut John B. Herrington, STS-113 mission specialist, participates in an Extravehicular Mobility Unit (EMU) fit check in a Space Station Airlock Test Article (SSATA) in the Crew Systems Laboratory at the Johnson Space Center (JSC).

All the spacewalks will be conducted from the station's Joint Airlock Quest. Before each, Lopez-Alegria and Herrington will use the ISS Exercise EVA Protocol. Designed to purge nitrogen from the body, the protocol involves breathing pure oxygen while exercising vigorously. It eliminates the need to spend many hours at reduced cabin pressure and allows hatches between the shuttle and the station to remain open. The protocol was first used during STS-104 during the first spacewalk from the Joint Airlock installed earlier during that mission.

Endeavour Pilot Paul Lockhart will be the Intravehicular (IV) crewmember, offering advice and coordinating spacewalk activities. Primary Canadarm2 operator during the spacewalks will be Expedition 5 crewmember Peggy Whitson, with help from Expedition 6 Commander Ken Bowersox and Expedition 6 Flight Engineer Don Pettit. Endeavour Commander Jim Wetherbee will operate the shuttle's robotic arm, providing video and documentation.

Lockhart and Expedition 5 Commander Valery Korzun will help with spacewalk preparation and be with Lopez-Alegria and Herrington in the Joint Airlock during depressurization to 10.2 psi.

Spacewalk No. 1, Flight Day Four: Connect power, data and fluid umbilicals between S0 and P1, release Crew and Equipment Translation Aid (CETA) launch locks, install Spool Positioning Devices (SPDs), drag link removal, and install Node Wireless video system External Transceiver Assemblies (WETA).

Before Lopez-Alegria and Herrington emerge from the airlock, Wetherbee will use the shuttle's robotic arm to grapple P1 and lift it from the payload bay, then hand it off to the station's Canadarm2, operated by Whitson and Bowersox. They will move P1 to the end of S0. After a claw attaches itself to P1 and draws it into position and bolts secure ends of the two segments, Lopez-Alegria and Herrington will emerge from the Joint Airlock and begin setting up for the first spacewalk.

Once he is clear of the airlock, Herrington will move to the rail lines along P1, where he will release CETA cart launch latches, a two-hour and 20-minute job. The task involves releasing a total of 24 bolts. First among them are the cart's brake system bolts; their removal enables the CETA's brakes to be used.

Meanwhile, Lopez-Alegria will maneuver to the cable tray on the bottom of P1. Working from a portable foot restraint, he will open covers of cable trays on the lower sides of S0 and P1, then demate connectors on the S0 side from temporary attachment points and connect their free ends to receptacles on P1.

Astronauts Michael E. Lopez-Alegria (left) and John B. Herrington, both STS-113 mission specialists, use the virtual reality lab at the Johnson Space Center (JSC) to train for their duties aboard the space shuttle Endeavour.

After that 45-minute task, Lopez-Alegria will begin installation of four 1½-inch SPD on Flex Hose Rotary Coupler (FHRC) Quick Disconnects (QDs). He then will move inboard along P1 to the truss' bay 12 and install two more 1½-inch SPDs.

SPDs are devices that maintain the QDs, in ammonia lines that are part of the station's cooling system, in a position to enable them to function optimally. The installation of the 1½-inch SPDs involves installing the aft part of the SPD, then moving a bail (QD valve) back about ¼-in and installing the forward part of the SPD. This keeps the QD valve in a fixed position.

Back together again, Herrington and Lopez-Alegria move on to P1's starboard drag link, located on the forward face of the truss.

They will work together to release that drag link, a large metal rod used as a launch restraint. Lopez-Alegria will release a bolt attaching the drag link to P1, while Herrington releases a similar bolt attaching the drag link to the keel. Lopez-Alegria takes the drag link to its stowage location on the P1 framework and attaches it with Herrington's assistance.

The processes are repeated on the P1 port drag link.

That 30-minute task completed, Lopez-Alegria moves to the cable tray atop P1. There he will make additional connections, opening thermal covers over cable trays atop S0 and P1, then demating connectors on the S0 side from temporary attachment points and connecting their free ends to receptacles on P1.

After that task, Lopez-Alegria and Herrington, who has done some additional work on the CETA, will combine on the final major task of the spacewalk, a two-hour installation on the Unity Node of the first WETA, designed to support spacewalkers' helmet cameras.

Lopez-Alegria moves to the P1's starboard keel pin, retrieves the WETA stanchion and takes it to the Joint Airlock. There he and Herrington will spend about 15 minutes attaching the WETA to the stanchion. Herrington retrieves the WETA from its temporary airlock stowage position. While Lopez-Alegria holds the WETA in place, Herrington uses a pistol-grip tool to secure a center jacking bolt and then two outer bolts.

Lopez-Alegria, with the WETA, and Herrington move to the installation location on the node. With help from Herrington, Lopez-Alegria secures it by driving a stanchion bolt. Subsequently he mates three stanchion power and data connectors to the node.

After about half an hour of EVA cleanup the spacewalkers will re-enter the airlock.

Spacewalk No. 2, Flight Day Six: Fluid Jumper Installation, keel pin removal, P1 WETA installation and CETA relocation.

Once they are out of the airlock and setup is complete, Lopez-Alegria and Herrington move to a point at the junction of S0 and P1 for a two-hour installation of fluid jumpers to move ammonia between the two. The two release two jumpers on S0, then move to the jumper install position.

Lopez-Alegria will mate and install SPDs on two jumper connections on the S0 side, while Herrington performs a similar task on the P1 side. Each connection will involve a three-minute leak check. Lopez-Alegria and Herrington reinstall the thermal booties and together they close their respective ends of the P1 and S0 utility tray shrouds. Then Herrington and Lopez-Alegria, the latter on the CETA cart, move on to P1's starboard keel pin.

Lopez-Alegria sets the CETA brakes, and at the worksite releases the top keel pin bolt, rotates the keel pin, then reinstalls the bolt. He then removes the lower keel pin bolt, frees the keel pin and reinstalls the bolt. Herrington moves the CETA along with Lopez-Alegria and the keel pin, a few feet down the tracks. From the new location, Lopez-Alegria installs the keel pin in stowage brackets inside the P1 framework, completing the half-hour task.

As part of Crew Equipment Interface Test activities, STS-113 Spacewalkers Michael Lopez-Alegria (left) and John Herrington look over tools that will be carried on the mission.

Working together, the spacewalkers move on to installation of the second WETA, on the P1 itself. This installation should take about an hour, and is completed in a manner similar to the Node WETA installation.

While Lopez-Alegria completes the connections to the P1 WETA, Herrington will perform a test of the Segment-to-Segment Attachment System on the outboard end of P1. Lopez-Alegria and Herrington then move on to release of the port keel pin, repeating the tasks performed during release of the starboard keel pin.

Finally, they will spend a little more than an hour moving the CETA launched on P1 to S1. Herrington will be on the end of Canadarm2, operated by Pettit, for this activity. The two spacewalkers will release the CETA from its tracks, move it around the Mobile Transporter (which supports the Mobile Base System for the Canadarm2), attach it to the tracks again and couple it to its sister CETA.

Spacewalkers will re-enter the airlock after about half an hour of cleanup operations.

Spacewalk No. 3, Flight Day Eight: SPD installation, Circuit Interrupt Device (CID) Main Bus Switching Unit (MBSU) reconfiguration and connect Ammonia Tank Assembly (ATA) umbilicals.

The third spacewalk is devoted almost entirely to installation of SPDs.

After setup, Herrington will enter a bay in the SO Truss and operate two CIDs allowing ground controllers to begin work on the MBSU reconfiguration. From there, Herrington will move to the top center of the P1 Truss and attach a foot restraint at the end of the Canadarm2. Herrington will then ingress the foot restraint and Pettit, at the arm's controls, will maneuver him to the starboard end of the P1. There Herrington will begin the installation of a dozen 1-inch SPDs on lines linking the Radiator Beam Valve Modules (RBVMs) and the radiator junction box.

He then gets off the arm and continues with the 1-inch SPD installations, moving out toward the outboard end of the P1. During this three-hour-plus phase of the spacewalk, Herrington will install a total of 18 SPDs.

Meanwhile Lopez-Alegria installs two 1-inch SPDs at the Z1 to P6 interface, and then moves to the bottom of the Z1 Truss at its junction with the U.S. laboratory Destiny. There he will install two 1-inch SPDs. Next he moves to the Moderate Temperature Loop Heat Exchanger on the lab's exterior, removes a Micro Meteoroid Orbital Debris shield and installs two 1-inch SPDs, and finally reinstalls the shield.

His next task is at the pump module on P1. There he will install three 1½-inch SPDs and a half-inch SPD.

Lopez-Alegria will take a break from SPD installation with his next activity, reconfiguration of electrical harnesses that route through Main Bus Switching Units.

That 40-minute task, involving relocating two dustcaps and changing four cable connections from two foot restraint positions in the interior of the S0 Truss in bay 4, is completed by Lopez-Alegria about four hours into the spacewalk. Following the RBVM SPD installation, Herrington will focus his attention on the Ammonia Tank Assembly (ATA) umbilicals. The P1 ATA is on the starboard-most bay of P1 on the aft face. That 40-minute job, linking the ATA to ammonia lines in the station's cooling system and the Nitrogen Tank Assembly lines to the ATA, involves relocation of four quick disconnect caps and hookup of four connections. Herrington also will install one ½-inch SPD during that process.

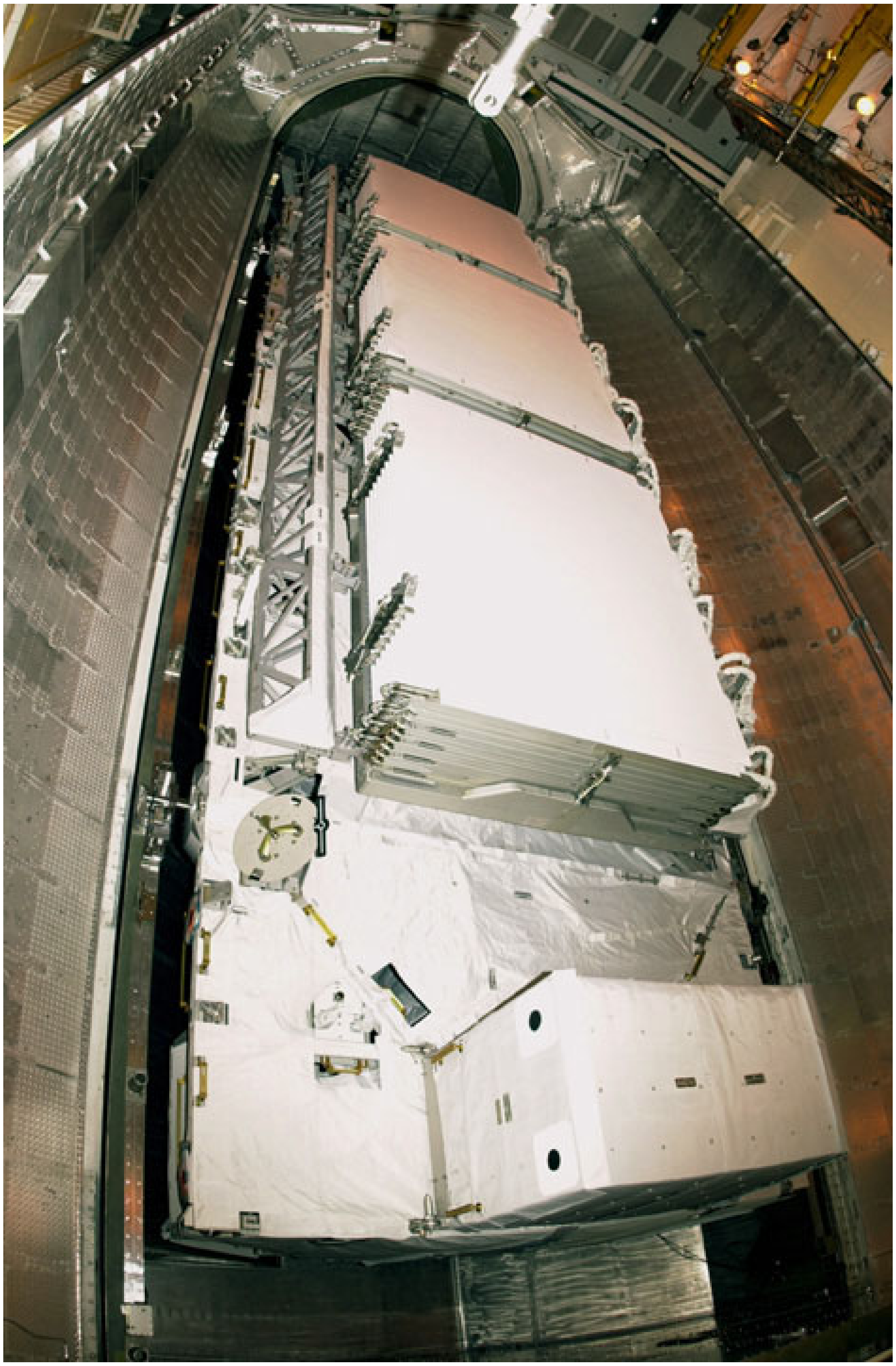
Herrington's final task of spacewalk No. 3 is installation of three 1½-inch and one ½-inch SPDs on S1 Pump Module connector lines. Lopez-Alegria also will move to S1, to install four 1½-inch SPDs on Flex Hose Rotary Coupler (FHRC) QDs. Those tasks accomplished, both spacewalkers will begin an EVA cleanup period and then move into the airlock.

Lopez-Alegria and Herrington install more than 40 SPDs during STS-113 spacewalks.

Payloads

Payload Overview

The primary cargo element to be delivered on Mission 11A is the first port truss segment, Port 1 (P1), of the main International Space Station (ISS) Integrated Truss Structure (ITS). The ITS will eventually be used to support the four power-generating Photo-Voltaic Modules (PVMs) of the ISS, the permanent External Active Thermal Control Subsystem (EATCS) and will also provide a translation path for the Mobile Servicing System (MSS) along specially designed truss rails. The truss rails allow the Space Station Remote Manipulator System (SSRMS) to be positioned at various locations along the truss for performing maintenance tasks, element installations, and providing EVA assistance.



At Launch Complex 39A, the payload canister doors are open to reveal the P1 Truss before transfer to the Payload Changeout Room.

Integrated within the P1 Truss segment are various hardware components and their associated cabling for powering and controlling the port side systems of the ITS. P1 is pre-integrated with Ultra-High Frequency (UHF) communication equipment, Thermal Radiator Rotary Joint (TRRJ), three EATCS radiators, DC-to-DC Converter Unit (DDCU), Remote Power Controller Module (RPCM), Nitrogen Tank Assembly (NTA), Ammonia Tank Assembly (ATA), Pump Module Assembly (PMA) and the second Crew Equipment and Translation Aid (CETA) cart, CETA Cart 2.

The middeck of Endeavour will be filled with Extravehicular Activity (EVA) tools and equipment, crew rotation equipment, Operations Data File (ODF), Crew Health Care System (CheCS), crew provisions, ISS Utilization payloads, which includes Human Research Facility (HRF) resupply and three Payload Mounting Panels (PMPs) to be replaced by returning powered payloads, Portable Computer System (PCS) items, and photo/TV equipment.

The Return Complement (RC) consists of crew rotation hardware, CheCS resupply, excess integration hardware, Russian hardware, and returning utilization complement, which consists of HRF passive stowage, Commercial Generic Bioprocessing Apparatus (CGBA), Single Thermal Enclosure System (STES), and the Plant Growth Bioprocessing Apparatus (PGBA).

Secondary Payloads

The MEMS-based Pico Satellite (PICOSAT) Inspector (MEPSI) payload consists of a launcher, or garage, which houses a set of two small deployable satellites, referred to as PICOSATs. Each PICOSAT weighs about 1 kilogram (2.2046 pounds). The two miniature satellites will be attached to each other with a tether on early flights. The launcher is mounted to a standard space shuttle-provided Adaptive Payload Carrier (APC). The total assembly, including launcher, firing circuit and PICOSATs, is referred to as the PICOSAT Launcher Assembly (PLA). The total weight, including the PLA and the attachment bracket, is about 8 kilograms (18 pounds).

After release, the PICOSATs operate on battery power for several days to complete mission objectives.

Payloads of Opportunity

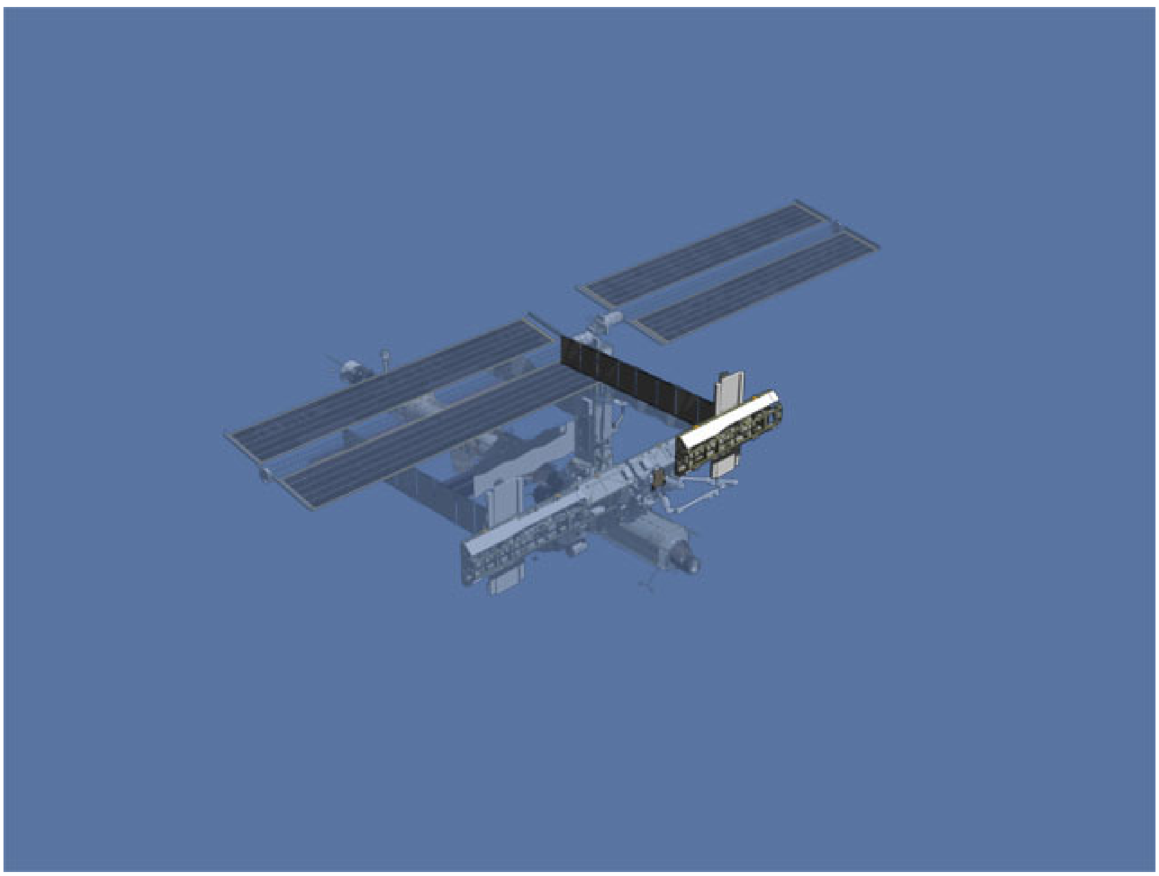
None.

Payloads

P1 Truss to Join Mirror Image S1 in Space

The Port One (P1) Truss is slated for launch to the International Space Station aboard space shuttle Endeavour no earlier than Nov. 10, 2002, from Kennedy Space Center, Fla. The truss is the next major addition to the space station's 11-segment Integrated Truss Structure that will eventually span more than 300 feet to carry power, data and temperature control for the orbital outpost's electronics. When completed, the ends of the truss structure will also house the station's solar arrays.

During Endeavour's mission, spacewalkers assisted by the ISS robotic arm, will attach P1 to the Starboard Zero (S0) Truss already in place aboard the U.S. laboratory module Destiny. Astronauts will make three spacewalks to complete installation and assembly of the P1. Space shuttle Atlantis delivered S1 to the ISS in October 2002 and it is attached to the other side of the S0 Truss.



The 27,506 lb. P1 Truss is primarily an aluminum structure that is 45 feet long, 13 feet high and 15 feet wide. The structure, along with one CETA (Crew and Equipment Translation Aid) cart, costs about $390 million.

Boeing designed the P1 Truss in Huntington Beach, Calif., and began construction there in January 1997. Work on P1 was completed in Huntsville, Ala., in June 2000. The P1 moved to Kennedy Space Center, Fla., in July 2000 for flight processing. Boeing delivered the P1 to NASA in November 2001 for final preparations and preflight checks.

Both P1 and S1 trusses will provide structural support for the Active Thermal Control System (ATCS), the Mobile Transporter, a CETA cart and antennas. The S1 has an S-band system; the P1 a UHF system. Both trusses also have mounts for cameras and lights. P1 also has a port for an S-band antenna. The S-band system is located on the P6 Truss and will be installed by spacewalkers on an upcoming mission.

Additionally, both S1 and P1 carry three radiators each containing eight panels as part of the ATCS or cooling system for the space station’s electronics. The radiators are deployed in orbit and use 99.9 percent pure ammonia as compared to 1 percent strength found in the household variety. Ammonia rather than water is used because of its low freezing point and ability to transfer heat.

The radiator assembly also rotates to keep itself in the shade and away from the sun. Each radiator has 18 launch locks securing the assembly during launch which will be deployed/stowed during a spacewalk. The Thermal Radiator Rotary Joint (TRRJ) rotates the three radiator structures in a 105-degree span either way. The TRRJ also transfers power and ammonia to the radiators.

The addition of P1 also extends the Mobile Transporter (MT) rail line. The MT car travels along the length of the truss structure and carries spacewalkers, tools, construction items and the space station robotic arm. Flying aboard P1 is one of two CETA carts that move spacewalkers along the MT rails to worksites along the truss structure. The cart is manually operated by a spacewalker and can also be used as a work platform. S1 and P1 carry one cart each.

Payloads

International Space Station S1 and P1 Truss Summary

The Starboard One (S1) and Port One (P1) trusses will be attached to the S0 Truss aboard the International Space Station. The trusses provide structural support for the Active Thermal Control System, Mobile Transporter (MT), Crew and Equipment Translation Aid (CETA) cart, camera/light operations, and S-band and UHF communications. Once in orbit, the S1 and P1 end bulkheads will be used as attachment points for the S0, P3 and S3 truss segments.

The CETA cart moves spacewalkers along the MT rails to worksites along the truss structure. The cart is manually operated by a spacewalker and can also be used as a work platform. S1 and P1 carry one cart each.

The Thermal Radiator Rotary Joint (TRRJ) rotates the three radiator structures in a 105-degree span either way. The TRRJ also transfers power and ammonia to the radiators.

Differences between S1 and P1

There are very few differences between the S1 and P1 elements. The primary structure (bulkheads and longerons) of S1 and P1 are mirror images of each other. All parts are all coated with an optical anodized surface preparation.

Another unique attribute of the two elements is their communication capability. The S1 was launched with an S-band antenna system, whereas P1 has a UHF capability. P1 also has a port for an S-band antenna. The S-band system is currently located on the P6 Truss and will be installed by spacewalkers on an upcoming mission.

Both trusses house the Active Thermal Control System. This system acts like the cooling system on a car radiator except this system uses 99.9 percent pure ammonia (compared to 1 percent in household products). The system will provide temperature control for the space station’s electronics.

Boeing technicians install a radiator on the Port One (P1) Truss inside the Kennedy Space Center, Fla., Space Station Processing Facility during summer 2002. The radiator will be used to control the temperature of the International Space Station's electronics.

Facts in brief:

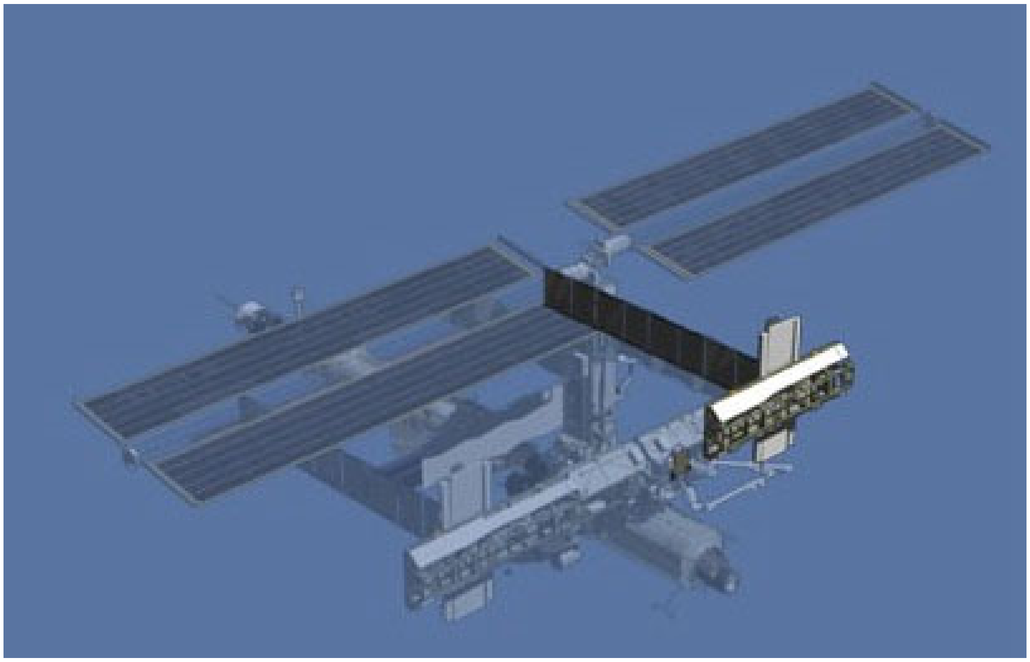
- Manufacturer: Boeing
- Dimensions: 45 ft. x 15 ft. x 13 ft.
- Weight: 27,717 lbs. (S1); 27,506 lbs. (P1)
- Cost: $390 million each (one CETA cart launched on each truss element)
- Structure: Primarily aluminum
- Major components: Primary structure is made of anodized aluminum and includes seven bulkheads per segment, eight longerons per segment, heat transport subsystem, radiator support beam, on-orbit video camera, electrical equipment, S-band antenna system; UHF antenna system for P1 and the Thermal Radiator Rotary Joint (TRRJ).
- Purpose: To carry power and data along the integrated truss structure to space station components. Also to provide active thermal protection to electrical components throughout the station.
- Construction: **P1:** Boeing designed the P1 Truss in Huntington Beach, Calif., and began construction there in January 1997. Work on P1 was completed in Huntsville, Ala., in June 2000. The P1 moved to Kennedy Space Center, Fla., in July 2000 for flight processing. Boeing delivered the P1 to NASA in November 2001 for final preparations and preflight checks. **S1:** Started assembly at Boeing plant in Huntington Beach in May 1997; moved to Boeing facility in Huntsville in February 1999 for completion and then to Boeing Florida Operations at Kennedy Space Center in October 1999 for flight processing. S1 handed off to NASA in November 2001.

- Major subcontractors: Lockheed Martin, Honeywell, L3 Communications, Hamilton Sundstrand and Parker Symetrics.

- Installation: S1 installed during mission STS-112/9A October 2002, P1 to be installed during STS-113/11A, November 2002.

- Radiator assembly: The entire radiator beam assembly (upper portion of the elements) rotates to keep the radiators in the shade. There are 18 launch locks that keep this radiator beam assembly together during launch – all deployed/stowed by EVA.

The Port One (P1) Truss for the International Space Station sits inside the Kennedy Space Center, Fla., Space Station Processing Facility during June 2002. The radiator assembly (covered by white thermal blankets) can be seen on top of the truss. Space shuttle Endeavour will deliver P1 during mission STS-113.



P1 Truss placement aboard ISS

More info at:

Space shuttle schedule -- http://www-pao.ksc.nasa.gov/kscpao/schedule/schedule.htm

Mission info – http://spaceflight.nasa.gov

Boeing ISS site – http://www.boeing.com/defense-space/space/spacestation/flash.html

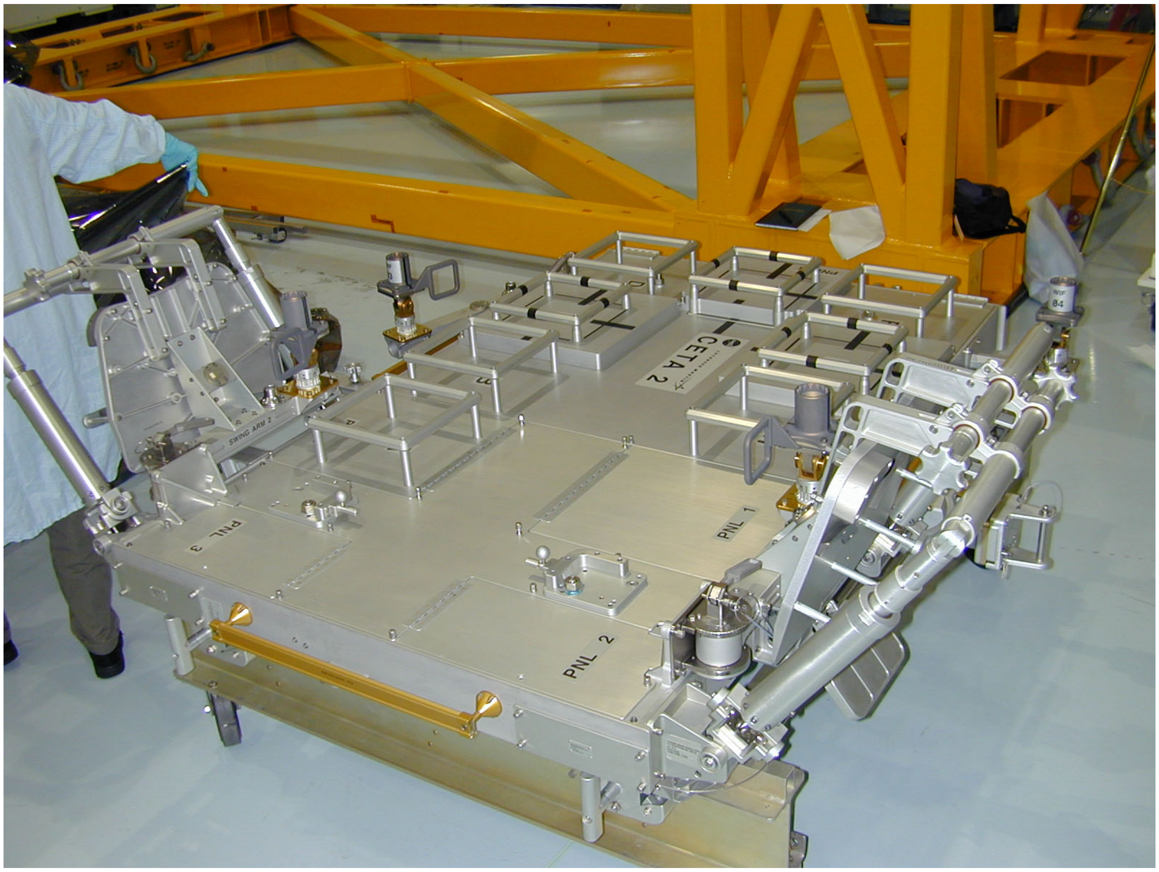
Truss photos – http://www.boeingmedia.com

Payloads

Crew and Equipment Translation Aid (CETA) Cart

What happens when Lockheed Martin and NASA CTSD team members engineer a solid, roughly 2,500-pound block of aluminum and transform it into a 142-pound frame assembled with more than 1,100 parts? You get the Crew and Equipment Translation Aid (CETA), a complex, dynamic mechanical translation device – NASA's equivalent of a flatbed truck. The second of two CETAs, CETA 2, will launch this fall on STS-113, station assembly flight 11A.

CETA, one of the largest pieces of extravehicular activity (EVA) equipment built for the International Space Station (ISS), will accompany the first portside truss, called Port One (P1), to orbit. This truss will become the backbone of the four solar wing assemblies and will incorporate many orbital replaceable units (ORU). Installation and maintenance of these ORUs – for example batteries, the DC-to-DC converter, the Remote Power Controller Module, and the multiplexer/demultiplexer – is critical. At this time, NASA uses space-walking crewmembers or robotics to repair or replace those units. The need for a work platform that could also provide the crew with a means of transporting themselves, the necessary tools and ORUs safely and easily along the truss became crucial. The SEAT-engineered CETA fulfills those requirements.



Crew and Equipment Translation Aid (CETA) Cart 2

The CETA is launched as an integrated part of the P1 Truss segment. Once deployed on orbit, crewmembers can propel themselves and accompanying hardware manually along the Mobile Transporter (MT) rails. On orbit, the two CETA carts will be located one on each side of the MT for usage flexibility. If required, a cart may be moved to the other side of the MT to complement the other cart. The CETA has attachment points for other EVA hardware such as the ORU Transfer Device (OTD), also known as the Space Crane; Articulating Portable Foot Restraint (APFR); EVA Tool Stowage Device (ETSD); and a host of other small crew and equipment restraining tools. During ISS assembly operations, crewmembers will also use CETA as a work platform to reach 90 percent of the worksites safely. When not in use the CETAs will attach to the MT for stowage and become part of a "train" that allows the SSRMS to move freely along the truss.

CETA is made of many components, including the following major subassemblies:

- A main frame;
- Launch restraints to ensure CETA is secured to the truss segment;

- A wheel/brake subsystem to move along the truss;
- A dynamic brake for speed control and a parking brake for use at worksites;
- Energy absorbers to reduce the impact of a hard stop;
- Three swing arms to provide access to structures along side the truss; and
- An ORU transfer flat bed for attaching ORUs.

The first CETA cart, CETA 1, was launched with the Starboard One (S1) Truss on STS-112 (9A) in October 2002.

Payloads

MEPSI Pre-flight Clears Way for Rapid Space Access of Miniature Platforms on Space Shuttle

The MEMS-based PICOSAT Inspector (MEPSI) experiment series will conduct its third space test mission as two miniature satellites are released on orbit from NASA's STS-113 shuttle mission. The tethered satellite pair, each measuring 4" x 4" x 5", will be released from a specialized spring-loaded launcher assembly mounted on the sidewall of the space shuttle Endeavour en-route from the International Space Station (ISS).

Funded by the Defense Advanced Research Projects Agency (DARPA), this "PICOSAT" mission represents a significant step forward in the development of an on-board autonomous inspection capability being directed by the Air Force Research Laboratory (AFRL) Information Directorate located in Rome, N.Y. Researchers at the Information Directorate envision MEPSI enhancing satellite command and control operations by providing active on-board imaging capability to assess spacecraft damage, monitor launch and deployment sequences, and augment servicing operations. This will provide the foundation for a rapid feedback capability for spacecraft operators to detect and respond to anomalies while maintaining continual service to their users, and enable ultimate spacecraft longevity.

MEPSI is integrated and flown under the direction of the Department of Defense Space Test Program. Third in a series of incremental flight experiments (two previous flights, one in February 2000 and the other in September 2001, were deployed from the Air Force's new OSP-Minotaur launch vehicle), the success of this mission also demonstrates a new capability for NASA's shuttle program that allows for PICOSAT type payloads to be flown on virtually any shuttle mission.

The two PICOSATs, built by The Aerospace Corporation and the NASA Jet Propulsion Laboratory (JPL), are adjoined by a 50-foot non-conducting tether to facilitate detection by Earth-based radar and keep them in radio range of each other. The objectives of the minimum three-day mission include:

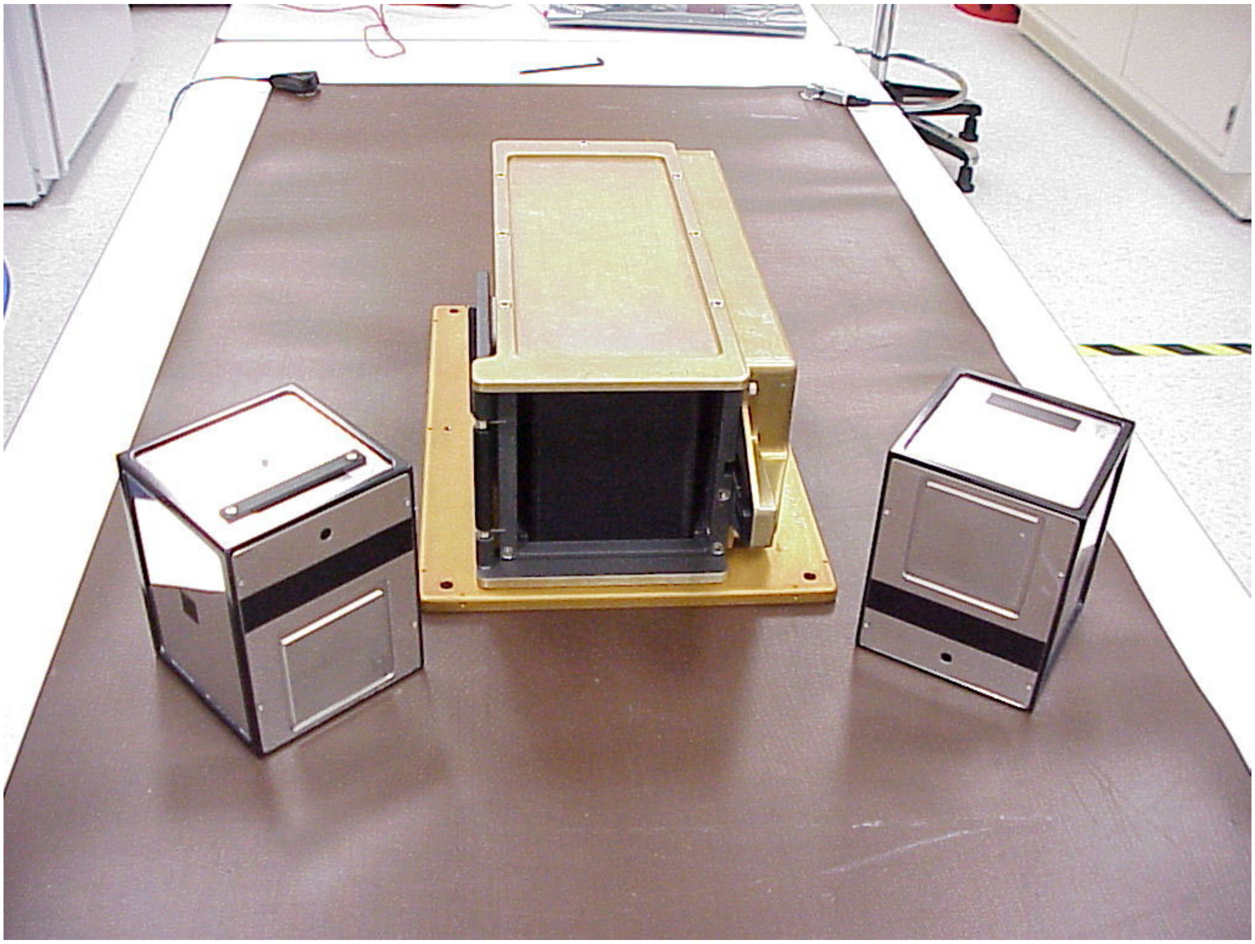
- Demonstration of a "new" 4-inch form factor launcher assembly approved for use in the shuttle cargo bay;
- Establish communications and data exchange between the two PICOSATs and the ground station;
- Exercise on-board Microelectromechanical Systems (MEMS) inertial measurement system;

- Implementation of MEMS RF switches in transmit/receive operation along the communications critical path;

- Improved RF transmit power.

Among the major challenges of this mission are to implement the greatest amount of science within a fairly minimal power budget.

In addition to the primary mission of realizing the MEPSI concept, the PICOSATs serve as a low-cost test bed for progressive development and insertion of micro- and nano-technologies into radically different space systems. The PICOSAT platform serves as an ideal means for proving revolutionary technologies and concepts without breaking the bank.



Experiments

Science Overview

The STS-113 mission will mark the beginning of a new expedition aboard the International Space Station, with a new crew and a combination of new and continuing scientific exploration.

The crew of Expedition 6 – the sixth crew to live and work on the orbiting outpost -- will be launched to the space station in November aboard space shuttle Endeavour. Endeavour will return the Expedition 5 crew to Earth. Expedition 6 is scheduled to end in March 2003.

Several new experiments will be ferried to the orbiting outpost during Expedition 6. The Expedition will feature a total of 19 new or continuing investigations. New experiments are expected to lead to insights in the fields of medicine, materials, plant science, commercial biotechnology, and manufacturing. Several experiments begun on earlier expeditions will return to Earth, while several others will continue operating during Expedition 6.

NASA's Marshall Space Flight Center in Huntsville, Ala., manages all science research experiment operations aboard the Station, coordination of the science mission planning work of a variety of international sources, as well as payload training for the station crew and payload operations ground personnel.

Experiments headed for the space station on STS-113 are:

Microgravity Science Glovebox-Coarsening in Solid Liquid Mixture (CSLM), an experiment to investigate the interaction of small and large particles in a mixture that can have an effect on the strength of materials ranging from turbine blades to dental fillings and porcelain. This experiment will be the third conducted in the Glovebox. Space shuttle Endeavour ferried the Glovebox to the station in June. Built by the European Space Agency, the Glovebox features a sealed work area with windows and attached rubber gloves that allow crewmembers to work safely with experiments involving chemicals, fluids and burning or molten samples.

Microgravity Science Glovebox-InSPACE, an experiment 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.

Foot/Ground Reaction Forces During Spaceflight, an experiment to characterize the load on the lower body and muscle activity in crewmembers while working on the Station. The human life science experiment is expected to provide data that could help maintain crew health on long duration space missions.

Protein Crystal Growth Single-locker Thermal Enclosure System (PCG-STES): Proteins to be grown in the microgravity environment of the space station will arrive on the STS-113 mission. A payload on two earlier station expeditions, the PCG-STES experiment facility will again provide a temperature-controlled environment for growing a new set of high-quality 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.

Zeolite Crystal Growth Furnace (ZCG): This experiment is sponsored by a commercial firm attempting to grow larger crystals in microgravity, with possible applications in chemical processes, electronic device manufacturing and other applications on Earth. New samples will be ferried up for processing in the ZCG furnace, which was first installed and used during Expedition Four.

Experiments returning to Earth on STS-113 are:

Protein Crystal Growth Single-locker Thermal Enclosure System (PCG-STES): Protein samples, ferried to the station aboard the STS-112 mission in October and crystallized during Expedition 5, will be carefully loaded aboard the shuttle for analysis soon after the shuttle lands.

Zeolite Crystal Growth Furnace (ZCG): Samples processed during Expedition 5 will be stowed aboard the shuttle for return to Earth on STS-113.

Solidification Using a Baffle in Sealed Ampoules (SUBSA): This Microgravity Science Glovebox experiment was designed to process crystals of indium antimonide, used to make semiconductors on Earth. The science objectives of this investigation were to test an automatically moving baffle, or barrier, designed to reduce movement of the melted material, to see if it could further reduce residual flow of the molten material caused by non-convective forces.

Microencapsulation Electrostatic Processing System (MEPS): Improvements in the manufacturing processes for enclosing liquids – including drugs – in microscopic capsules in microgravity conditions also were investigated. Samples processed during Expedition 5 will be returned to Earth, while experiment hardware remains on board to support future experiments.

On the Internet:

For fact sheets, imagery and more on Expedition Six experiments and payload operations, click on http://www.scipoc.msfc.nasa.gov

Experiments

DSOs and DTOs

Detailed Supplementary Objectives (DSOs) are space and life science investigations. Their purpose is to:

- Determine the extent of physiological deconditioning resulting from spaceflight
- Test countermeasures to those changes
- Characterize the environment of the space shuttle and/or space station relative to crew health

Detailed Test Objectives (DTOs) are aimed at testing, evaluating or documenting space shuttle systems or hardware, or proposed improvements to the space shuttle or space station hardware, systems and operations.

Such experiments aboard during STS-113 are:

DSO 490B

Bioavailability and Performance Effects of Promethazine During Spaceflight, Protocol B

Promethazine (PMZ) is the anti-motion sickness medication of choice for treating Space Motion Sickness (SMS) during shuttle missions. The side effects associated with PMZ include dizziness, drowsiness, sedation, and impaired psychomotor performance, which could impact crew performance of mission operations. Early anecdotal reports from crewmembers indicate that these central nervous system side effects of PMZ are absent or greatly attenuated in microgravity.

The objectives are to:

- Evaluate the effects of microgravity on PMZ bioavailability, performance, side effects and efficacy in the treatment of SMS
- Establish dose-response relationship of PMZ and the bioavailability of PMZ through intramuscular (IM), oral, suppository routes of administration
- Compare these results with preflight evaluations

DSO 493

Monitoring Latent Virus Reactivation and Shedding in Astronauts

The premise of this DSO is to determine the frequency of induced reactivation of herpes viruses, herpes virus shedding and clinical disease after exposure to the physical, physiological and psychological stressors associated with spaceflight.

DSO 498

Spaceflight and Immune Function

The premise of this DSO is to characterize the effects of spaceflight on selected immune elements that are important in maintaining an effective defense against infectious agents. The roles of neutrophils, monocytes, and cytotoxic cells – important elements of the immune response – have not been studied adequately in the U.S. space program. These studies will complement ongoing and previous investigations in space immunology.

This investigation is designed to determine the functional status of important elements of the immune response providing valuable data to help in the assessment of infectious disease risks associated with long-duration spaceflight.

DSO 499

Eye Movements and Motion Perception Induced by Off-Vertical Axis Rotation (OVAR) at Small Angles of Tilt After Spaceflight

Sensorimotor adaptation to the absence of gravity during orbital flight leads to perceptual and motor coordination problems upon return to Earth. The hypothesis is that there are adaptive changes in how the central nervous system processes gravitational tilt information from the vestibular (otolith) system. Eye movements and perceptual responses during constant velocity off-vertical axis rotation (OVAR) will reflect changes in otolith function as crewmembers readapt to Earth's gravity. The time course of recovery will be a function of flight duration (i.e., slower recovery for long-duration crewmembers).

This DSO will examine changes in spatial neural processing of gravitational tilt information following adaptation to microgravity. Postflight oculomotor and perceptual responses during off-vertical axis rotation will be compared with preflight baselines to track the time course of recovery. Comparison of data from short-duration and long-duration (ISS) crewmembers will allow assessment of the effect of flight duration.

DSO 500

Spaceflight-induced Reactivation of Latent Epstein-Barr Virus

The combined effects of microgravity along with associated physical and psychological stress will decrease Epstein-Barr virus (EBV)-specific T-cell immunity and reactivate latent EBV in infected B-lymphocytes.

This investigation will examine the mechanisms of spaceflight-induced alterations in human immune function and latent virus reactivation. Specifically, this study will determine the magnitude of immunosuppression as a result of spaceflight by:

- Analysis of stress hormones
- Quantitative analysis of EBV replication using molecular and serological methods
- Determining virus-specific T-cell immune function

DSO 503S

Test of Midodrine as a Countermeasure Against Postflight Orthostatic Hypotension

Following exposure to spaceflight, upright posture can result in the inability to maintain adequate arterial pressure and cerebral perfusion (orthostatic or postural hypotension). This may result in presyncope (lightheadedness) or syncope (loss of consciousness) during re-entry or egress.

The objective of this DSO is to evaluate a new pharmacological countermeasure for protection from postflight orthostatic hypotension. This experiment will measure the efficacy of midodrine in reducing the incidence and/or severity of orthostatic hypotension in returning astronauts. Efficacy will be evaluated with an expanded tilt test.

DSO 632B

Pharmacokinetics and Contributing Physiologic Changes During Spaceflight, Protocol B

Physical, environmental and physiologic conditions of spaceflight will alter gastrointestinal (GI) function and physiology; these alterations will affect the pharmacokinetics of oral medications.

The objective of this DSO is to determine changes in the GI function and physiology in microgravity and examine the pharmacokinetics of orally administered pharmaceutical probe acetaminophen.

Results from salivary pharmacokinetics of acetaminophen indicate absorption and bioavailability of oral liquid dosages may be better and more reliable than that of an equivalent solid dosage form. The comparisons were based on DSO 458, “Pharmacokinetics of Acetaminophen,” which had seven subjects taking Tylenol tablets, and DSO 622, “Gastrointestinal Function During Extended Duration Spaceflight,” which had four subjects taking Tylenol syrup.

DSO 634

Sleep-Wake Actigraphy and Light Exposure During Spaceflight

Disruption of sleep during spaceflight, both short- and long-duration, is associated with inappropriately timed (non-24 hour) or insufficiently intense light exposure. Sleep disruption and circadian misalignment will lead to subjective dissatisfaction with self-reported sleep quality and daytime alertness. Both of these conditions are associated with insomnia and associated impairment of alertness and cognitive performance that could impair mission success.

This experiment will use state-of-the-art ambulatory technology to monitor sleep-wake activity and light exposure patterns obtained in flight. This data should help better understand the effects of spaceflight on sleep as well as aid in the development of effective countermeasures for both short- and long-duration spaceflight.

DTO 805

Crosswind Landing Performance

DTO 805 is to demonstrate the capability to perform a manually controlled landing in the presence of a 90-degree, 10-15 knots steady state crosswind. This DTO has been previously manifested on 73 flights and last flown on STS-112.

Shuttle Reference Data

Shuttle Abort History

RSLS Abort History:

(STS-41 D) June 26, 1984

The countdown for the second launch attempt for Discovery's maiden flight ended at T-4 seconds when the orbiter's computers detected a sluggish valve in main engine #3.The main engine was replaced and Discovery was finally launched on August 30, 1984.

(STS-51 F) July 12, 1985

The countdown for Challenger's launch was halted at T-3 seconds when on-boardcomputers detected a problem with a coolant valve on main engine #2. The valve wasreplaced and Challenger was launched on July 29, 1985.

(STS-55) March 22, 1993

The countdown for Columbia's launch was halted by on-board computers at T-3seconds following a problem with purge pressure readings in the oxidizer preburner onmain engine #2 Columbia's three main engines were replaced on the launch pad, andthe flight was rescheduled behind Discovery's launch on STS-56. Columbia finallylaunched on April 26, 1993.

(STS-51) August 12, 1993

The countdown for Discovery's third launch attempt ended at the T-3 second markwhen on-board computers detected the failure of one of four sensors in main engine #2which monitor the flow of hydrogen fuel to the engine. All of Discovery's main engineswere ordered replaced on the launch pad, delaying the Shuttle's fourth launch attemptuntil September 12, 1993.

(STS-68) August 18, 1994

The countdown for Endeavour's first launch attempt ended 1.9 seconds before liftoffwhen on-board computers detected higher than acceptable readings in one channel of asensor monitoring the discharge temperature of the high pressure oxidizer turbopump inmain engine #3. A test firing of the engine at the Stennis Space Center in Mississippi onSeptember 2nd confirmed that a slight drift in a fuel flow meter in the engine caused aslight increase in the turbopump's temperature. The test firing also confirmed a slightlyslower start for main engine #3 during the pad abort, which could have contributed tothe higher temperatures. After Endeavour was brought back to the Vehicle

AssemblyBuilding to be outfitted with three replacement engines, NASA managers set October2nd as the date for Endeavour's second launch attempt.

Abort to Orbit History:

(STS-51 F) July 29, 1985

After an RSLS abort on July 12, 1985, Challenger was launched on July 29, 1985. Fiveminutes and 45 seconds after launch, a sensor problem resulted in the shutdown ofcenter engine #1, resulting in a safe "abort to orbit" and successful completion of themission.

Shuttle Reference Data

Shuttle Abort Modes

RSLS ABORTS

These occur when the onboard shuttle computers detect a problem and command a halt inthe launch sequence after taking over from the Ground Launch Sequencer and before SolidRocket Booster ignition.

ASCENT ABORTS

Selection of an ascent abort mode may become necessary if there is a failure that affectsvehicle performance, such as the failure of a space shuttle main engine or an orbitalmaneuvering system. Other failures requiring early termination of a flight, such as a cabinleak, might also require the selection of an abort mode. There are two basic types of ascent abort modes for space shuttle missions: intact aborts

and contingency aborts. Intact aborts are designed to provide a safe return of the orbiter toa planned landing site. Contingency aborts are designed to permit flight crew survivalfollowing more severe failures when an intact abort is not possible. A contingency abort would generally result in a ditch operation.

INTACT ABORTS

There are four types of intact aborts: abort to orbit (ATO), abort once around (AOA), transoceanic abort landing (TAL) and return to launch site (RTLS).

Return to Launch Site

The RTLS abort mode is designed to allow the return of the orbiter, crew, and payload tothe launch site, Kennedy Space Center, approximately 25 minutes after lift-off.The RTLS profile is designed to accommodate the loss of thrust from one space shuttle main engine between lift-off and approximately four minutes 20 seconds, at which time not enough main propulsion system propellant remains to return to the launch site. An RTLS can be considered to consist of three stages--a powered stage, during which the space shuttle main engines are still thrusting; an ET separation phase; and the glide phase, during which the orbiter glides to a landing at the Kennedy Space Center. The powered RTLS phase begins with the crew selection of the RTLS abort, which is done after solid rocket booster separation. The crew selects the abort mode by positioning the abort rotary switch to RTLS and depressing the abort push button. The time at which the RTLS is selected depends on the reason for the abort. For example, a three-engine RTLS is selected at the last moment, approximately three minutes 34 seconds into the mission; whereas an RTLS chosen due to an engine out at lift-off is selected at the earliest time, approximately two minutes 20 seconds into the mission (after solid rocket booster separation).

After RTLS is selected, the vehicle continues downrange to dissipate excess main propulsion system propellant. The goal is to leave only enough main propulsion system propellant to be able to turn the vehicle around, fly back towards the Kennedy Space Center and achieve the proper main engine cutoff conditions so the vehicle can glide to the Kennedy Space Center after external tank separation. During the downrange phase, a pitch-around maneuver is initiated (the time depends in part on the time of a space shuttle main engine failure) to orient the orbiter/external tank configuration to a heads up attitude, pointing toward the launch site. At this time, the vehicle is still moving away from the launch site, but the space shuttle main engines are now thrusting to null the downrange velocity. In addition, excess orbital maneuvering system and reaction control system propellants are dumped by continuous orbital maneuvering system and reaction control system engine thrustings to improve the orbiter weight and center of gravity for the glide phase and landing.

The vehicle will reach the desired main engine cutoff point with less than 2 percent excess propellant remaining in the external tank. At main engine cutoff minus 20 seconds, a pitchdown maneuver (called powered pitch-down) takes the mated vehicle to the required external tank separation attitude and pitch rate. After main engine cutoff has been commanded, the external tank separation sequence begins, including a reaction control system translation that ensures that the orbiter does not recontact the external tank and that the orbiter has achieved the necessary pitch attitude to begin the glide phase of the RTLS.

After the reaction control system translation maneuver has been completed, the glide phase of the RTLS begins. From then on, the RTLS is handled similarly to a normal entry.

Transoceanic Abort Landing

The TAL abort mode was developed to improve the options available when a space shuttle main engine fails after the last RTLS opportunity but before the first time that an AOA can be accomplished with only two space shuttle main engines or when a major orbiter system failure, for example, a large cabin pressure leak or cooling system failure, occurs after the last RTLS opportunity, making it imperative to land as quickly as possible.

In a TAL abort, the vehicle continues on a ballistic trajectory across the Atlantic Ocean to land at a predetermined runway. Landing occurs approximately 45 minutes after launch. The landing site is selected near the nominal ascent ground track of the orbiter in order to make the most efficient use of space shuttle main engine propellant. The landing site also must have the necessary runway length, weather conditions and U.S. State Department approval. Currently, the three landing sites that have been identified for a due east launch are Moron, Spain; Dakar, Senegal; and Ben Guerur, Morocco (on the west coast of Africa).

To select the TAL abort mode, the crew must place the abort rotary switch in the TAL/AOA position and depress the abort push button before main engine cutoff. (Depressing it after main engine cutoff selects the AOA abort mode.) The TAL abort mode begins sending commands to steer the vehicle toward the plane of the landing site. It also rolls the vehicle heads up before main engine cutoff and sends commands to begin an orbital maneuvering system propellant dump (by burning the propellants through the orbital maneuveringsystem engines and the reaction control system engines). This dump is necessary to increase vehicle performance (by decreasing weight), to place the center of gravity in the proper place for vehicle control, and to decrease the vehicle's landing weight.

TAL is handled like a nominal entry.

Abort to Orbit

An ATO is an abort mode used to boost the orbiter to a safe orbital altitude when performance has been lost and it is impossible to reach the planned orbital altitude. If a space shuttle main engine fails in a region that results in a main engine cutoff under speed, the Mission Control Center will determine that an abort mode is necessary and will inform the crew. The orbital maneuvering system engines would be used to place the orbiter in a circular orbit.

Abort Once Around

The AOA abort mode is used in cases in which vehicle performance has been lost to such an extent that either it is impossible to achieve a viable orbit or not enough orbital maneuvering system propellant is available to accomplish the orbital maneuvering system thrusting maneuver to place the orbiter on orbit and the deorbit thrusting maneuver. In addition, an AOA is used in cases in which a major systems problem (cabin leak, loss of cooling) makes it necessary to land quickly. In the AOA abort mode, one orbital maneuvering system thrusting sequence is made to adjust the post-main engine cutoff orbit so a second orbital maneuvering system thrusting sequence will result in the vehicle deorbiting and landing at the AOA landing site (White Sands, N.M.; Edwards Air Force Base; or the Kennedy Space Center). Thus, an AOA results in the orbiter circling the Earth once and landing approximately 90 minutes after lift-off.

After the deorbit thrusting sequence has been executed, the flight crew flies to a landing at the planned site much as it would for a nominal entry.

CONTINGENCY ABORTS

Contingency aborts are caused by loss of more than one main engine or failures in other systems. Loss of one main engine while another is stuck at a low thrust setting may also necessitate a contingency abort. Such an abort would maintain orbiter integrity for in-flight crew escape if a landing cannot be achieved at a suitable landing field.

Contingency aborts due to system failures other than those involving the main engines would normally result in an intact recovery of vehicle and crew. Loss of more than one main engine may, depending on engine failure times, result in a safe runway landing. However, in most three-engine-out cases during ascent, the orbiter would have to be ditched. The inflight crew escape system would be used before ditching the orbiter.

ABORT DECISIONS

There is a definite order of preference for the various abort modes. The type of failure and the time of the failure determine which type of abort is selected. In cases where performance loss is the only factor, the preferred modes would be ATO, AOA, TAL and RTLS, in that order. The mode chosen is the highest one that can be completed with the remaining vehicle performance.

In the case of some support system failures, such as cabin leaks or vehicle cooling problems, the preferred mode might be the one that will end the mission most quickly. In these cases, TAL or RTLS might be preferable to AOA or ATO. A contingency abort is never chosen if another abort option exists.

The Mission Control Center-Houston is prime for calling these aborts because it has a more precise knowledge of the orbiter's position than the crew can obtain from onboard systems. Before main engine cutoff, Mission Control makes periodic calls to the crew to tell them which abort mode is (or is not) available. If ground communications are lost, the flight crew has onboard methods, such as cue cards, dedicated displays and display information, to determine the current abort region.

Which abort mode is selected depends on the cause and timing of the failure causing the abort and which mode is safest or improves mission success. If the problem is a space shuttle main engine failure, the flight crew and Mission Control Center select the best option available at the time a space shuttle main engine fails.

If the problem is a system failure that jeopardizes the vehicle, the fastest abort mode that results in the earliest vehicle landing is chosen. RTLS and TAL are the quickest options (35 minutes), whereas an AOA requires approximately 90 minutes. Which of these is selected depends on the time of the failure with three good space shuttle main engines.

The flight crew selects the abort mode by positioning an abort mode switch and depressing an abort push button.

Shuttle Reference Data

Space Shuttle Rendezvous Maneuvers

COMMON SHUTTLE RENDEZVOUS MANEUVERS

OMS-1 (Orbit insertion) - Rarely used ascent abort burn

OMS-2 (Orbit insertion) - Typically used to circularize the initial orbit following ascent, completing orbital insertion. For ground-up rendezvous flights, also considered a rendezvous phasing burn

NC (Rendezvous phasing) - Performed to hit a range relative to the target at a future time

NH (Rendezvous height adjust) - Performed to hit a delta-height relative to the target at a future time

NPC (Rendezvous plane change) - Performed to remove planar errors relative to the target at a future time

NCC (Rendezvous corrective combination) - First on-board targeted burn in the rendezvous sequence. Using star tracker data, it is performed to remove phasing and height errors relative to the target at Ti

Ti (Rendezvous terminal intercept) - Second on-board targeted burn in the rendezvous sequence. Using primarily rendezvous radar data, it places the Orbiter on a trajectory to intercept the target in one orbit

MC-1, MC-2, MC-3, MC-4 (Rendezvous midcourse burns) - These on-board targeted burns use star tracker and rendezvous radar data to correct the post-Ti trajectory in preparation for the final, manual proximity operations phase

Shuttle Reference Data

Space Shuttle Main Engines

Developed in the 1970s by NASA's Marshall Space Flight Center in Huntsville, Ala., the Space Shuttle Main Engine is the most advanced liquid-fueled rocket engine ever built. Its main features include variable thrust, high performance, reusability, high redundancy, and a fully integrated engine controller.

The shuttle's three main engines are mounted on the Orbiter aft fuselage in a triangular pattern. Spaced so that they are movable during launch, the engines are used – in conjunction with the Solid Rocket Boosters – to steer the shuttle vehicle.

Each of these powerful main engines is 14 feet (4.2 meters) long, weighs approximately 7,000 pounds (3,150 kilograms) and is 7.5 feet (2.25 meters) in diameter at the end of its nozzle.

The engines operate for about eight-and-one-half minutes during liftoff and ascent -- burning more than 500,000 gallons (1.9 million liters) of super-cold liquid hydrogen and liquid oxygen propellants stored in the huge external tank attached to the underside of the shuttle. The engines shut down just before the shuttle, traveling at about 17,000 mph (28,000 kilometers per hour), reaches orbit.

The Main Engine operates at greater temperature extremes than any mechanical system in common use today. The fuel, liquefied hydrogen at -423 degrees Fahrenheit (-253 degrees Celsius) is the second coldest liquid on Earth. When it and the liquid oxygen are combusted, the temperature in the main combustion chamber is 6,000 degrees Fahrenheit (3,316 degrees Celsius), hotter than the boiling point of iron.

The main engines use a staged combustion cycle so that all propellants entering the engines are used to produce thrust or power -- more efficiently than any previous rocket engine. In a staged combustion cycle, propellants are first burned partially at high pressure and relatively low temperature -- then burned completely at high temperature and pressure in the main combustion chamber. The rapid mixing of the propellants under these conditions is so complete that 99 percent of the fuel is burned.

At normal operating level, the engines generate 490,847 pounds of thrust (measured in a vacuum). Full power is 512,900 pounds of thrust; minimum power is at 316,100 pounds of thrust.

The engine can be throttled by varying the output of the pre-burners, thus varying the speed of the high-pressure turbopumps and, therefore, the flow of the propellant.

At approximately 26 seconds into launch the main engines are throttled down to 316,000 pounds of thrust to keep the dynamic pressure on the vehicle below a specified level -- about 580 pounds per square foot or max q. Then, the engines are throttled back up to normal operating level at approximately 60 seconds. This reduces stress on the vehicle.

The main engines are throttled down again at approximately seven minutes 40 seconds into the mission to maintain 3 g's – three times the Earth's gravitational pull – again reducing stress on the crew and the vehicle. This acceleration level is about one-third the acceleration experienced on previous crewed space flights.

Approximately 10 seconds before Main Engine Cutoff or MECO, the cutoff sequence begins; about three seconds later the main engines are commanded to begin throttling at 10-percent thrust per second to 65-percent thrust. This is held for approximately 6.7seconds, and the engines are shut down.

The engine performance has the highest thrust for its weight of any engine yet developed. In fact, one Space Shuttle Main Engine generates sufficient thrust to maintain the flight of two-and-one-half 747 airplanes.

The Space Shuttle Main Engine is also the first rocket engine to use a built-in electronic digital controller, or computer. The controller will accept commands from the Orbiter for engine start, change in throttle, shutdown, and monitor engine operation. In the event of a failure, the controller automatically corrects the problem or safely shuts down the engine.

NASA continues to increase the reliability and safety of shuttle flights through a series of enhancements to the Space Shuttle Main Engines. The engines were modified in 1988, 1995, 1998 and 2001. Modifications include new high-pressure fuel and oxidizer turbopumps that reduce maintenance and operating costs of the engine, a two-duct powerhead that reduces pressure and turbulence in the engine, a single-coil heat exchanger that lowers the number of post flight inspections required. Another modification incorporates a large-throat main combustion chamber that improves the engine's reliability by reducing pressure and temperature in the chamber.

NASA projects an upcoming enhancement – the Advanced Health Management System – will further improve safety, reliability and performance. The Advanced Health Management System is a high tech system that couples optical and vibration sensors with advanced processing and computing technology. It will monitor the main engines and "see" any problems. After the orbiter lands, the engines are removed and returned to a processing facility at Kennedy Space Center, Fla., where they are rechecked and readied for the next flight. Some components are returned to the main engine's prime contractor, Rocketdyne Propulsion & Power unit of the Boeing Company, Canoga Park, Calif., for regular maintenance. The main engines are designed to operate for 7.5 accumulated hours.

Shuttle Reference Data

Space Shuttle Solid Rocket Boosters

The two SRBs provide the main thrust to lift the space shuttle off the pad and up to an altitude of about 150,000 feet, or 24 nautical miles (28 statute miles). In addition, the two SRBs carry the entire weight of the external tank and orbiter and transmit the weight load through their structure to the mobile launcher platform.

Each booster has a thrust (sea level) of approximately 3,300,000 pounds at launch. They are ignited after the three space shuttle main engines' thrust level is verified. The two SRBs provide 71.4 percent of the thrust at lift- off and during first-stage ascent. Seventy- five seconds after SRB separation, SRB apogee occurs at an altitude of approximately 220,000 feet, or 35 nautical miles (40 statute miles). SRB impact occurs in the ocean approximately 122 nautical miles (140 statute miles) downrange.

The SRBs are the largest solid-propellant motors ever flown and the first designed for reuse. Each is 149.16 feet long and 12.17 feet in diameter.

Each SRB weighs approximately 1,300,000 pounds at launch. The propellant for each solid rocket motor weighs approximately 1,100,000 pounds. The inert weight of each SRB is approximately 192,000 pounds.

Primary elements of each booster are the motor (including case, propellant, igniter and nozzle), structure, separation systems, operational flight instrumentation, recovery avionics, pyrotechnics, deceleration system, thrust vector control system and range safety destruct system.

Each booster is attached to the external tank at the SRB’s aft frame by two lateral sway braces and a diagonal attachment. The forward end of each SRB is attached to the external tank at the forward end of the SRB’s forward skirt. On the launch pad, each booster also is attached to the mobile launcher platform at the aft skirt by four bolts and nuts that are severed by small explosives at lift-off.

During the downtime following the Challenger accident, detailed structural analyses were performed on critical structural elements of the SRB. Analyses were primarily focused in areas where anomalies had been noted during postflight inspection of recovered hardware.

One of the areas was the attach ring where the SRBs are connected to the external tank. Areas of distress were noted in some of the fasteners where the ring attaches to the SRB motor case. This situation was attributed to the high loads encountered during water impact. To correct the situation and ensure higher strength margins during ascent, the attach ring was redesigned to encircle the motor case completely (360 degrees). Previously, the attach ring formed a C and encircled the motor case 270 degrees.

Additionally, special structural tests were performed on the aft skirt. During this test program, an anomaly occurred in a critical weld between the hold-down post and skin of the skirt. A redesign was implemented to add reinforcement brackets and fittings in the aft ring of the skirt.

These two modifications added approximately 450 pounds to the weight of each SRB.

The propellant mixture in each SRB motor consists of an ammonium perchlorate (oxidizer, 69.6 percent by weight), aluminum (fuel, 16 percent), iron oxide (a catalyst, 0.4 percent), a polymer (a binder that holds the mixture together, 12.04 percent), and an epoxy curing agent (1.96 percent). The propellant is an 11-point star-shaped perforation in the forward motor segment and a double-truncated-cone perforation in each of the aft segments and aft closure. This configuration provides high thrust at ignition and then reduces the thrust by approximately a third 50 seconds after lift-off to prevent overstressing the vehicle during maximum dynamic pressure.

The SRBs are used as matched pairs and each is made up of four solid rocket motor segments. The pairs are matched by loading each of the four motor segments in pairs from the same batches of propellant ingredients to minimize any thrust imbalance. The segmented-casing design assures maximum flexibility in fabrication and ease of transportation and handling. Each segment is shipped to the launch site on a heavy-duty rail car with a specially built cover.

The nozzle expansion ratio of each booster beginning with the STS-8 mission is 7-to-79. The nozzle is gimbaled for thrust vector (direction) control. Each SRB has its own redundant auxiliary power units and hydraulic pumps. The all-axis gimbaling capability is 8 degrees. Each nozzle has a carbon cloth liner that erodes and chars during firing. The nozzle is a convergent-divergent, movable design in which an aft pivot-point flexible bearing is the gimbal mechanism.

The cone- shaped aft skirt reacts the aft loads between the SRB and the mobile launcher platform. The four aft separation motors are mounted on the skirt. The aft section contains avionics, a thrust vector control system that consists of two auxiliary power units and hydraulic pumps, hydraulic systems and a nozzle extension jettison system.

The forward section of each booster contains avionics, a sequencer, forward separation motors, a nose cone separation system, drogue and main parachutes, a recovery beacon, a recovery light, a parachute camera on selected flights and a range safety system.

Each SRB has two integrated electronic assemblies, one forward and one aft. After burnout, the forward assembly initiates the release of the nose cap and frustum and turns on the recovery aids. The aft assembly, mounted in the external tank/SRB attach ring, connects with the forward assembly and the orbiter avionics systems for SRB ignition commands and nozzle thrust vector control. Each integrated electronic assembly has a multiplexer/ demultiplexer, which sends or receives more than one message, signal or unit of information on a single communication channel.

Eight booster separation motors (four in the nose frustum and four in the aft skirt) of each SRB thrust for 1.02 seconds at SRB separation from the external tank. Each solid rocket separation motor is 31.1 inches long and 12.8 inches in diameter.

Location aids are provided for each SRB, frustum/drogue chutes and main parachutes. These include a transmitter, antenna, strobe/converter, battery and salt water switchelectronics. The location aids are designed for a minimum operating life of 72 hours and when refurbished are considered usable up to 20 times. The flashing light is an exception. It has an operating life of 280 hours. The battery is used only once.

The SRB nose caps and nozzle extensions are not recovered.

The recovery crew retrieves the SRBs, frustum/drogue chutes, and main parachutes. The nozzles are plugged, the solid rocket motors are dewatered, and the SRBs are towed back to the launch site. Each booster is removed from the water, and its components are disassembled and washed with fresh and deionized water to limit salt water corrosion. The motor segments, igniter and nozzle are shipped back to Thiokol for refurbishment.

Each SRB incorporates a range safety system that includes a battery power source, receiver/ decoder, antennas and ordnance.

HOLD-DOWN POSTS

Each solid rocket booster has four hold-down posts that fit into corresponding support posts on the mobile launcher platform. Hold-down bolts hold the SRB and launcher platform posts together. Each bolt has a nut at each end, but only the top nut is frangible. The top nut contains two NASA standard detonators, which are ignited at solid rocket motor ignition commands.

When the two NSDs are ignited at each hold-down, the hold-down bolt travels downward because of the release of tension in the bolt (pretensioned before launch), NSD gas pressure and gravity. The bolt is stopped by the stud deceleration stand, which contains sand. The SRB bolt is 28 inches long and is 3.5 inches in diameter. The frangible nut is captured in a blast container.

The solid rocket motor ignition commands are issued by the orbiter''s computers through the master events controllers to the hold-down pyrotechnic initiator controllers on the mobile launcher platform. They provide the ignition to the hold-down NSDs. The launch processing system monitors the SRB hold-down PICs for low voltage during the last 16 seconds before launch. PIC low voltage will initiate a launch hold.

SRB IGNITION

SRB ignition can occur only when a manual lock pin from each SRB safe and arm device has been removed. The ground crew removes the pin during prelaunch activities. At T minus five minutes, the SRB safe and arm device is rotated to the arm position. The solid rocket motor ignition commands are issued when the three SSMEs are at or above 90-percent rated thrust, no SSME fail and/or SRB ignition PIC low voltage is indicated and there are no holds from the LPS.

The solid rocket motor ignition commands are sent by the orbiter computers through the MECs to the safe and arm device NSDs in each SRB. A PIC single-channel capacitor discharge device controls the firing of each pyrotechnic device. Three signals must be present simultaneously for the PIC to generate the pyro firing output. These signals--arm, fire 1 and fire 2--originate in the orbiter general-purpose computers and are transmitted to the MECs. The MECs reformat them to 28-volt dc signals for the PICs. The arm signal charges the PIC capacitor to 40 volts dc (minimum of 20 volts dc).

The fire 2 commands cause the redundant NSDs to fire through a thin barrier seal down a flame tunnel. This ignites a pyro booster charge, which is retained in the safe and arm device behind a perforated plate. The booster charge ignites the propellant in the igniter initiator; and combustion products of this propellant ignite the solid rocket motor initiator, which fires down the length of the solid rocket motor igniting the solid rocket motor propellant.

The GPC launch sequence also controls certain critical main propulsion system valves and monitors the engine-ready indications from the SSMEs. The MPS start commands are issued by the onboard computers at T minus 6.6 seconds (staggered start--engine three, engine two, engine one--all approximately within 0.25 of a second), and the sequence monitors the thrust buildup of each engine. All three SSMEs must reach the required 90-percent thrust within three seconds; otherwise, an orderly shutdown is commanded and safing functions are initiated.

Normal thrust buildup to the required 90-percent thrust level will result in the SSMEs being commanded to the lift-off position at T minus three seconds as well as the fire 1 command being issued to arm the SRBs. At T minus three seconds, the vehicle base bending load modes are allowed to initialize (movement of approximately 25.5 inches measured at the tip of the external tank, with movement towards the external tank).

At T minus zero, the two SRBs are ignited, under command of the four onboard computers; separation of the four explosive bolts on each SRB is initiated (each bolt is 28 inches long and 3.5 inches in diameter); the two T-0 umbilicals (one on each side of the spacecraft) are retracted; the onboard master timing unit, event timer and mission event timers are started; the three SSMEs are at 100 percent; and the ground launch sequence is terminated.

The solid rocket motor thrust profile is tailored to reduce thrust during the maximum dynamic pressure region.

ELECTRICAL POWER DISTRIBUTION

Electrical power distribution in each SRB consists of orbiter-supplied main dc bus power to each SRB via SRB buses A, B and C. Orbiter main dc buses A, B and C supply main dc bus power to corresponding SRB buses A, B and C. In addition, orbiter main dc bus C supplies backup power to SRB buses A and B, and orbiter bus B supplies backup power to SRB bus C. This electrical power distribution arrangement allows all SRB buses to remain powered in the event one orbiter main bus fails.

The nominal dc voltage is 28 volts dc, with an upper limit of 32 volts dc and a lower limit of 24 volts dc.

HYDRAULIC POWER UNITS

There are two self-contained, independent HPUs on each SRB. Each HPU consists of an auxiliary power unit, fuel supply module, hydraulic pump, hydraulic reservoir and hydraulic fluid manifold assembly. The APUs are fueled by hydrazine and generate mechanical shaft power to a hydraulic pump that produces hydraulic pressure for the SRB hydraulic system. The two separate HPUs and two hydraulic systems are located on the aft end of each SRB between the SRB nozzle and aft skirt. The HPU components are mounted on the aft skirt between the rock and tilt actuators. The two systems operate from T minus 28 seconds until SRB separation from the orbiter and external tank. The two independent hydraulic systems are connected to the rock and tilt servoactuators.

The APU controller electronics are located in the SRB aft integrated electronic assemblies on the aft external tank attach rings.

The APUs and their fuel systems are isolated from each other. Each fuel supply module (tank) contains 22 pounds of hydrazine. The fuel tank is pressurized with gaseous nitrogen at 400 psi, which provides the force to expel (positive expulsion) the fuel from the tank to the fuel distribution line, maintaining a positive fuel supply to the APU throughout its operation.

The fuel isolation valve is opened at APU startup to allow fuel to flow to the APU fuel pump and control valves and then to the gas generator. The gas generator's catalytic action decomposes the fuel and creates a hot gas. It feeds the hot gas exhaust product to the APU two-stage gas turbine. Fuel flows primarily through the startup bypass line until the APU speed is such that the fuel pump outlet pressure is greater than the bypass line's. Then all the fuel is supplied to the fuel pump.

The APU turbine assembly provides mechanical power to the APU gearbox. The gearbox drives the APU fuel pump, hydraulic pump and lube oil pump. The APU lube oil pump lubricates the gearbox. The turbine exhaust of each APU flows over the exterior of the gas generator, cooling it, and is then directed overboard through an exhaust duct.

When the APU speed reaches 100 percent, the APU primary control valve closes, and the APU speed is controlled by the APU controller electronics. If the primary control valve logic fails to the open state, the secondary control valve assumes control of the APU at 112-percent speed.

Each HPU on an SRB is connected to both servoactuators on that SRB. One HPU serves as the primary hydraulic source for the servoactuator, and the other HPU serves as the secondary hydraulics for the servoactuator. Each sevoactuator has a switching valve that allows the secondary hydraulics to power the actuator if the primary hydraulic pressure drops below 2,050 psi. A switch contact on the switching valve will close when the valve is in the secondary position. When the valve is closed, a signal is sent to the APU controller that inhibits the 100-percent APU speed control logic and enables the 112-percent APU speed control logic. The 100-percent APU speed enables one APU/HPU to supply sufficient operating hydraulic pressure to both servoactuators of that SRB.

The APU 100-percent speed corresponds to 72,000 rpm, 110-percent to 79,200 rpm, and 112-percent to 80,640 rpm.

The hydraulic pump speed is 3,600 rpm and supplies hydraulic pressure of 3,050, plus or minus 50, psi. A high-pressure relief valve provides overpressure protection to the hydraulic system and relieves at 3,750 psi.

The APUs/HPUs and hydraulic systems are reusable for 20 missions.

THRUST VECTOR CONTROL

Each SRB has two hydraulic gimbal servoactuators: one for rock and one for tilt. The servoactuators provide the force and control to gimbal the nozzle for thrust vector control.

The space shuttle ascent thrust vector control portion of the flight control system directs the thrust of the three shuttle main engines and the two SRB nozzles to control shuttle attitude and trajectory during lift-off and ascent. Commands from the guidance system are transmitted to the ATVC drivers, which transmit signals proportional to the commands to each servoactuator of the main engines and SRBs. Four independent flight control system channels and four ATVC channels control six main engine and four SRB ATVC drivers, with each driver controlling one hydraulic port on each main and SRB servoactuator.

Each SRB servoactuator consists of four independent, two-stage servovalves that receive signals from the drivers. Each servovalve controls one power spool in each actuator, which positions an actuator ram and the nozzle to control the direction of thrust.

The four servovalves in each actuator provide a force-summed majority voting arrangement to position the power spool. With four identical commands to the four servovalves, the actuator force-sum action prevents a single erroneous command from affecting power ram motion. If the erroneous command persists for more than a predetermined time, differential pressure sensing activates a selector valve to isolate and remove the defective servovalve hydraulic pressure, permitting the remaining channels and servovalves to control the actuator ram spool.

Failure monitors are provided for each channel to indicate which channel has been bypassed. An isolation valve on each channel provides the capability of resetting a failed or bypassed channel.

Each actuator ram is equipped with transducers for position feedback to the thrust vector control system. Within each servoactuator ram is a splashdown load relief assembly to cushion the nozzle at water splashdown and prevent damage to the nozzle flexible bearing.

SRB RATE GYRO ASSEMBLIES

Each SRB contains two RGAs, with each RGA containing one pitch and one yaw gyro. These provide an output proportional to angular rates about the pitch and yaw axes to the orbiter computers and guidance, navigation and control system during first-stage ascent flight in conjunction with the orbiter roll rate gyros until SRB separation. At SRB separation, a switchover is made from the SRB RGAs to the orbiter RGAs.

The SRB RGA rates pass through the orbiter flight aft multiplexers/ demultiplexers to the orbiter GPCs. The RGA rates are then mid-value- selected in redundancy management to provide SRB pitch and yaw rates to the user software. The RGAs are designed for 20 missions.

SRB SEPARATION

SRB separation is initiated when the three solid rocket motor chamber pressure transducers are processed in the redundancy management middle value select and the head-end chamber pressure of both SRBs is less than or equal to 50 psi. A backup cue is the time elapsed from booster ignition.

The separation sequence is initiated, commanding the thrust vector control actuators to the null position and putting the main propulsion system into a second-stage configuration (0.8 second from sequence initialization), which ensures the thrust of each SRB is less than 100,000 pounds. Orbiter yaw attitude is held for four seconds, and SRB thrust drops to less than 60,000 pounds.

The SRBs separate from the external tank within 30 milliseconds of the ordnance firing command.

The forward attachment point consists of a ball (SRB) and socket (ET) held together by one bolt. The bolt contains one NSD pressure cartridge at each end. The forward attachment point also carries the range safety system cross-strap wiring connecting each SRB RSS and the ET RSS with each other.

The aft attachment points consist of three separate struts: upper, diagonal and lower. Each strut contains one bolt with an NSD pressure cartridge at each end. The upper strut also carries the umbilical interface between its SRB and the external tank and on to the orbiter.

There are four booster separation motors on each end of each SRB. The BSMs separate the SRBs from the external tank. The solid rocket motors in each cluster of four are ignited by firing redundant NSD pressure cartridges into redundant confined detonating fuse manifolds.

The separation commands issued from the orbiter by the SRB separation sequence initiate the redundant NSD pressure cartridge in each bolt and ignite the BSMs to effect a clean separation.

Shuttle Reference Data

Space Shuttle Super Light Weight Tank (SLWT)

The super lightweight external tank (SLWT) made its first shuttle flight June 2, 1998, on mission STS-91. The SLWT is 7,500 pounds lighter than the standard external tank. The lighter weight tank will allow the shuttle to deliver International Space Station elements (such as the service module) into the proper orbit.

The SLWT is the same size as the previous design. But the liquid hydrogen tank and the liquid oxygen tank are made of aluminum lithium, a lighter, stronger material than the metal alloy used for the shuttle's current tank. The tank's structural design has also been improved, making it 30% stronger and 5% less dense.

The SLWT, like the standard tank, is manufactured at Michoud Assembly, near New Orleans, Louisiana, by Lockheed Martin.

The 154-foot-long external tank is the largest single component of the space shuttle. It stands taller than a 15-story building and has a diameter of about 27 feet. The external tank holds over 530,000 gallons of liquid hydrogen and liquid oxygen in two separate tanks. The hydrogen (fuel) and liquid oxygen (oxidizer) are used as propellants for the shuttle's three main engines.

Acronyms and Abbreviations

A/L	Airlock
AA	Antenna Assembly
AAA	Avionics Air Assembly
ABC	Audio Bus Coupler
AC	Assembly Complete
ACBM	Active Common Berthing System
ACS	Assembly Contingency System
ACS	Atmosphere Control and Supply
ACS	Attitude Control System
ACSM	Attitude Control System Moding
ACU	Arm Computer Unit
AEA	Antenna Electronics Assembly
AOH	Assembly Operations Handbook
APAS	Androgynous Peripheral Attach System
APAS	Androgynous Peripheral Attachment System
APCU	Assembly Power Converter Unit
APDS	Androgynous Peripheral Docking System
APM	Attached Pressurized Module
APPCM	Arm Pitch Plane Change Mode
AR	Atmosphere Revitalization
ARCU	American-to-Russian Converter Units
ARIS	Active Rack Isolation System
ARS	Air Revitalization System
ARS	Atmosphere Revitalization Subsystem
ASCR	Assured Safe Crew Return
ATA	Ammonia Tank Assembly
ATCS	Active Thermal Control System
ATU	Audio Terminal units
AUAI	Assembly Contingency System/UHF Audio Interface
AVU	Advanced Vision Unit
AVU	Artificial Vision Unit
AVV	Accumulator Vent Valve
BBC	Bolt Bus Controller
BC	Bus Controller
BCDU	Battery Charge/Discharge Unit
BCU	Bus Controller Unit
BDU	Backup Drive Unit
BG	Beta Gimbal
BGA	Beta Gimbal Assembly
BGDTS	Beta Gimbal Deployment Transition Structure

BGHS	Beta Gimbal Housing Subassembly
BIT/BITE	Built-In Test/Built-In Test Equipment
BMRRM	Bearing Motor and Roll Ring Module
BSP	Baseband Signal Processor
C&C	Command and Control
C&DH	Command and Data Handling
C&M	Control and Monitor
C&T	Communications and Tracking
C&W	Caution and Warning
C/A	Coarse/Acquisition
C/L	Crew Lock
CA	Control Attitude
CAS	Common Attach System
CBM	Common Berthing Mechanism
CCAA	Common Cabin Air Assembly
CCD	Cursor Control Device
CCMS	Concentric Cable Management System
CCTV	Closed Circuit TV
CDRA	Carbon Dioxide Removal Assembly
CDRS	Carbon Dioxide Removal System
CDS	Command and Data Software
CETA	Crew and Equipment Translation Aid
CEU	Control Electronics Unit
CGBA	Commercial Generic Bioprocessing Apparatus
CHeCS	Crew Health Care System
CHX	Condensing Heat Exchanger
CMG	Control Moment Gyroscopes
COAS	Crew Optical Alignment Sight
COTS	Commercial Off The Shelf
CR	Change Request
CSA	Canadian Space Agency
CSA	Computer Systems Architecture
CSCI	Computer Software Configuration Item
CVIU	Common Video Interface Unit
CVT	Current Value Table
CVV	Carbon dioxide Vent Valve
CWC	Contingency Water Collection
CWC	Contingency Water Container
DAIU	Docked Audio Interface Unit
DC	Docking Compartment
DCP	Display and Control Panel
DCSU	Direct Current Switching Unit

DDCU	DC-to-DC Converter Unit
DDCU-E	DC-to-DC Converter Unit – External
DDCU-I	DC-to-DC Converter – Internal
DLA	Drive Locking Assembly
DMS-R	Data Management System-Russian
DPA	Digital Pre-Assembly
DPS	Data Processing System
E/L	Equipment Lock
EACP	EMU Audio Control Panel
EACP	EV Audio Control Panel
EAIU	EMU Audio Interface Unit
EATCS	External Active Thermal Control Subsystem
ECLSS	Environmental Control and Life Support System
ECU	Electronic Control Unit
ED	Engagement Drive
EDDA	EMU Don/Doff Assembly
EEATCS	Early External Active Thermal Control Subsystem
EFGF	Electrical Flight Grapple Fixture
EIA	Electrical Interface Assembly
EMU	Extravehicular Mobility Unit
EPS	Electrical Power System
ESA	External Sampling Adapter
ESSMDM	Enhanced Space Station Multiplexer/Demultiplexer
ESU	End Stop Unit
ETVCG	Pg 3-4
EVA	Extra Vehicular Activity
EV-CPDS	Extra-Vehicular – Charged Particle Directional Spectrometer
EVR	Extravehicular Robotics
EVSU	External Video Switching Units
EXPRESS	EXpedite the PRocessing of Experiments to the Space Station
EXT	External
FC	Firmware Controller
FCC	Flat Collector Circuit
FCV	Flow Control Valve
FD	Flight Day
FDIR	Failure, Detection, Isolation, and Recovery
FDS	Fire Detection Suppression
FET	Field Effect Transistors
FGB	Functional Cargo Block
FPU	Fluid Pumping Unit
FQDC	Fluid Quick Disconnect Coupling
FRD	Flight Requirements Document

FRGF	Flight Releasable Grapple Feature
FWCI	Firmware Configuration Items
GFE	Government Furnished Equipment
GFI	Ground Fault Interrupter
GLONASS	Global Navigational Satellite System
GNC	Guidance, Navigation, and Control
GPS	Global Positioning System
GUI	Graphical User Interface
HC	Hand Controller
HCA	Hollow Cathode Assembly
HDR	High Data Rate
HEPA	High Efficiency Particulate Air
HGA	High Gain Antenna
HHL	Hand Held Lidar
HPGT	High Pressure Gas Tank
HRF	Human Research Facility
HRFM	High Rate Frame Multiplexer
HRM	High Rate Modem
I/O	Input/Output
IAC	Internal Audio Controller
IAS	Internal Audio Subsystem
IAS	Internal Audio System
IATCS	Internal Active Thermal Control Subsystem
IATCS	Internal Active Thermal Control System
IDA	Integrated Diode Assembly
IDRD	Increment Definition and Requirements Document
IEA	Integrated Equipment Assembly
IELK	Individual Equipment Liner Kit
IFHX	Interface Heat Exchanger
IMCS	Integrated Mission Control System
IMV	Intermodule Ventilation
INT	Internal
IOC	Input/Output Controller
IOCU	Input/Output Controller Unit
IP	International Partner
IRU	Inflight Refill Unit
ISA	Internal Sampling Adapter
ISPR	International Standard Payload Racks
ISS	International Space Station
ISSPO	International Space Station Program Office
ISSSH	International Space Station Systems Handbook

ITCS	Internal Thermal Control System
ITS	Integrated Truss Structure
IUA	Interface Umbilical Assembly
IVA	Intra-Vehicular Activity
IVSU	Internal Video Switch Unit
JEU	Joint Electronic Units
Lab	Laboratory
LAN	Local Area Network
LCA	Lab Cradle Assembly
LCA	Loop Crossover Assembly
LCD	Liquid Crystal Display
LDI	Local Data Interface
LDR	Low Data Rate
LDU	Linear Drive Unit
LED	Light Emitting Diode
LEE	Latching End Effector
LFDP	Load Fault Detect Protect
LFDP	Load Fault Detection Protection
LGA	Low Gain Antenna
LLA	Low Level Analog
LT	Low Temperature
LTA	Launch-To-Activation
LTL	Low Temperature Loop
LTU	Load Transfer Unit
LVLH	Local Vertical Local Horizontal
MA	Mechanical Assembly
MAM	Manual Augmented Mode
MBM	Manual Berthing Mechanism
MBS	Mobile remote servicer Base System
MBSU	Main Bus Switching Units
MC	Midcourse Correction
MCA	Major Constituent Analyzer
MCAS	MBS Common Attach System
MCC	Mission Control Center
MCC-H	Mission Control Center-Houston
MCC-M	Mission Control Center-Moscow
MCDS	Multifunction Cathode Ray Tube Display System
MCS	Motion Control System
MCU	MBS Computer Unit
MDM	Multiplexer/Demultiplexer
METOX	Metal Oxide

MFCV	Manual Flow Control Valve
MFSC	Marshall Spaceflight Center
MHS	MCU Host Software
MIP	Mission Integration Plan
MLI	Multi-Layer Insulation
MMT	Mission Management Team
MPEV	Manual Pressure Equalization Valve
MPLM	Multi-Purpose Logistics Module
MPM	Manipulator Positioning Mechanism
MRL	Manipulator Retention Latch
MRS	Mobile Remote Servicer
MSD	Mass Storage Device
MSG	Microgravity Science Glovebox
MSS	Mobile Servicing System
MT	Mobile Transporter
MT	Moderate Temperature
MTCL	MT Capture Latch
MTL	Moderate Temperature Loop
MTS	Module to Truss Segment
MTSAS	Module to Truss Segment Attachment System
MTWsN	Move To Worksite number N
NASA	National Aeronautics and Space Administration
NCC	Nominal Corrective Combination
NCG	Non-Condensable Gas
NET	No Earlier
NIA	Nitrogen Interface Assembly
NIV	Nitrogen Isolation Valve
NTA	Nitrogen Tank Assembly
OCA	Orbital Communications Adapter
OCJM	Operator Commanded Joint Position Mode
OCPM	Operator Commanded POR Mode
OCS	Operations and Control Software
ODS	Orbiter Docking System
OIU	Orbiter Interface Unit
OIV	Oxygen Isolation Valve
OMI	On-Orbit Maintainable Items
OMS	Orbital Maneuvering System
OPP	OSVS Patch Panel
OPS	Operations
Ops	Operations
ORBT	Optimized RBar Targeting
ORCA	Oxygen Recharge Compressor Assembly

ORU	Orbital Replacement Units
OSVS	Orbiter Space Vision System
OTD	ORU Transfer Device
P&S	Pointing and Support
P/L	Payload
P1	Port 1
PAS	Payload Attach System
PBA	Portable Breathing Apparatus
PC	Personal Computer
PCA	Pressure Control Assembly
PCBM	Passive Common Berthing System
PCC	Power Converter Controller
PCG	Protein Crystal Growth
PCMCIA	Personal Computer Memory Card International Adapter
P-Code	Precision Code
PCP	Pressure Control Panel
PCR	Portable Computer Receptacle
PCS	Portable Computer System
PCT	Post-Contact Thrusting
PCU	Plasma Contactor Unit
PDGF	Power and Data Grapple Fixture
PDIP	Payload Data Interface Panel
PDRS	Payload Deployment and Retrieval System
PDU	Power Drive Unit
PEHG	Payload Ethernet Hub Gateways
PFCS	Pump and Flow Control Subassembly
PFE	Portable Fire Extinguisher
PGBA	Plant Generic Bioprocessing Apparatus
PGSC	Portable General Support Computer
PJAM	Prestored Joint Position Autosequence Mode
PM	Pump Module
PMCU	Power Management Control Unit
POA	Payload/ORU Accommodation
POR	Points of Reference
POST	Power On Self-Test
PP	Planning Period
PPA	Pump Package Assembly
PPAM	Prestored POR Autosequence Mode
PPRV	Positive Pressure Relief Valve
PRLA	Payload Retention Latch Assemblies
Prox-Ops	Proximity Operations
PRPV	Positive Pressure Release Valves
PTCS	Passive Thermal Control System

PTU	Pan/Tilt Unit
PVCA	Photovoltaic Controller Application
PVCE	Photovoltaic Controller Element
PVM	Photovoltaic Module
PVR	Photovoltaic Radiator
PVTCS	Photovoltaic Thermal Control System
PWR	Payload Water Reservoir
QD	Quick Disconnect
R/P	Receiver/Processors
RACU	Russian-to-American Converter Units
RAIU	Russian Audio Interface Unit
RAM	Random Access Memory
RAMV	Rheostat Air Mix Valve
RBI	Remote Bus Isolators
RBVM	Radiator Beam Valve Module
RF	Radio Frequency
RFCA	Rack Flow Control Assembly
RFG	Radio Frequency Group
RGA	Rate Gyros Assembly
RHC	Rotational Hand Controller
RHX	Regenerative Heat Exchanger
RJMC	Rotary Joint Motor Controller
RMS	Remote Manipulator System
RPC	Remote Power Controller
RPCM	Remote Power Controller Module
RPDA	Remote Power Distribution Assembly
RPOP	Rendezvous and Prox-Ops Program
RS	Russian Segment
RSP	Resupply Stowage Platforms
RSR	Resupply Stowage Rack
RSTS	Rack Standalone Temperature Sensor
RSU	Roller Suspension Unit
RT	Remote Terminal
RTD	Resistive Thermal Devices
RWS	Robotic Workstation
S&M	Structures and Mechanisms
SARJ	Solar Alpha Rotary Joint
SASA	S-band Antenna Support Assembly
SAW	Solar Array Wing
SCA	Switchgear Controller Assembly
SCI	Signal Conditioning Interface

SCU	Service and Cooling Umbilical
SCU	Sync and Control Unit
SD	Smoke Detector
SDO	Solenoid Driver Output
SDS	Sample Delivery System
SEM	Shunt Electronics Module
SFCA	System Flow Control Assembly
SFU	Squib Firing Unit
SGANT	Space-to-Ground Antenna
SIGI	Space Integrated Global Positioning System/Inertial Navigation System
SJRM	Single Joint Rate Mode
SM	Service Module
SMCC	Shuttle Mission Control Center
SOC	State of Charge
SPCE	Servicing Performance and Checkout Equipment
SPDA	Secondary Power Distribution Assembly
SPDM	Special Purpose Dexterous Manipulator
SPG	Single Point Ground
SSAS	Segment-to-Segment Attach System
SSC	Station Support Computer
SSC	Subsystem Computer
SSMDM	Space Station Multiplexer/Demultiplexer
SSOR	Space-to-Space Orbiter Radio
SSP	Space Shuttle Program
SSP	Standard Switch Panel
SSRMS	Space Station Remote Manipulator System
SSSR	Space-to-Space Station Radio
SSU	Sequential Shunt Unit
STCR	Starboard Thermal Control Radiator
STES	Single Locker Thermal Enclosure
STS	Space Transportation System
SVS	Synthetic Vision System
TA	Thruster Assist
TBD	To Be Determined
TC	Terminal Computers
TCCS	Trace Contaminant Control Subassembly
TCCV	Temperature Check Control Valve
TCS	Thermal Control System
TCS	Trajectory Control Sensor
TCTV	Temperature Control and Check Valve
TD	Translation Drive
TDRS	Tracking and Data Relay Satellite

TDRSS	Tracking and Data Relay Satellite System
TEA	Torque Equilibrium Attitude
TFR	Translation Foot Restraints
THC	Temperature and Humidity Control
THC	Translational Hand Controller
TI	Transition Initiation
TORU	Teleoperator Control Mode
TORVA	Twice Orbital rate +Rbar to +Vbar Approach
TRC	Transmitter Receiver Controller
TRRJ	Thermal Radiator Rotary Joint
TSP	Twisted Shielded Pairs
TTCR	Trailing Thermal Control Radiator
TUS	Training Umbilical System
TV	Television
TVIS	Treadmill Vibration Isolation System
TWMV	Three-Way Mixing Valve
UDG	User Data Generation
UHF	Ultra-High Frequency
UIA	Umbilical Interface Assembly
UIP	Utility Interface Panel
ULCAS	Unpressurized Logistics Carrier Attach System
UMA	Umbilical Mechanism Assembly
UOP	Utility Outlet Panel
USOS	United States Orbital Segment
VAJ	Vacuum Access Jumper
VBSP	Video Baseband Signal Processor
VCP	Video Camera Port
VCSA	Video Camera Support Assembly
VDS	Video Distribution Subsystem
VDS	Video Distribution System
VDU	Video Distribution Unit
VES	Vacuum Exhaust System
VGS	Video Graphics Software
VRCV	Vent/Relief Control Valve
VRIV	Vent/Relief Isolation Valve
VRS	Vacuum Resource System
VRV	Vent/Relief Valve
VSC	Video Signal Converter
VTR	Video Tape Recorders
WETA	Wireless video system External Transceiver Assemblies
WHS	Workstation Host Software

WRM	Water Recovery and Management
WS	Water Separator
WVA	Water Vent Assembly
ZSR	Zero-g Stowage Rack

Media Assistance

NASA Television Transmission

NASA Television is available through the GE2 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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