First Visit to an Outpost in Orbit

STS-96

BOEING NASA USA United Space Alliance

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Updated May 20, 1999

STS-96 Table of Contents

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STS-96

Mission Overview

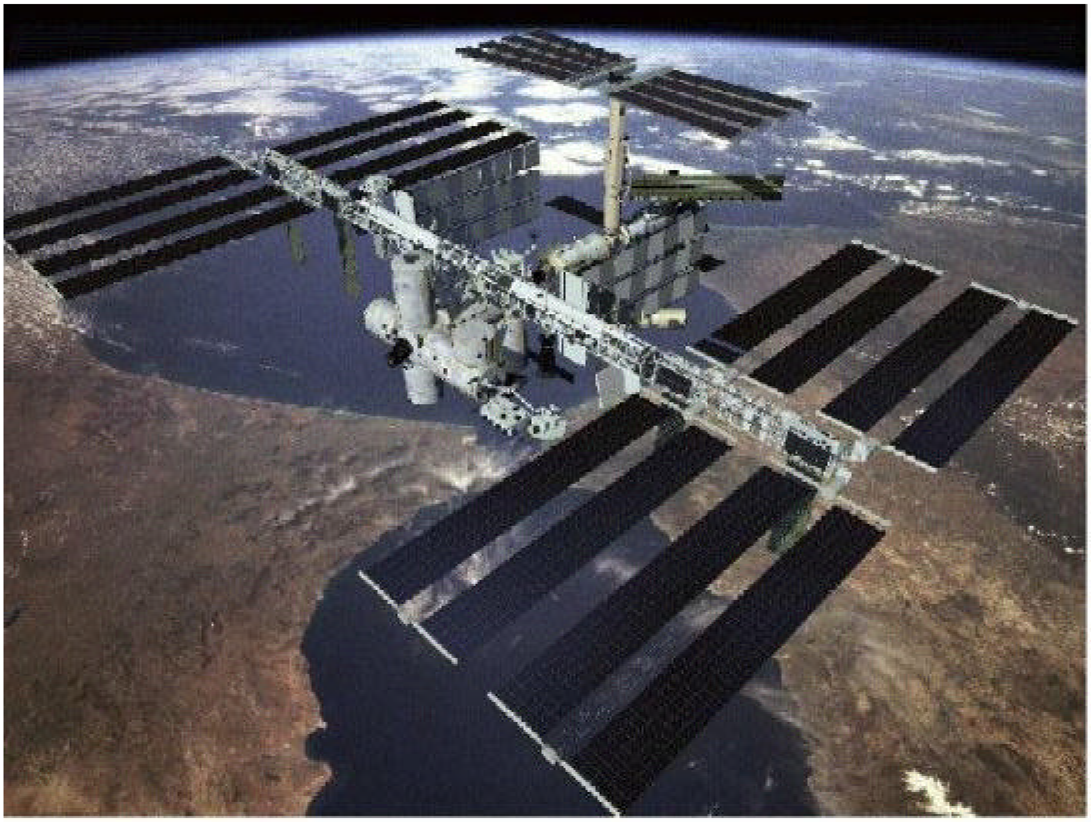
DISCOVERY'S CREW TO MAKE FIRST STATION VISIT

The Shuttle Discovery's international crew of seven will become the first visitors to a new star in orbit on mission STS-96, preparing the International Space Station for the arrival of its early living quarters and laying out a welcome mat for the first station crew.

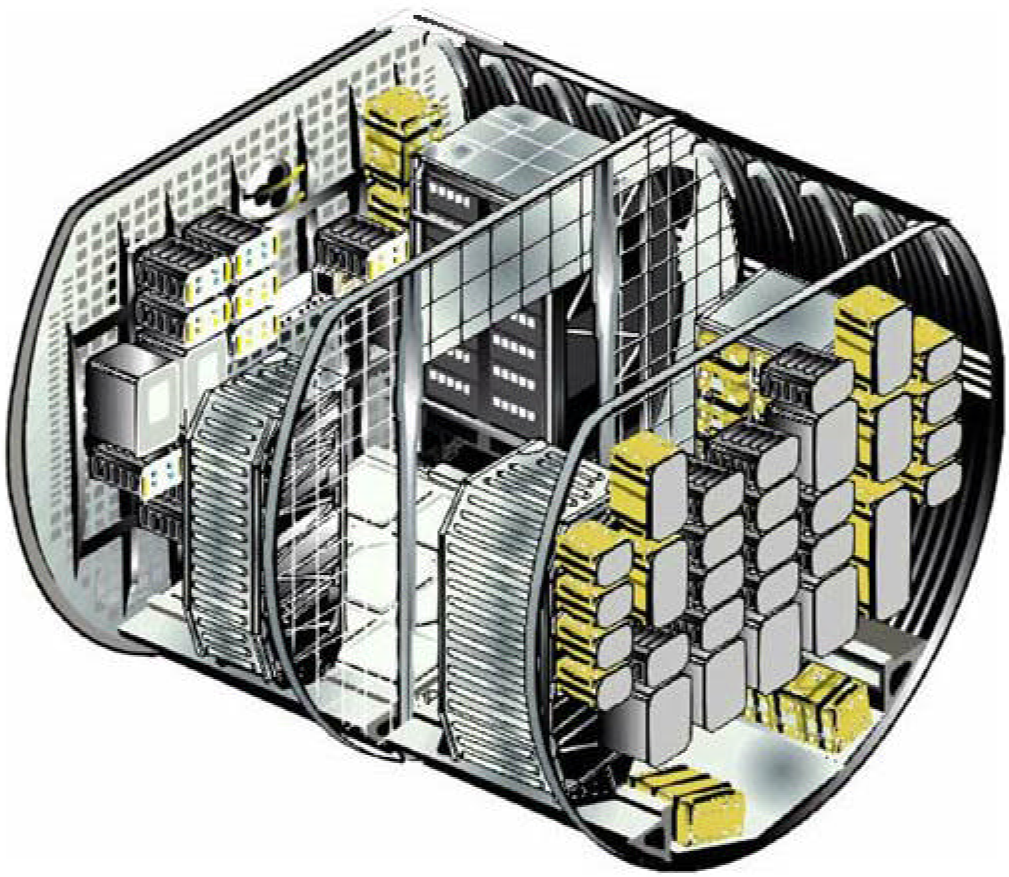
Discovery will spend six days linked to the new outpost as the crew transfers and installs gear that could not be launched aboard the Zarya and Unity modules due to weight limitations. The Shuttle will carry more than 3,600 pounds of supplies to be stored aboard the station, ranging from food and clothes for the first crew to laptop computers, a printer and cameras.

Discovery's crew, led by U.S. Navy Commander Kent Rominger, 42, reflects the global nature of the station with three of five international partners represented. Included are cosmonaut Valery Tokarev, 46, a colonel in the Russian Air Force, and Canadian Space Agency astronaut Julie Payette, 35, who will become the first Canadian to board the station. U.S. Air Force Lt. Col. Rick Husband, 41, will serve as pilot, and a spacewalk will be performed by astronauts Tammy Jernigan,40, and Dr. Daniel Barry, 42. Jernigan and Barry will attach a United States-built spacewalkers' "crane" and parts of a Russian-built crane to the exterior for use on future missions. Astronaut Ellen Ochoa rounds out the crew as flight engineer and operator of the Shuttle's mechanical arm.

Discovery's mission will set the stage for the launch this fall of the Russian-provided Service Module, the first station living quarters, and the arrival in early 2000 of the first three-person station crew. STS-96 is the first of two Shuttle missions scheduled to visit the International Space Station this year to continue its assembly, an unprecedented task that turns Earth orbit into an ever-changing construction site, joining more than 100 elements on 45 assembly flights.



The International Space Station will allow humankind to harness as never before one of the fundamental forces of nature – gravity – to perform research that may result in new medicines, materials and industries on Earth. The station's scientific studies, performed in six state-of-the-art laboratories, may even lead to a new understanding of the fundamental laws of nature while they pave the way for the future human exploration of space. Partners in the United States-led station include Canada, 11 member nations of the European Space Agency, Japan and Russia. Italy and Brazil also are contributing.



Much of the gear destined for the station will be housed inside a double Spacehab module in Discovery's payload bay. The spacewalking gear and cranes will be stored outside in the Shuttle bay on a new piece of equipment called the Integrated Cargo Carrier, a removable platform that will be used on many future station assembly flights. The carrier, which will remain in the Shuttle bay throughout STS-96, also includes a large, new spacewalking equipment storage box developed by Spacehab.

In addition to its primary cargo of station supplies, Discovery will carry aloft a small satellite called Starshine that will provide educational observations for students around the world. More than 1,000 schools across America and the world have helped construct the satellite and will participate in the project, calculating its orbit as they learn about math and physics. Although only slightly larger than a basketball, Starshine is covered by almost 900 highly polished mirrors that will make it visible from the ground. It will be released from Discovery after the Shuttle has left the station.

Discovery also will conduct several evaluations of equipment for future use on the station and the Shuttle. Two new Shuttle sensor systems will be tested. One system, called the Shuttle Vibration Forces experiment, will record vibrations between the Shuttle and its cargo to assist in planning future flights. Another test, called the Integrated Vehicle Health Monitoring System, will send information on several of Discovery's systems to the Kennedy Space Center, FL, during flight and may shorten the time needed to prepare Shuttles for launch. Another evaluation will check equipment that may be used on future flights to transfer water and fluids from the Shuttle to the station. Another study, called the Volatile Removal Assembly, will test the operation of equipment that will be used to help recycle station wastewater.

Already easily visible from Earth, the International Space Station will grow brighter as Discovery docks and continue to increase in magnitude as its assembly in orbit progresses during the next five years. Components built at factories around the world are now being readied for upcoming launches at the Kennedy Space Center and at the Russian launch site, the Baikonur Cosmodrome in Kazakstan.

Updated: 05/14/1999

STS-96

Discovery OV103

Launch: Thursday, May 27, 1999
6:48 AM (eastern time)

Mission Objectives

The major objective of the first shuttle mission of the year is the transfer of almost two tons of logistical supplies from the shuttle Discovery to the International Space Station.

These supplies will be used to not only continue the outfitting of the Unity and Zarya modules already joined together in orbit, but will be used by a future Shuttle assembly crew later this year to set up the Russian Service Module for occupancy by a three-man crew early next year.

In addition to the supply delivery, the astronauts will deploy a small satellite called STARSHINE which will be observed by international students on Earth as they calculate its precise orbit and the rate of its orbital decay over a period of time.

The seven crew members will also collect data from an experiment designed to test the amount of vibration imparted on shuttle-based payloads and will begin to demonstrate the effect of technological upgrades to the shuttle through the use of orbiter health monitoring devices designed to improve the quality of life aboard future shuttles while making their use more efficient over time.

Crew

Commander:	Kent V. Rominger
Pilot:	Rick D. Husband
Mission Specialist 1:	Tamara E. Jernigan
Mission Specialist 2:	Ellen Ochoa
Mission Specialist 3:	Daniel T. Barry
Mission Specialist 4:	Julie Payette
Mission Specialist 5:	Valery Tokarev

Launch

Orbiter:	Discovery OV103
Launch Site:	Pad 39-B Kennedy Space Center
Launch Window:	10 minutes
Altitude:	173nm (205 nm for rendezvous)
Inclination:	51.6
Duration:	9 Days 19 Hrs. 55 Min.

Vehicle Data

Shuttle Liftoff Weight:	4,514,454 lbs.
Orbiter/Payload Liftoff Weight:	262,035 lbs.
Orbiter/Payload Landing Weight:	220,980 lbs.

Payload Weights

IVHM-2	254 lbs.
STARSHINE	353 lbs.
ICC	3050 lbs.
SVFE	327 lbs.
SPACEHAB	16072 lbs.

Software Version: OI-27

Space Shuttle Main Engines

SSME 1: SN-2047 (2nd flt.) **SSME 2:** SN-2051 (1st flt.) **SSME 3:** SN-2049 (1st flt.)

External Tank: ET-100 (4th Super Light Weight Tank)

SRB Set: BI098

Auxiliary Power Units:

APU-1: SN-310 **APU-2:** SN-204 **APU-3:** SN-404

Fuel Cells:

FC-1: SN-117 **FC-2:** SN-111 **FC-3:** SN-103

Shuttle Aborts

Abort Landing Sites

RTLS: Shuttle Landing Facility, KSC
TAL: Zaragoza, Spain; Alternates: Ben Guerrir, Moron
AOA: Shuttle Landing Facility, KSC; Alternates: White Sands Space Harbor

Landing

Landing Date:	06/06/99
Landing Time:	2:43 AM (eastern time)
Primary Landing Site:	Shuttle Landing Facility, KSC
	First alternate, Edwards Air Force Base Second alternate, White Sands Space Harbor

Payloads

Cargo Bay

Integrated Vehicle Health Monitoring HEDS Technology Demonstration 2

Student-Tracked Atmospheric Research Satellite for Heuristic International Networking Equipment (STARSHINE)

Integrated Cargo Carrier

Shuttle Vibration Forces Experiment

SPACEHAB

Spacehab

MIRTs Changeout

Cargo Transfer

Shuttle Reference and 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-board computers detected a problem with a coolant valve on main engine #2. The valve was replaced 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-3 seconds following a problem with purge pressure readings in the oxidizer preburner on main engine #2 Columbia's three main engines were replaced on the launch pad, and the flight was rescheduled behind Discovery's launch on STS-56. Columbia finally launched on April 26, 1993.

(STS-51) August 12, 1993
The countdown for Discovery's third launch attempt ended at the T-3 second mark when on-board computers detected the failure of one of four sensors in main engine #2 which monitor the flow of hydrogen fuel to the engine. All of Discovery's main engines were ordered replaced on the launch pad, delaying the Shuttle's fourth launch attempt until September 12, 1993.

(STS-68) August 18, 1994
The countdown for Endeavour's first launch attempt ended 1.9 seconds before liftoff when on-board computers detected higher than acceptable readings in one channel of a sensor monitoring the discharge temperature of the high pressure oxidizer turbopump in main engine #3. A test firing of the engine at the Stennis Space Center in Mississippi on September 2nd confirmed that a slight drift in a fuel flow meter in the engine caused a slight increase in the turbopump's temperature. The test firing also confirmed a slightly slower start for main engine #3 during the pad abort, which could have contributed to the higher temperatures. After Endeavour was brought back to the Vehicle Assembly Building to be outfitted with three replacement engines, NASA managers set October 2nd 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. Five minutes and 45 seconds after launch, a sensor problem resulted in the shutdown of center engine #1, resulting in a safe "abort to orbit" and successful completion of the mission.

Updated: 05/11/1999

Shuttle Reference and Data

Shuttle Abort Modes

RSLS ABORTS

These occur when the onboard Shuttle computers detect a problem and command a halt in the launch sequence after taking over from the Ground Launch Sequencer and before Solid Rocket Booster ignition.

ASCENT ABORTS

Selection of an ascent abort mode may become necessary if there is a failure that affects vehicle performance, such as the failure of a space shuttle main engine or an orbital maneuvering system. Other failures requiring early termination of a flight, such as a cabin leak, 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 to a planned landing site. Contingency aborts are designed to permit flight crew survival following more severe failures when an intact abort is not possible. A contingency abort would generally result in a ditch operation.

INTACT ABORTS

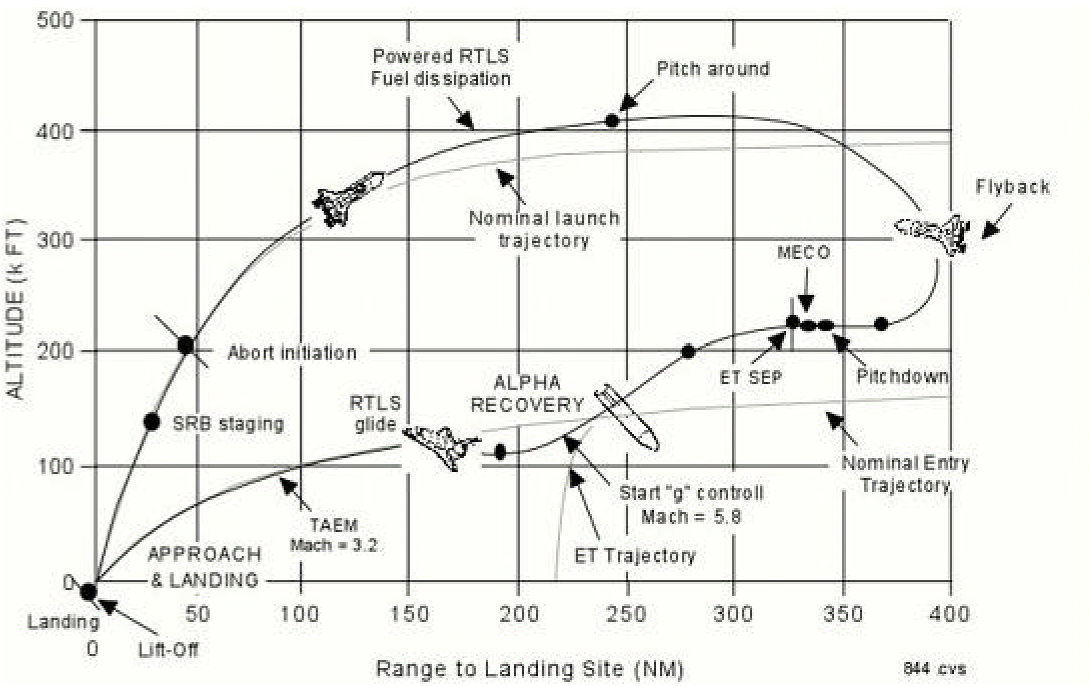
There are four types of intact aborts: abort to orbit (ATO), abort once around (AOA), transoceanic abort landing (TAL) and return to launch site (RTLS).

Return to Launch Site

The RTLS abort mode is designed to allow the return of the orbiter, crew, and payload to the 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.

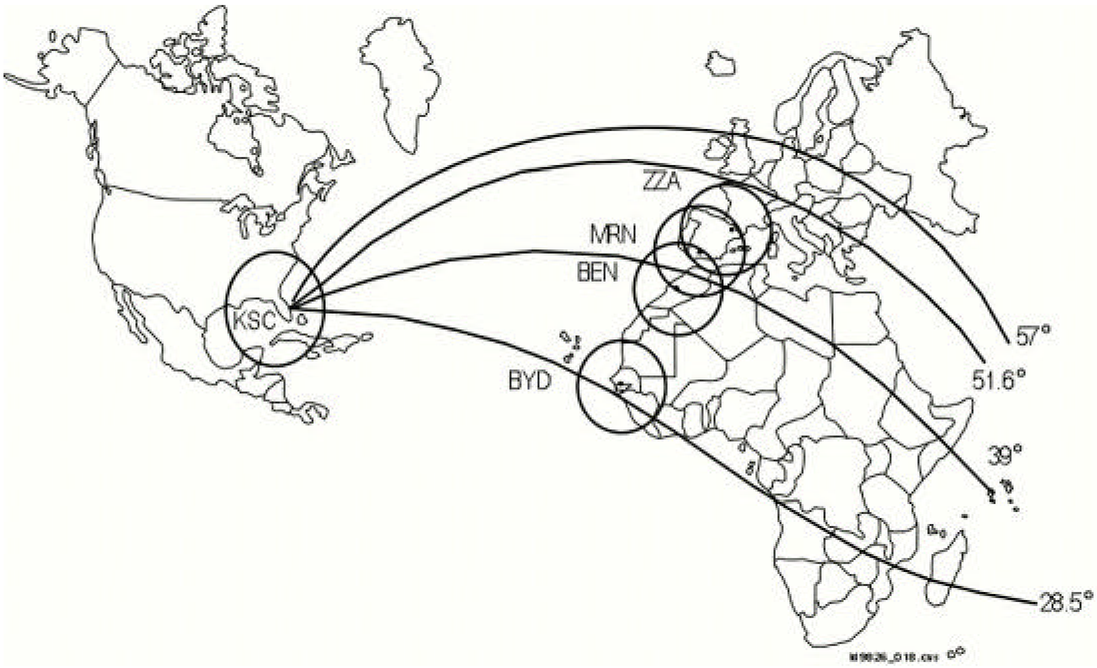
The vehicle will reach the desired main engine cutoff point with less than 2 percent excess propellant remaining in the external tank. At main engine cutoff minus 20 seconds, a pitch-down maneuver (called powered pitch-down) takes the mated vehicle to the required external tank separation attitude and 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.

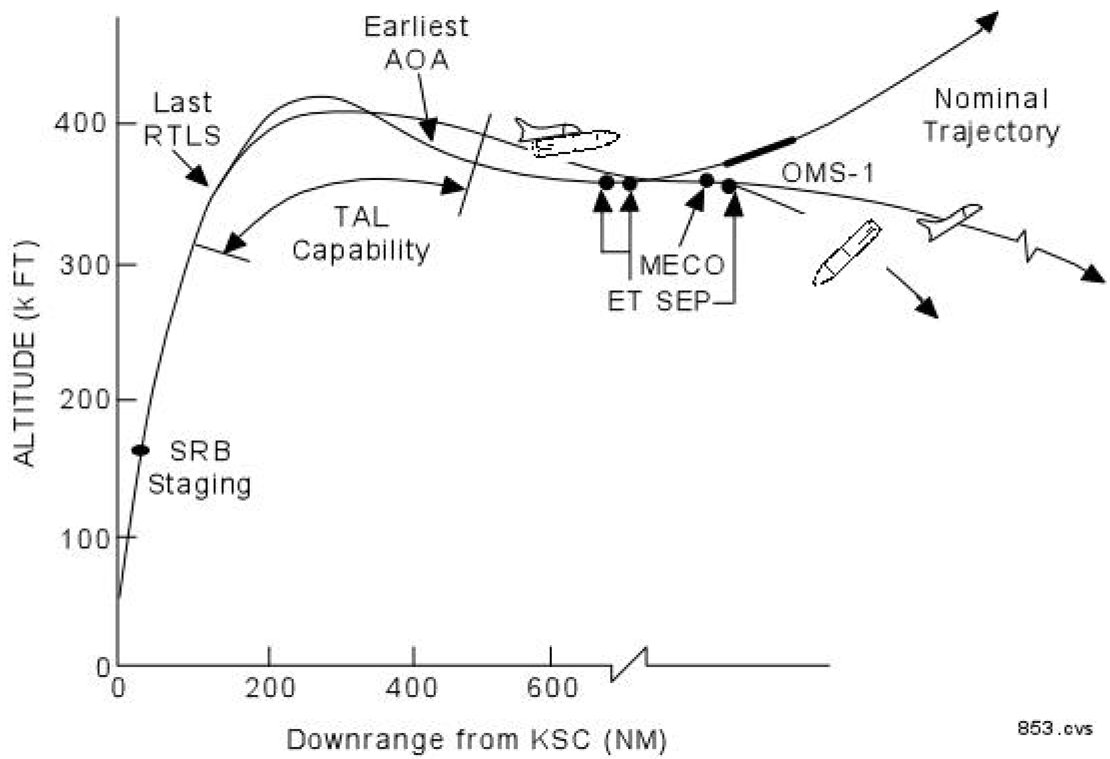
Transoceanic Abort Landing

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 maneuvering system 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.

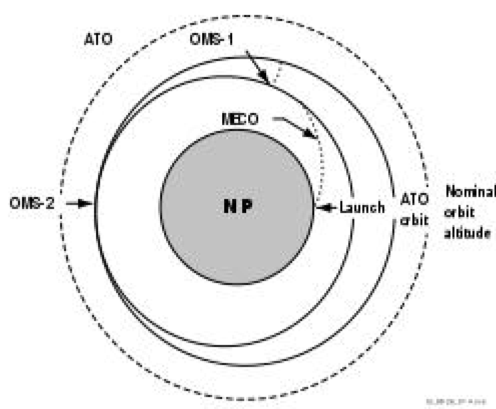


TAL versus Nominal Ascent

TAL is handled like a nominal entry.

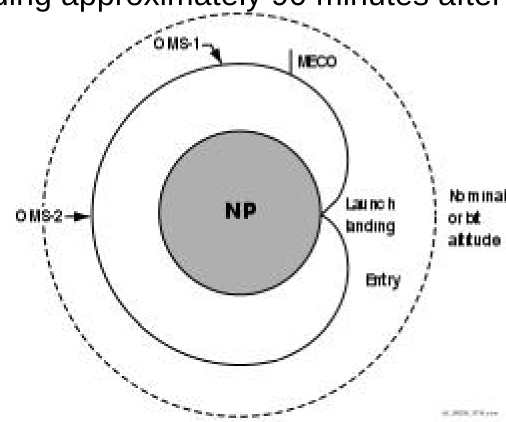
Abort to Orbit

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 in-flight 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.

Crew Profile Menu

Commander: Kent V. Rominger

During the flight, the Commander has onboard responsibility for the vehicle, crew, mission success and safety of flight.
NASA EXPERIENCE: Selected by NASA in March 1992, Rominger reported to the Johnson Space Center in August 1992. He completed one year of training and is qualified for assignment as a pilot on future Space Shuttle flight crews. Rominger was initially assigned to work technical issues for the Astronaut Office Operations Development Branch. A veteran of three space flights, Rominger has logged over 1,090 hours in space. He flew as pilot on STS-73 in 1995, STS-80 in 1996 and STS-85 in 1997. Rominger is assigned to command the crew of Discovery on STS-96, a logistics and resupply mission for the International Space Station. Launch is targeted for May 1999.
SPACE FLIGHT EXPERIENCE: STS-73 Columbia (October 20 to November 5, 1995) was the second United States Microgravity Laboratory mission. The mission focused on materials science, biotechnology, combustion science, the physics of fluids, and numerous scientific experiments housed in the pressurized Spacelab module. In completing his first space flight, Rominger orbited the earth 256 times, traveled over 6 million miles, and logged a total of 15 days, 21 hours, 52 minutes and 21 seconds in space. STS-80 Columbia (November 19 to December 7, 1996) was a 17-day mission during which the crew deployed and retrieved the Wake Shield Facility (WSF) and the Orbiting Retrievable Far and Extreme Ultraviolet Spectrometer (ORFEUS) satellites. The free-flying WSF created a super vacuum in its wake and grew thin film wafers for use in semiconductors and other high-tech electrical components. The ORFEUS instruments, mounted on the reusable Shuttle Pallet Satellite, studied the origin and makeup of stars. In completing his second space flight, Rominger orbited the earth a record 278 times, traveled over 7 million miles and logged 17 days, 15 hours and 53 minutes in space. STS-85 (August 7-19, 1997) was a 12-day mission during which the crew deployed and retrieved the CRISTA-SPAS satellite, operated the Japanese Manipulator Flight Demonstration (MFD) robotic arm, studied changes in the Earth's atmosphere and tested technology destined for use on the future International Space Station. The mission was accomplished in 189 Earth orbits, traveling 4.7 million miles in 11 days, 20 hours and 27 minutes. AUGUST 1998

Ascent Seating: Flight Deck - Port Forward
Entry Seating: Flight Deck - Port Forward

Pilot: Rick D. Husband

The pilot assists the Mission Commander in controlling and operating the Shuttle. In addition, the pilot may assist in the deployment and retrieval of satellites utilizing the Shuttle's robot arm, and often coordinates the activities of astronauts conducting space walks or Extravehicular Activities.
During STS-96, pilot Rick Husband will be a back-up EVA crew member and also is the back-up robot arm operator during the space walks.
NASA EXPERIENCE: Husband was selected as an astronaut candidate by NASA in December 1994. He reported to the Johnson Space Center in March 1995 to begin a year of training and evaluation. Upon completion of training, Husband was named the Astronaut Office representative for Advanced Projects at Johnson Space Center, working on Space Shuttle Upgrades, the Crew Return Vehicle (CRV) and studies to return to the Moon and travel to Mars. Husband is assigned to pilot Discovery on STS-96, an 11-day logistics and resupply mission for the International Space Station. Launch is targeted for May 1999.

Ascent Seating: Flight Deck - Starboard Forward
Entry Seating: Flight Deck - Starboard Forward

Mission Specialist 1: Tamara E. Jernigan

Dr. Jernigan will serve as the prime space walking crew member on STS-96, designated EV 1, because of her striped space suit. She will also be the first crew member to enter the International Space Station the day after she conducts her space walk with Dan Barry. Jernigan will also serve as a backup to Ellen Ochoa for many procedures involving the shuttle's robot arm, or remote manipulator system, except during the space walks when pilot Rick Husband is the back-up arm operator.

NASA EXPERIENCE: Selected as an astronaut candidate by NASA in June 1985, Dr. Jernigan became an astronaut in July 1986. Her assignments since then have included: software verification in the Shuttle Avionics Integration Laboratory (SAIL); operations coordination on secondary payloads; spacecraft communicator (CAPCOM) in Mission Control for STS-30, STS-28, STS-34, STS-33, and STS-32; lead astronaut for flight software development; Chief of the Astronaut Office Mission Development Branch; Deputy Chief of the Astronaut Office. A veteran of four space flights, Dr. Jernigan has logged over 1,277 hours in space. She was a mission specialist on STS-40 (June 5-14, 1991) and STS-52 (October 22-November 1, 1992), was the payload commander on STS-67 (March 2-18, 1995), and again served as a mission specialist on STS-80 (November 19 to December 7, 1996). Dr. Jernigan is currently the Assistant for Station to the Chief of the Astronaut Office, directing crew involvement in the development and operation of the Station. SPACE FLIGHT EXPERIENCE: STS-40 Spacelab Life Sciences (SLS-1) was a dedicated space and life sciences mission aboard Space Shuttle Columbia. During the nine-day flight crew members performed experiments which explored how humans, animals and cells respond to microgravity and readapt to Earth's gravity on return. Other payloads included experiments designed to investigate materials science, plant biology and cosmic radiation. Mission duration was 218 hours, 14 minutes, 20 seconds. Landing was at Edwards Air Force Base, California. STS-52 was also launched aboard Space Shuttle Columbia. During the ten-day flight, the crew deployed the Italian Laser Geodynamic Satellite (LAGEOS) which will be used to measure movement of the Earth's crust, and operated the U.S. Microgravity Payload 1 (USMP-1). Also, the Space Vision System (SVS), developed by the Canadian Space Agency, was tested by the crew using a small target assembly which was released from the remote manipulator system. The SVS will be used for Space Station construction. In addition, numerous other experiments were performed by the crew encompassing the areas of geophysics, materials science, biological research and applied research for Space Station. Mission duration was 236 hours, 56 minutes 13 seconds. Landing was at Kennedy Space Center, Florida. STS-67 Astro-2 mission aboard the Space Shuttle Endeavour was the second flight of the Astro observatory, a unique complement of three telescopes. During this record-setting 16-day mission, the crew conducted observations around the clock to study the far ultraviolet spectra of faint astronomical objects and the polarization of ultraviolet light coming from hot stars and distant galaxies. Mission duration was 399 hours and 9 minutes. Landing was at Edwards Air Force Base in California. On STS-80 the crew aboard Space Shuttle Columbia successfully deployed and retrieved the Wake Shield Facility (WSF) and the Orbiting Retrievable Far and Extreme Ultraviolet Spectrometer (ORFEUS) satellites. The free-flying WSF created a super vacuum in its wake and grew thin film wafers for use in semiconductors and other high-tech electrical components. The ORFEUS instruments, mounted on the reusable Shuttle Pallet Satellite, studied the origin and makeup of stars. Her two planned spacewalks were lost due to a jammed outer hatch on the airlock. Mission duration was a record breaking 423 hours, 53 minutes. MARCH 1998

Ascent Seating: Mid Deck - Port
Entry Seating: Mid Deck - Port
EV1

Mission Specialist 2: Ellen Ochoa

Dr. Ochoa will serve as the prime robot arm operator during STS-96, using the arm to maneuver Tammy Jernigan and Dan Barry for certain tasks during their space walk. Ochoa will also be the prime crew member in charge of the tools to be used in Discovery's rendezvous with the International Space Station and is responsible for activating and deactivating the systems of the double Spacehab module in the cargo bay. In addition, Ochoa is the so-called "loadmaster" during the flight, responsible for the transfer of thousands of pounds of hardware and logistical items from Discovery to the International Space Station for future use.

EXPERIENCE: As a doctoral student at Stanford, and later as a researcher at Sandia National Laboratories and NASA Ames Research Center, Dr. Ochoa investigated optical systems for performing information processing. She is a co-inventor on three patents for an optical inspection system, an optical object recognition method, and a method for noise removal in images. As Chief of the Intelligent Systems Technology Branch at Ames, she supervised 35 engineers and scientists in the research and development of computational systems for aerospace missions. Dr. Ochoa has presented numerous papers at technical conferences and in scientific journals. Selected by NASA in January 1990, Dr. Ochoa became an astronaut in July 1991. Her technical assignments to date include flight software verification, crew representative for flight software and computer hardware development, crew representative for robotics development, testing, and training, Assistant for Space Station to the Chief of the Astronaut Office, directing crew involvement in the development and operation of the Station, and spacecraft communicator (CAPCOM) in Mission Control. A veteran of two space flights, Dr. Ochoa has logged over 484 hours in space. Dr. Ochoa is assigned to the crew of STS-96, a 10-day logistics and resupply mission for the International Space Station. Launch is targeted for May 1999. In April 1993, Dr. Ochoa flew as a Mission Specialist on STS-56, carrying ATLAS-2. During this 9-day mission the crew of Discovery conducted atmospheric and solar studies in order to better understand the effect of solar activity on the Earth's climate and environment. Dr. Ochoa used the Remote Manipulator System (RMS) to deploy and capture the Spartan satellite, which studied the solar corona. Dr. Ochoa was the Payload Commander on the STS-66 Atmospheric Laboratory for Applications and Science-3 mission (November 3-14, 1994). ATLAS-3 continues the series of Spacelab flights to study the energy of the Sun during an 11-year solar cycle and to learn how changes in the sun's irradiance affect the Earth's climate and environment. Dr. Ochoa used the RMS to retrieve the CRISTA-SPAS atmospheric research satellite at the end of its 8-day free flight.

Ascent Seating: Flight Deck - Center Aft
Entry Seating: Flight Deck - Center Aft
RMS

Mission Specialist 3: Daniel T. Barry

In addition to his role as one of two space walkers during the flight, Dr. Barry will be in charge of the operation of the various computers the crew members will use. Barry will be one of three crew members responsible for the systems of the International Space Station during the docked phase of the flight, and will participate in a number of secondary experiments and technology demonstrations.

NASA EXPERIENCE: Selected by NASA in March 1992, Dr. Barry reported to the Johnson Space Center in August 1992. He completed one year of training and is qualified for assignment as a mission specialist on Space Shuttle flight crews. Dr. Barry has worked on primary payload development, the Shuttle Avionics Integration Laboratory (SAIL), portable computing issues for Space Shuttle, Chief of Astronaut Appearances, and as a source board member for the NASA Space Biomedical Research Institute (NSBRI). He flew on STS-72 in 1996, and has logged over 214 hours in Space, including a 6 hour, 9 minute spacewalk. Dr. Barry is assigned to STS-96 as an EVA crewmember. STS-96 will be the first flight to dock to the International Space Station. Launch is targeted for May 1999. SPACE FLIGHT EXPERIENCE: STS-72 Endeavour (January 11-20, 1996) was a 9-day flight during which the crew retrieved the Space Flyer Unit (launched from Japan 10-months earlier), deployed and retrieved the OAST-Flyer, and Dr. Barry performed a 6 hour, 9 minute spacewalk designed to demonstrate and evaluate techniques to be used in the assembly of the International Space Station. Mission duration was 142 Earth orbits, traveling 3.7 million miles in 214 hours and 41 seconds. AUGUST 1998

Ascent Seating: Flight Deck - Starboard Aft
Entry Seating: Mid Deck - Center
EV2

Mission Specialist 4: Julie Payette

Payette will be the prime crew member in charge of Unity's systems while Discovery is docked to the International Space Station and will assist Valery Tokarev in monitoring Zarya's systems during the docked phase of the mission. Payette is the lead crew member for any in-flight maintenance of station systems or hardware, and will join Valery Tokarev for the swapout of battery voltage regulators in Zarya. She will also be the prime choreographer for the space walk to be conducted by Tammy Jernigan and Dan Barry. Payette is responsible for stowing equipment on the ISS and aboard Discovery, operating the Shuttle's robot arm for a camera survey, and will be in charge of the STARSHINE student science satellite.

Canadian Space Agency Astronaut. Ms. Payette was selected as an astronaut by the Canadian Space Agency (CSA) in June 1992 and underwent training in Canada. After basic training, she worked as a technical advisor for the MSS (Mobile Servicing System), the Canadian contribution to the International Space Station. In 1993, Ms. Payette established the Human-Computer Interaction (HCI) Group at the Canadian Astronaut Program and served as a technical specialist on the NATO International Research Study Group (RSG-10) on speech processing (1993-1996). In preparation for a space assignment, Ms. Payette studied Russian and logged over 120 hours of of reduced gravity flight time aboard various parabolic aircraft (KC-135, T-33, Falcon-20, DC-9). In April 1996, Ms. Payette completed a deep-sea diving hard suit training program in Vancouver BC and was certified as a one-atmosphere diving suit operator. Ms. Payette obtained her captaincy on military jet at the Canadian Air Force Base in Moose Jaw, Saskatchewan in February 1996. She has since obtained her military instrument rating and continues to fly regularly with the training squadron. Ms. Payette has logged more than 600 hours of flight time, including 150 hours on the Tutor CT-114 jet aircraft. NASA EXPERIENCE: Ms. Payette reported to the Johnson Space Center in August 1996 to begin mission specialist training. She completed initial astronaut training in April 1998 and was assigned to work technical issues for the Astronaut Office EVA/Robotics Branch. Ms. Payette is assigned as a mission specialist on the crew of STS-96 Atlantis, a 10-day logistics and resupply mission for the International Space Station. Launch is targeted for May 1999. AUGUST 1998

Ascent Seating: Mid Deck - Center
Entry Seating: Flight Deck - Starboard Aft
IV1

Mission Specialist 5: Valery Tokarev

Tokarev will join Tammy Jernigan as the first crew members to enter the International Space Station on the fifth day of the flight and will be responsible for Zarya's systems during the docked phase of the flight. He will be joined by Julie Payette for the swapout of battery voltage regulators aboard Zarya and will be involved in moving logistical items from Discovery to the ISS during six days of docked operations.

Valery Ivanovich Tokarev (Colonel, Russian Air Force) Test Cosmonaut at the Yu.A. Gagarin Cosmonaut Training Center In 1987, Valery Tokarev was selected to join the cosmonaut corps to fly the Buran spacecraft. Since 1994,he has served as commander of a group of cosmonauts of aerospace systems and, since 1997, as a test cosmonaut for the Yuri A. Gagarin Cosmonaut Training Center. SEPTEMBER 1998

Ascent Seating: Mid Deck - Starboard
Entry Seating: Mid Deck - Starboard

Flight Day Summary

DATE TIME (EST)	DAY	MET	EVENT
05/27/99 6:48:00 AM	1	000/00:00	Launch Time
05/27/99 7:32:00 AM	1	000/00:44	OMS 2
05/27/99 9:49:00 AM	1	000/03:01	NC-1
05/27/99 11:48:00 AM	1	000/05:00	Flight Day 1 Sleep
05/27/99 7:48:00 PM	2	000/13:00	Flight Day 2 Wake
05/27/99 10:48:00 PM	2	000/16:00	SHAB Activation
05/27/99 10:50:00 PM	2	000/16:02	NC-2
05/27/99 11:53:00 PM	2	000/17:05	EMU Checkout
05/28/99 2:35:00 AM	2	000/19:47	NPC
05/28/99 3:18:00 AM	2	000/20:30	RMS C/O
05/28/99 4:33:00 AM	2	000/21:45	Waste Dump
05/28/99 7:16:00 AM	2	001/00:28	NC 3
05/28/99 8:03:00 AM	2	001/01:15	10.2 Cabin Depress
05/28/99 9:48:00 AM	2	001/03:00	Flight Day 2 Sleep
05/28/99 5:18:00 PM	3	001/10:30	Flight Day 3 Wake
05/28/99 5:42:00 PM	3	001/10:54	FGB OSK Build
05/28/99 7:16:00 PM	3	001/12:28	NH
05/28/99 8:01:00 PM	3	001/13:13	NC 4
05/28/99 9:33:00 PM	3	001/14:45	Ti
05/28/99 10:38:00 PM	3	001/15:50	SSC C/O
05/28/99 10:48:00 PM	3	001/16:00	SK at 170 ft (estimated)
05/28/99 10:53:00 PM	3	001/16:05	EPCS Setup
05/28/99 11:04:00 PM	3	001/16:16	+Rbar Arrival
05/28/99 11:31:00 PM	3	001/16:43	-Rbar Arrival
05/29/99 12:16:00 AM	3	001/17:28	Push from 30 ft
05/29/99 12:21:00 AM	3	001/17:33	Contact
05/29/99 12:41:00 AM	3	001/17:53	Docking complete
05/29/99 3:13:00 AM	3	001/20:25	Early Ingress PMA 2
05/29/99 3:28:00 AM	3	001/20:40	CBM Controller Removal
05/29/99 3:43:00 AM	3	001/20:55	Node 1 Powerup
05/29/99 4:28:00 AM	3	001/21:40	Early Egress PMA 2
05/29/99 9:48:00 AM	3	002/03:00	Flight Day 3 Sleep
05/29/99 5:48:00 PM	4	002/11:00	Flight Day 4 Wake
05/29/99 6:48:00 PM	4	002/12:00	Node 1 IMV Valve Reconfig

Flight Day Summary, continued

DATE TIME (EST)	DAY	MET	EVENT
05/29/99 7:48:00 PM	4	002/13:00	EVA Prep
05/29/99 9:28:00 PM	4	002/14:40	Early Comm Ant Survey via RMS
05/29/99 11:03:00 PM	4	002/16:15	EVA 1 A/L Egress
05/30/99 4:58:00 AM	4	002/22:10	EVA 1 A/L Ingress
05/30/99 5:38:00 AM	4	002/22:50	OSVS Target Survey
05/30/99 9:48:00 AM	4	003/03:00	Flight Day 4 Sleep
05/30/99 5:48:00 PM	5	003/11:00	Flight Day 5 Wake
05/30/99 7:38:00 PM	5	003/12:50	PMA 2 Ingress
05/30/99 7:48:00 PM	5	003/13:00	Simo Dump
05/30/99 7:48:00 PM	5	003/13:00	SHAB Config
05/30/99 8:33:00 PM	5	003/13:45	Node Ingress
05/30/99 8:58:00 PM	5	003/14:10	PMA 1 Ingress
05/30/99 9:08:00 PM	5	003/14:20	FGB Ingress
05/30/99 10:03:00 PM	5	003/15:15	Bar Code Labels Installation
05/30/99 10:03:00 PM	5	003/15:15	Rack Pin Install
05/30/99 10:08:00 PM	5	003/15:20	CWC Initial S/U, Bag 1 of 7
05/30/99 10:33:00 PM	5	003/15:45	First ZSR Installation
05/30/99 10:38:00 PM	5	003/15:50	MIRTS Install (Batt Block 4)
05/30/99 11:03:00 PM	5	003/16:15	Second ZSR Installation
05/30/99 11:33:00 PM	5	003/16:45	Early Comm IFM Start
05/31/99 12:03:00 AM	5	003/17:15	ZSR Label Installation
05/31/99 12:08:00 AM	5	003/17:20	MIRTS Install (Batt Blocks 5 & 6)
05/31/99 12:13:00 AM	5	003/17:25	Transfer Ops Begin
05/31/99 12:23:00 AM	5	003/17:35	14.7 Cabin Repress
05/31/99 1:38:00 AM	5	003/18:50	MIRTS C/O (Batt Block 3)
05/31/99 1:58:00 AM	5	003/19:10	Radiation Monitors Deploy
05/31/99 2:03:00 AM	5	003/19:15	Node 1 Hatch Inspection
05/31/99 2:03:00 AM	5	003/19:15	Acoustic Sample, 1 of 2
05/31/99 2:38:00 AM	5	003/19:50	Muffler Install, Pt 1 of 2
05/31/99 3:58:00 AM	5	003/21:10	CWC Fill Init, Bag 2 of 7
05/31/99 5:13:00 AM	5	003/22:25	Formaldehyde Mon Dply
05/31/99 5:48:00 AM	5	003/23:00	PAO Event-CDR, MS1, MS3
05/31/99 9:18:00 AM	5	004/02:30	Flight Day 5 Sleep
05/31/99 5:18:00 PM	6	004/10:30	Flight Day 6 Wake
05/31/99 8:08:00 PM	6	004/13:20	MIRTS Install (Batt 1 & 2)
05/31/99 8:18:00 PM	6	004/13:30	CWC Fill Init, Bag 3 of 7
05/31/99 8:18:00 PM	6	004/13:30	Transfer Ops Begin
05/31/99 9:43:00 PM	6	004/14:55	Muffler Install, Pt 2 of 2
05/31/99 11:08:00 PM	6	004/16:20	Acoustic Sample, 2 of 2
06/01/99 1:18:00 AM	6	004/18:30	PAO Event-CDR, MS5
06/01/99 2:13:00 AM	6	004/19:25	CWC Fill Init, Bag 4 of 7

Flight Day Summary, continued

DATE TIME (EST)	DAY	MET	EVENT
06/01/99 2:28:00 AM	6	004/19:40	DTO 700-14 Ops 2 Test
06/01/99 3:03:00 AM	6	004/20:15	VRA Initial Setup
06/01/99 5:13:00 AM	6	004/22:25	Formaldehyde Mon Retreive
06/01/99 5:33:00 AM	6	004/22:45	Simo Dump
06/01/99 8:48:00 AM	6	005/02:00	Flight Day 6 Sleep
06/01/99 4:48:00 PM	7	005/10:00	Flight Day 7 Wake
06/01/99 7:08:00 PM	7	005/12:20	PAO Event-CDR, MS4
06/01/99 8:03:00 PM	7	005/13:15	Transfer Ops Begin
06/01/99 8:13:00 PM	7	005/13:25	CWC Fill Init, Bag 5 of 7
06/01/99 8:58:00 PM	7	005/14:10	VRA Science Activation
06/01/99 11:13:00 PM	7	005/16:25	VRA Sample Pair 1
06/01/99 11:58:00 PM	7	005/17:10	Crew Conference
06/02/99 1:38:00 AM	7	005/18:50	VRA Sample Pair 2
06/02/99 2:03:00 AM	7	005/19:15	CWC Fill Init, Bag 6 of 7
06/02/99 4:48:00 AM	7	005/22:00	VRA Sample Pair 3
06/02/99 5:23:00 AM	7	005/22:35	PAO Event-CDR, PLT, MS2
06/02/99 8:48:00 AM	7	006/02:00	Flight Day 7 Sleep
06/02/99 4:48:00 PM	8	006/10:00	Flight Day 8 Wake
06/02/99 7:48:00 PM	8	006/13:00	Transfer Ops Begin
06/02/99 7:48:00 PM	8	006/13:00	VRA Sample Pair 4
06/02/99 7:48:00 PM	8	006/13:00	N1 Hatch Adjustment
06/02/99 7:48:00 PM	8	006/13:00	DTO 1214
06/02/99 7:48:00 PM	8	006/13:00	Rack Pin Locate
06/02/99 8:48:00 PM	8	006/14:00	FGB Dust Filter
06/02/99 9:38:00 PM	8	006/14:50	SDS Valves Troubleshoot
06/02/99 9:48:00 PM	8	006/15:00	CWC Fill Init, Bag 7 of 7
06/02/99 9:48:00 PM	8	006/15:00	FGB Harmful Cart Rplc
06/02/99 10:13:00 PM	8	006/15:25	VRA Sample Pair 5
06/02/99 11:48:00 PM	8	006/17:00	O2 Repress
06/03/99 1:03:00 AM	8	006/18:15	VRA Sample Pair 6
06/03/99 1:23:00 AM	8	006/18:35	FGB PGO Egress
06/03/99 2:28:00 AM	8	006/19:40	FGB GA Egress
06/03/99 2:33:00 AM	8	006/19:45	VRA Deact
06/03/99 3:13:00 AM	8	006/20:25	PMA 1 Egress
06/03/99 3:48:00 AM	8	006/21:00	Node 1 Egress
06/03/99 4:08:00 AM	8	006/21:20	PMA 2 Egress
06/03/99 4:18:00 AM	8	006/21:30	Reboost
06/03/99 4:38:00 AM	8	006/21:50	VEST/PMA 2 Depress
06/03/99 5:18:00 AM	8	006/22:30	ISS Egress Complete
06/03/99 8:48:00 AM	8	007/02:00	Flight Day 8 Sleep
06/03/99 9:48:00 AM	8	007/03:00	NCS TFL U/L

Flight Day Summary, continued

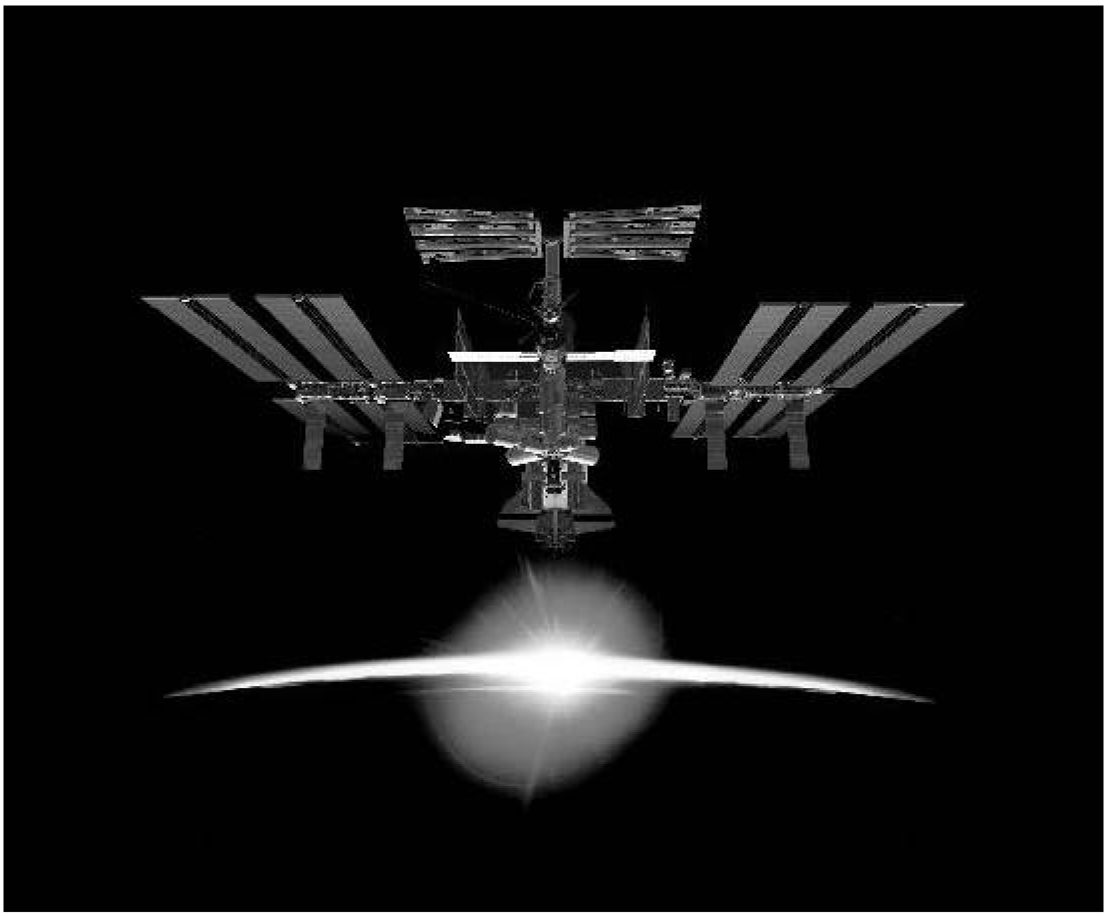
DATE TIME (EST)	DAY	MET	EVENT
06/03/99 11:48:00 AM	8	007/05:00	NCS S/W Patch U/L
06/03/99 1:48:00 PM	8	007/07:00	NCS DBL U/L
06/03/99 3:48:00 PM	9	007/09:00	Flight Day 9 Wake
06/03/99 6:37:00 PM	9	007/11:49	Undock
06/03/99 8:08:00 PM	9	007/13:20	Final Sep
06/03/99 8:48:00 PM	9	007/14:00	FGB OSK Build
06/03/99 9:03:00 PM	9	007/14:15	Simo Dump
06/03/99 9:18:00 PM	9	007/14:30	PILOT Training
06/03/99 9:43:00 PM	9	007/14:55	Space Flight Awareness
06/04/99 12:48:00 AM	9	007/18:00	Off Duty
06/04/99 8:48:00 AM	9	008/02:00	Flight Day 9 Sleep
06/04/99 4:48:00 PM	10	008/10:00	Flight Day 10 Wake
06/04/99 7:48:00 PM	10	008/13:00	FCS C/O & RCS H/F
06/04/99 7:48:00 PM	10	008/13:00	SHAB Stow
06/04/99 9:13:00 PM	10	008/14:25	Cabin Stow
06/04/99 9:53:00 PM	10	008/15:05	MAGR OPS3 GPS Test
06/04/99 11:18:00 PM	10	008/16:30	PAO Taped Message
06/05/99 12:48:00 AM	10	008/18:00	D/O Brief
06/05/99 3:11:00 AM	10	008/20:23	Starshine Deploy
06/05/99 4:03:00 AM	10	008/21:15	L-1 Comm Check, part 1 of 2
06/05/99 5:03:00 AM	10	008/22:15	L-1 Comm Check, part 2 of 2
06/05/99 5:33:00 AM	10	008/22:45	Ku-antenna stow
06/05/99 8:48:00 AM	10	009/02:00	Flight Day 10 Sleep
06/05/99 4:48:00 PM	11	009/10:00	Flight Day 11 Wake
06/06/99 2:21:00 AM	11	009/19:33	Deorbit Tig
06/06/99 3:25:00 AM	11	009/20:37	Landing at KSC

Updated: 05/20/1999

Rendezvous

Docking Mechanisms

Overview



ISS Docking Mechanism plans for Discovery, other Shuttles and this first logistics mission call for Discovery to dock at the ISS on Day 3 and remain there for six days. The Shuttle's external airlock will be connected to Unity's Pressurized Mating Adapter (PMA) 2 using an interlocking system designed in Russia. It is termed an Androgynous Peripheral Attach System. Discovery's crew will control PMA-2's docking mechanism from the cockpit.

Pressurized Mating Adapters

Two PMAs are attached to Unity, one at each end. They provide passageways for crew, equipment and supplies. They also feature docking mechanisms for space shuttles at one end and Zarya at the other.

Because they are pressurized, heated and supplied with hand-hold grips, the 8-ft-long, tunnel-like PMAs permit shirt-sleeved crews to pass between Discovery and the ISS.

Androgynous Peripheral Attach System

A structural ring, a movable ring, alignment guides, latches, hooks, dampers and fixers are integrated to form the Androgynous Peripheral Attach System. It mates with an exact copy, and each can act as the passive or active half.

During docking, the active half's capture ring extends outward from the structural ring toward the passive half. Upon contact, the system dampens out any relative motion between the docking vehicles. Once that is accomplished, the capture ring aligns the two vehicles. It is then retracted with the passive ring still attached. Twenty-four structural hooks snug the connection down to form an airtight seal.

History/Background

The Androgynous Peripheral Attach System's technological roots reach back to the Apollo-Soyuz and Shuttle-Mir missions. The System is built by Moscow-based RSC-Energia.

Updated: 05/14/1999

Rendezvous

Rendezvous and Docking

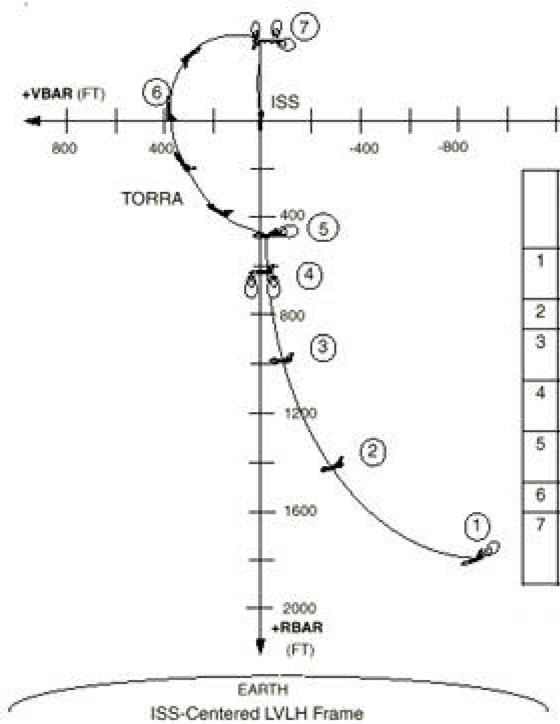
Overview

Discovery’s rendezvous and docking with the International Space Station actually 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 Discovery to a point about eight nautical miles behind the station, the starting point for a final approach to the station.

Terminal Phase

About three hours before the scheduled docking time on Flight Day Three, Discovery will reach the point about eight nautical miles behind the ISS. At that time, Discovery's jets will be fired in a Terminal Phase Initiation (TI) burn to begin the final phase of the rendezvous. Discovery will close the final eight nautical miles to the station during the next orbit. As Discovery closes in, the shuttle’s rendezvous radar system will begin tracking the station and providing range and closing rate information to the crew.

STS-96 FRR
TERMINAL PHASE AND TORRA



	APPROX. PET (h:mm)	EVENT*
1	0:00	MANUAL PHASE TAKEOVER (POST MC4) 2000 FT (Rdot= -3.0 fps)
2	0:03	1500 FT BRAKING GATE (Rdot= -2.3 fps)
3	0:08	1000 FT BRAKING GATE (Rdot= -1.5 fps) SWITCH TO LOWZ
4	0:13	600 FT BRAKING GATE (Rdot= -0.8 fps) RBAR ARRIVAL
5	0:16	500 FT (Rdot= -0.6 fps) INITIATE TORRA (DAP A10/B10)
6	0:28	VBAR CROSSING
7	0:39	ARRIVE -RBAR NEAR 350 FT AND BEGIN SNOOPY MANEUVER IF NECESSARY (DAP A8/B8)

*All ranges CG-to-CG

As Discovery begins to close in on the station, flight controllers will command the station to the docking orientation, perpendicular to the Earth's surface with the Unity module pointed toward space and Zarya toward Earth. For Discovery's final approach, the solar panels on the station will be "feathered" to have their edge facing the shuttle. Also, when within about 1,000 feet of the station, Commander Kent Rominger will use Discovery's steering jets in a mode called "Low Z," a mode that fires jets offset rather than pointed directly at the station to control the shuttle's approach. This jet mode together with the solar panel's feathering prevent exhaust from shuttle jets from flexing and overstressing the station's solar panels.

Proximity Operations

As Discovery reaches close proximity to the station, the Trajectory Control Sensor, a laser ranging device mounted in the shuttle payload bay, will supplement the shuttle’s onboard navigation information by supplying additional data on the range and closing rate. As Discovery closes in, the shuttle will have the opportunity for several small successive engine firings to fine-tune its approach using its onboard navigation information. As Discovery moves to within about a half-mile of the station, Rominger will take over manual control of the shuttle's approach, flying the spacecraft from the aft flight deck and monitoring the approach through the rear and overhead windows.

Rominger will slow Discovery's approach and fly to a point about 500 feet directly below the station, from which he will begin a half-circle of the station. During the rendezvous, Rominger will be assisted by Pilot Rick Husband in controlling Discovery's approach. Mission Specialists Tammy Jernigan and Ellen Ochoa also will play key roles in the rendezvous, with Jernigan operating the shuttle's docking mechanism and Ochoa assisting with the rendezvous navigation. The crew will use a handheld laser pointed through the shuttle windows to provide supplemental information on the station's range and closing rate.

Rominger will fly Discovery to cross about 350 feet in front of the station and then continue to reach a point about 250 feet directly above the station. He will stop Discovery and then slowly descend toward the station to a point about 170 feet away from it. At approximately 170 feet distant, Rominger will hold Discovery's position for about a half-hour to allow the station to move within range of Russian communications stations. Also at this time, Jernigan will power up the docking mechanism and prepare it for contact and capture with the station. A day ahead of the rendezvous, the docking mechanism is scheduled to be checked out and its docking ring extended.

Final Approach

Once the station is in communications with Russia and flight controllers have confirmed it is in the proper configuration for docking, Rominger will begin the final approach.

Using the view from a centerline camera fixed in the center of Discovery's docking mechanism, Rominger will precisely align the shuttle mechanism with the docking mechanism on Unity's conical mating adapter as he approaches. At a distance of about 30 feet, Rominger will stationkeep momentarily to adjust the alignment, if necessary.

Docking

For Discovery's docking, Rominger will maintain the shuttle's speed relative to the station at about one-tenth of a foot per second, and keep the docking mechanisms aligned to within three inches of one another. As Discovery moves to within 25 feet, Rominger will switch the shuttle steering jets back to normal mode from "Low Z" to provide better control of Discovery for the final docking.

When Discovery makes contact with the station, latches will automatically attach the two spacecraft together. Immediately after Discovery docks, the shuttle's steering jets will be deactivated and ground controllers will command off the station's steering jets to reduce the forces acting at the docking interface. Shock absorber-type springs in the docking mechanism will dampen any relative motion between the shuttle and the station.

Once relative motion between the spacecraft has been stopped, Jernigan will command the docking ring on Discovery's mechanism to retract and close latches in the mechanism to firmly secure the shuttle to the station. Once the two vehicles are firmly secured, the shuttle’s steering jets will be reactivated to control both spacecraft for the duration of the docked operations.

Updated: 05/11/1999

Rendezvous

Undocking, Separation and Fly-Around

Overview

Once Discovery is ready to undock, the initial separation will be performed by springs in the docking mechanism that will gently push the shuttle away from the station. Both Discovery and the station's steering jets will be shut off to avoid any inadvertent firings during this initial separation.

Once the docking mechanism's springs have pushed Discovery away to a distance of about two feet, when the docking devices will be clear of one another, Husband will turn the shuttle's steering jets back on in "Low Z" mode and fire them to begin very slowly moving away. From the aft flight deck, Pilot Rick Husband will manually control Discovery within a tight corridor as he separates from the ISS, essentially the reverse of the task performed by Commander Kent Rominger when Discovery docked.

Discovery will continue away to a distance of about 450 feet, where Husband will begin the close flyaround of the station, first crossing a point directly behind, then directly underneath and then again above the station. If Discovery's propellant reserves allow it, Husband will circle the station twice as the crew records views of the exterior with still photography and video. As Discovery crosses directly above the station for the second time, Husband will fire Discovery's jets to perform a final separation. The separation firing will put Discovery on a course that will have it pass about a half-mile behind the station and then about a mile and a half below the station before moving ahead of it with constantly increasing distance.

Updated: 05/11/1999

EVAs

Space Walk to Install U.S., Russian Crane Systems

Overview

Astronauts Tammy Jernigan and Daniel Barry will conduct a six-hour space walk on flight day four to install crane systems that will be used on future missions to assist in assembly and transfer operations. The two astronauts will be assisted by Flight Engineer Ellen Ochoa, who will operate the Shuttle's robotic arm from inside Discovery.

Getting Ready

Preparations for the space walk begin early in the mission, on flight day two, with the checkout of the space suits, also called extravehicular mobility units, or EMUs. Later that day, the air pressure in the crew cabin will be reduced from the standard operating pressure at 14.7 psi to 10.2 psi in order to gradually condition the astronauts to an atmospheric environment more closely resembling that of the space suits, themselves, which operate at 4.3 psi. This technique reduces the time required for the astronauts to "prebreathe" pure oxygen so that nitrogen may be cleansed from their bloodstream to prevent a condition commonly called the "bends." The astronauts will prepare their EVA tools and review procedures for their installation operation on the third day of the mission.

The Space Walk

On flight day four, Jernigan and Barry will don their space suits, pre-breathe pure oxygen to cleanse the remaining nitrogen from their blood streams, and exit the Orbiter into the payload bay for six hours of preparation, installation and cleanup. Jernigan, designated "EV1" will exit the airlock first and, after configuring tethers for the start of the space walk, will be joined by Barry, designated "EV2." Jernigan will be visibly distinguished by a red stripe around the legs on her space suit.

Preparations will include the placement of a work station and portable foot restraints into position for the installation of an American-built crane, called the ORU Transfer Device, or OTD, and the Russian-built crane called Strela (Russian, for "arrow"). Installation of the OTD and Strela are estimated to take about 1 hour each.

Ready to begin the installation work, Jernigan will fix her boots to a foot restraint on the end of the Shuttle's robotic arm, and Ochoa will maneuver her from a foot restraint at Pressurized Mating Adapter (PMA-1) to the Integrated Cargo Carrier (ICC). PMA-1 is a passageway between Unity and Zarya, and the ICC is a flatbed pallet attached in Discovery's payload bay.

Jernigan will meet Barry on the Integrated Cargo Carrier, where they will retrieve the small, 209-pound U.S. OTD. While holding the crane, Jernigan will be transported back to PMA-1. Barry will join her to attach the crane to an EVA worksite fixture on the PMA.

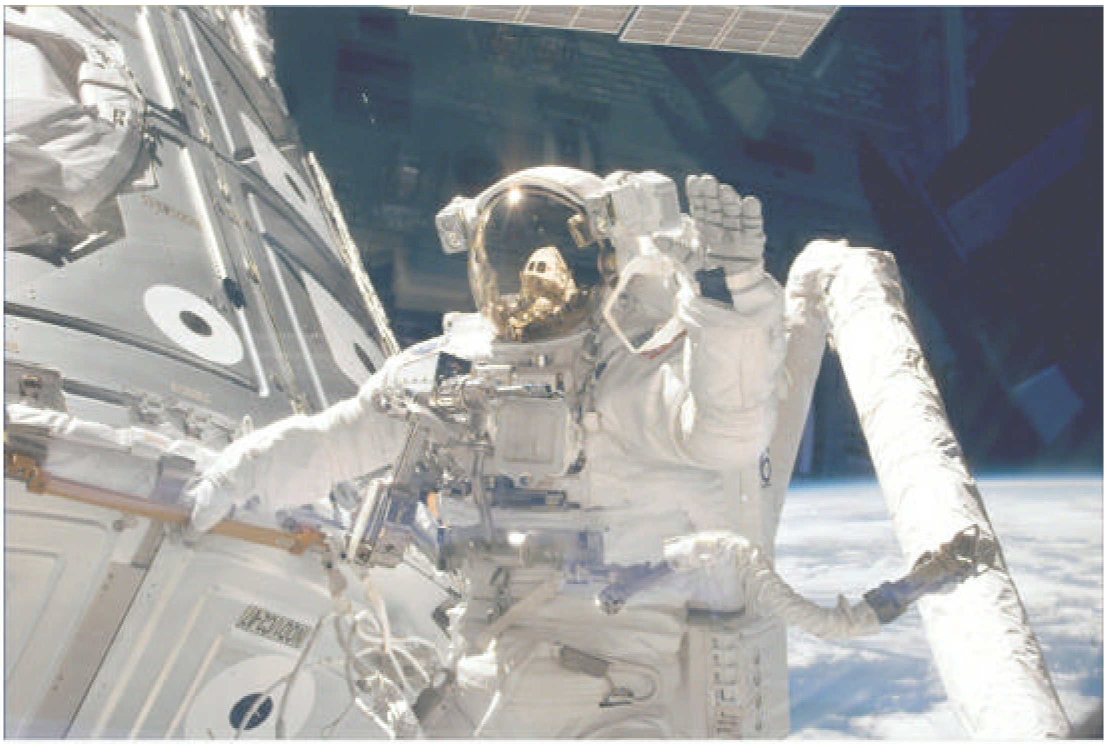
The two will return to the Integrated Cargo Carrier and retrieve the 165-pound operator post and 33-pound grapple fixture adapter plate for the Russian crane, Strela. They will assemble those pieces on one of the two PMA-2 grapple fixtures. PMA-2 connects the Shuttle external airlock to Unity.

Strela is an updated version of the crane used on Mir. It will primarily be used for Science Power Platform operations. Assembly of the three-metric-ton capacity crane will be completed during this year's second ISS logistics mission. A 45-ft. telescopic boom will then be added to the operator post, and the completed assembly will be moved to a grapple fixture on Zarya.

The astronauts will then return to the ICC to retrieve two portable foot restraints and transfer them into PMA-1. They will return to the Integrated Cargo Carrier, one last time, to remove three tool and hardware bags and three additional pieces of EVA support equipment from the SPACEHAB

Oceaneering Space System box. The bags will contain tools for handling ISS replacement parts and to assist in the assembly of the Space Station, as well as on-orbit installable handrails. Jernigan and Barry will stow them on Unity.

If time permits, the two space walkers will also install a thermal cover on a Unity trunion pin, inspect Zarya's paint, checkout the ODT and survey the Early Communications System antenna on the starboard side of Unity.



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EVA Timeline for Space Walk to Install U.S., Russian Crane Systems

Time	Event	Prime	Backup
0:00	Airlock Egress	Tamara Jernigan	Daniel Barry
00:30	Post Depress/Egress; and set-up for EVA activities in Payload Bay	Tamara Jernigan	Daniel Barry
01:30	Crane Setup by RMS Operator Ochoa; Crane Removal and Installation by Jernigan & Barry	Tamara Jernigan	Daniel Barry
02:30	STRELA Set up by RMS Operator Ochoa; STRELA Remove and Install by Jernigan and Barry	Tamara Jernigan	Daniel Barry
03:45	IAPFR Pre-Retrieve and Install with RMS; IAPFR Remove by EV1, Docking Target Install by EV2	Tamara Jernigan	Daniel Barry
04:30	Logistics Bags Retrieve by RMS Operator; Tool Bag Install by EV1 and EV2; Photo Survey by EV1	Tamara Jernigan	Daniel Barry
05:30	Foot Restraint Install, and Payload Bay Clean Up	Tamara Jernigan	Daniel Barry
06:15	Airlock Ingress and Re-press (approx. 20 minutes)	Tamara Jernigan	Daniel Barry
06:35	EVA Conclusion	Tamara Jernigan	Daniel Barry

Updated: 05/14/1999

Payloads

Cargo Transfer

SpaceHab

Prime: Julie Payette

Overview

Mission Specialists working in the pressurized, shirtsleeves environment provided by SPACEHAB are tasked with moving some 750 items to the ISS from the cargo carrier's racks, lockers and other stowage facilities. A number of those items are being stowed aboard the Station for use by crews on future missions, beginning with the addition of Russia's Service Module:

Items	ISS Mission /Year Planned	ISS Location
Computers, printers, cables	2R Russian Service Module / 1999	Zarya
Vacuum access jumper, charcoal canisters, adapters	3A Integrated Truss Z1 / 1999	Unity
Oxygen canisters	4A Integrated Truss P6 / 1999	Unity
Vacuum access jumper	5A US Laboratory Module / 2000	Unity

Russian hardware that will be placed on the ISS during STS-96 includes:

· Life support systems replacement spares
· Sanitary and hygienic equipment
· Medical support equipment
· On-board computer system replacement parts
· Maintenance repair kits
· Base unit and related components of the Strela ("Arrow") crane
· Zarya sound damping kits
· MIRT repair kits

Priorities

Logistics experts for this mission developed a categorical priority system for moving cargo that puts the highest value on ensuring the safe entry and exit of the crew members as they move between the shuttle and the ISS. These priorities were set in accordance with the most mission critical to the least, while accounting for what would be left undone were the mission to be terminated earlier than planned.

Examples from each category are shown below, starting with the highest priority.

1. Ingress/safety
· ISS oxygen communication assembly
· Atmosphere sampling bottles
· Charcoal filter analyzer element
· Zarya muffler [acoustic damping] hardware

2. Critical spares
· MIRTs
· Sequential shunt unit
· Common Berthing Mechanism seal patch kits
· Early communication command telemetry processor

3. Incremental assembly
· Tools and power equipment
· Tethers and related gear
· Photo-TV cameras, film, tape
· Space suits and associated garments, equipment

4. Crew health maintenance
· Medical support equipment
· Cardiorecorder
· Audio dosimeter biobag
· Formaldehyde monitor kit

5. Pre-position for future missions

6. Resupply
· 2A recovery hardware
· Driver drill charger kit
· Braycote lubricant
· Emergency exit decal

7. Spares/non-assembly equipment
· IMAX 3D movie production hardware, accessories
· Crew provisions
· Clothing
· Sleeping bags

8. Detailed test objectives
· Velcro ties
· Single-sided tape
· Strain gage extension cables
· Flex hose assembly

Cargo Handling

Despite the virtual weightlessness in which the astronauts will work, moving the SPACEHAB's cargo won't be easy. In carefully choreographed movements not unlike those of research divers retrieving specimens from a coral reef, the Mission Specialists will ease each cargo item out of its individual location and push or pull it to its destination.

En route, the items must be taken through Discovery's cargo bay tunnel, negotiated around a right-angle turn and into Pressurized Mating Adapter 2, and either deposited in Unity or pushed on into Zarya.

Additional Tasks

If time permits, additional tasks will be performed during the spacewalk and internal transfers.

Space-walking astronauts Jernigan and Barry may have time to survey, for instance, discoloration on Unity, the starboard omnidirectional antenna for the ISS Early Communications System, and the paint on Zarya.

Mission Specialists inside will try to find the time to pressure-check a nitrogen line, inspect Unity's forward and aft hatch mechanisms and adjust them if necessary, and trouble-shoot a sample delivery system valve. If there is sufficient shuttle propellant following Discovery's undocking from the ISS, a fly-around visual inspection will be performed prior to de-orbit and landing.

Payloads

Integrated Cargo Carrier

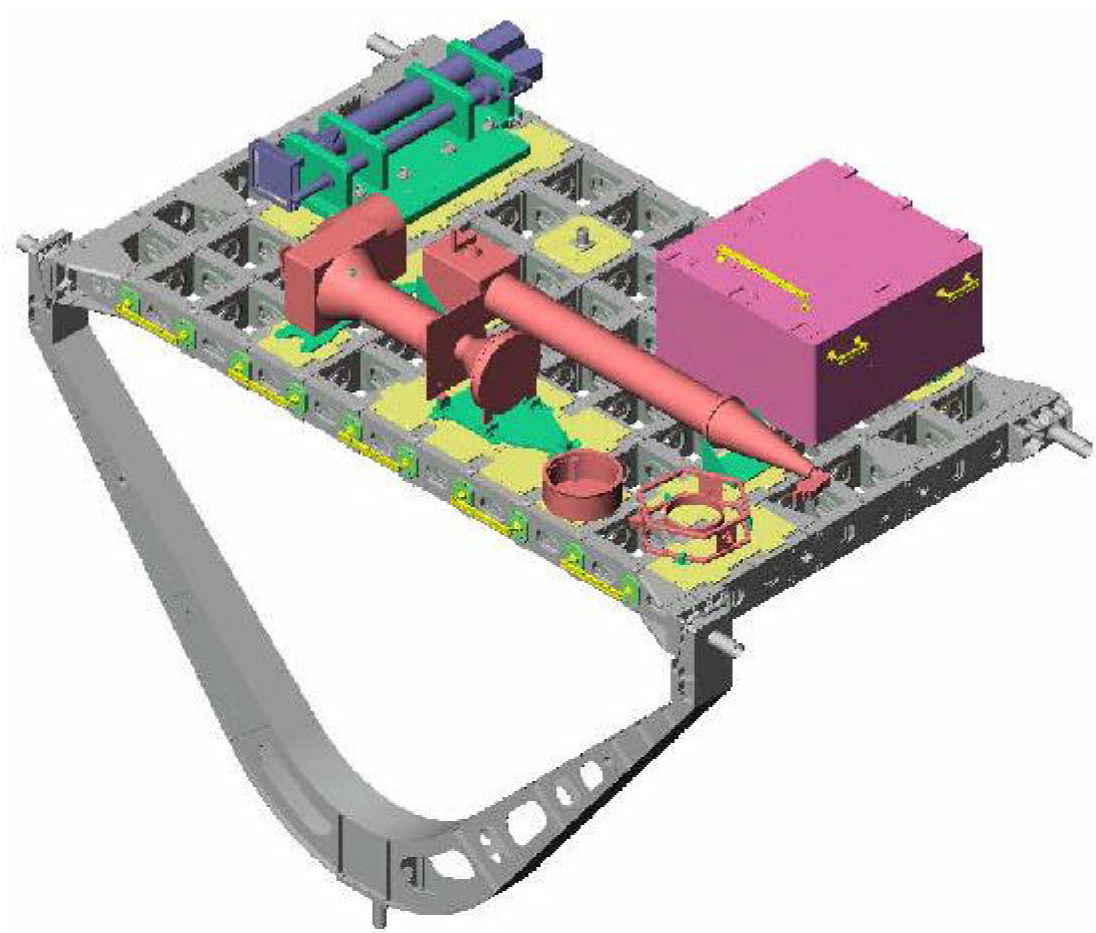
Payload Bay

3050 lbs. lbs.

Prime:

Backup:

Overview



The Integrated Cargo Carrier is an unpressurized flat bed pallet and keel yoke assembly housed in Discovery's payload bay. Constructed of aluminum, it is eight feet long, 15 feet wide and 10 inches thick and has the capability to carry cargo on both faces of the pallet, both atop and below.

During STS-96, the ICC will carry the U.S. space walkers' crane, which is called the OTD for Orbital Replacement Unit Transfer Device. The OTD weighs 209 pounds and will be mounted to the exterior of Unity during a space walk by astronauts Tammy Jernigan and Dan Barry. It also will carry 198 pounds of parts for the Russian Strela crane which will be stowed on the exterior of Pressurized Mating Adapter 2 (PMA-2)by Jernigan and Barry.

Also mounted to the ICC, is the Spacehab-Oceaneering Space System Box (SHOSS), which is designed to carry up to 400 pounds of space-walking tools and flight equipment to assist astronauts during ISS assembly.

The ICC provides sufficient surface area in the cargo bay to carry approximately 3,000 pounds of cargo which would otherwise have to be carried in the Shuttle's cabin.

The ICC will be used by astronauts throughout the construction of the Space Station as it transports hardware from locations on the station's exterior to work sites on the truss assemblies.

Updated: 05/19/1999

Payloads

Integrated Vehicle Health Monitoring HEDS Technology Demonstration 2

Payload Bay

254 lbs. lbs.

Prime: Rick Husband

Overview

This is the second of two planned flights of the IVHM HTD, an experiment designed to evaluate the feasibility of using modern commercial sensors to monitor the health of space shuttle systems during flight in order to reduce ground processing of NASA's fleet of orbiters. IVHM HTD-1 was flown on STS-95 in October-November of 1998.

Shuttle processing currently involves the verification of thousands of requirements to determine the health of shuttle systems. In early 1997, NASA studied these requirements to determine if it could reduce the processing time and increase vehicle safety. NASA found that ground processing (planned and unplanned) could potentially be reduced 15 to 20%. Planned work could be reduced by implementing a system with predictive capabilities to monitor subsystem health in real time during flight and by extending the service life of life-limited components. Unplanned work could be reduced by improving visibility of system health and streamlining problem isolation.

IVHM is essentially an advanced form of a traditional vehicle instrumentation system, which consists of sensors (pressure, temperature, voltage, strain, acceleration, etc.), wiring, signal conditioning devices, multiplexing devices, and recording devices. But an IVHM system goes a step further by providing the capability to process data instead of merely recording data. This allows an onboard trend analysis that could detect system degradation and control in-flight systems checkout in addition to allowing more efficient system servicing and checkout on the ground.

During the terminal launch countdown, an IVHM data stream is transmitted to the Launch Control Center for processing and viewing. Approximately 10 seconds before takeoff, the IVHM processor autonomously begins recording data. Data is recorded during ascent and during predefined periods on orbit. The recorded data is dumped to a ground system after the mission.

On STS-96, the experiment will be activated during prelaunch cryogenic propellant servicing. The pilot will deactivate the HTD about one hour after launch. The crew will activate the experiment for one hour each day during the mission.

The IVHM HTD-2 experiment package consists of an air transport rack for data acquisition and processing and two remote health nodes mounted on a getaway special beam in the orbiter payload bay. The ATR and RHNs are connected by cables to 120 sensors in the orbiter aft crew compartment and payload bay.

One of the technologies to be demonstrated is microelectromechanical sensing for detecting the presence of hazardous gas and sensing pressure in vacuum-jacketed lines in the orbiter's cryogenic distribution system. Other technology demonstrations include Bragg-Grating fiber-optic sensing for hazardous gas detection and structural strain/temperature determination, thermal flow meter leak detection, accelerometers for space shuttle main engine pump vibration sensing, VME bus architecture, and flash card memory.

The HTDs will also provide data on the performance of commercial computing products, such as a VME bus architecture and ATR chassis, and on the effects of radiation and heat on commercial and military VME hardware.

The focus of IVHM HTD-2 is to determine the health of selected functions of the orbiter's main propulsion system, main engines, and power reactant storage and distribution system. The technologies to be developed include Bragg-Grating fiber-optic sensors for hydrogen, strain, and temperature sensing and smart sensors for hydrogen, oxygen, and pressure sensing. IVHM HTD-2 will also evaluate distributed data acquisition by the remote health nodes with fiber data distributed interface communication and a lightweight, low-power microelectronic hardware platform; real-time information processing of space shuttle main engine pump vibration; solid-state data storage; and advanced control room equipment and applications.

A complete flight IVHM system consists of advanced lightweight, low-power sensors; distributed data acquisition and processing; real-time information processing, including diagnostics, prognostics, and vehicle autonomy for control or suggested action; and advanced solid-state, high-density data storage. A complete ground IVHM system consists of improved control room architectures and automated ground support equipment. This experiment will advance the development of a subset of a complete IVHM system.

History/Background

The IVHM HTD experiments are part of NASA's Human Exploration and Development of Space enterprise. HEDS is pursuing answers to myriad research and engineering questions that must be answered as humans learn to live and work in space. The goals of the HEDS enterprise are to explore the solar system, use the environment of space to expand scientific knowledge, provide safe and affordable human access to space, and enrich life on Earth through space.

Benefits

The IVHM HTDs are providing data on the performance of advanced sensing technologies and commercial products which may be useful in reducing the cost and time associated with processing the space shuttle, streamlining problem troubleshooting, and improving NASA's awareness of shuttle systems during operation. Technologies and products that are found to be useful will be incorporated into an IVHM system for the shuttle. The data from these experiments may also be used to benefit other programs, such as liquid flyback boosters, X vehicles, the crew return vehicle, and lunar/Mars missions.

Updated: 05/11/1999

Payloads

MIRTs Changeout

SpaceHab

Prime: Julie Payette

Backup: Valery Tokarev

Overview

On Flight Days 5 and 6, astronaut Julie Payette and Cosmonaut Valery Ivanovich Tokarev will replace all 18 of the battery charge/discharge units that support Zarya's six nickel-cadmium batteries. Known by the Russian acronym "MIRTs," they are thought to be responsible for voltage problems first detected in January.

MIRTs are part of a system that indicates the level of charge for each of Zarya's batteries and, in turn, dictates when the onboard charging system will begin to taper-off the power supply to each.

Flight controllers have been working around the problem by cycling the batteries, fully charging, and then fully discharging them every week. This procedure resets the charge indication and maintains the batteries at peak performance. It appears that when Zarya's MIRTs measure the cumulative charge or amp-hour readings of each battery, they introduce a slight error in a compensation factor and thus prevent full charge/discharge cycles from occurring.

Replacement of the units -- they measure 5.9 x 4.7 x 3 inches and weigh 1.43 pounds -- may reduce the need for weekly cycling, resulting in better long-term battery performance and additional backup equipment capabilities for the ISS. Payette and Tokarev were trained for this part of the mission in mid-March at the Gagarin Cosmonaut Training Center at Star City outside Moscow, where a full-scale Zarya mock-up is located, and will follow procedures jointly developed by engineers at Mission Control Center Moscow and Mission Control Center-Houston.

The MIRTs are located under Zarya's floor panels.

Updated: 05/11/1999

Payloads

Shuttle Vibration Forces Experiment

Payload Bay

327 lbs. lbs.

Principal Investigator: Terry Scharton, Jet Propulsion Laboratory, Pasadena, Calif.

Overview

The Shuttle Vibration Forces experiment will measure the dynamic forces between Discovery and a canister attached to the orbiter's payload bay wall. The experiment is designed to validate a new vibration testing method that, if proven, will enable NASA to fly more sophisticated equipment on space shuttle missions.

The vibration method that SVF will test has been used on other NASA flight programs. It involves limiting the force of the vibration test to the force expected during flight.

Commercial triaxial force transducers and three wideband stand-alone acceleration measurement devices built by the Johnson Space Center will measure the dynamic forces.

The SVF payload will be carried in a standard getaway special canister mounted on the sidewall of the payload bay. The force transducers have been incorporated into four custom brackets, which replace the brackets normally used to attach GAS canisters to the sidewall GAS adapter beam.

The SVF payload is self-supporting (the payload is battery powered and the data is recorded within the payload) and does not require any crew interface. The payload will be activated automatically by orbiter lift-off vibrations and will operate for approximately 240 seconds.

STS-96 is the second flight of the SVF experiment. The experiment's first flight was STS-90 in April 1998.

History/Background

The powerful rocket engines used on the shuttle and other launch vehicles generate a great deal of noise and vibration at liftoff. All shuttle equipment must be designed for this severe environment, and most of the cargo for shuttle missions is subjected to extreme vibration testing to ensure that it will survive.

Because conventional vibration testing methods have not changed substantially in 50 years, they are not well suited for lightweight and sometimes delicate aerospace equipment. Equipment, which could survive space flight, often fails during vibration testing, wasting effort and money because the equipment must be redesigned and retested.

Benefits

The experiment is designed to validate a new vibration testing method that, if proven, will enable NASA to fly more sophisticated equipment on space shuttle missions.

Updated: 05/11/1999

Payloads

SPACEHAB

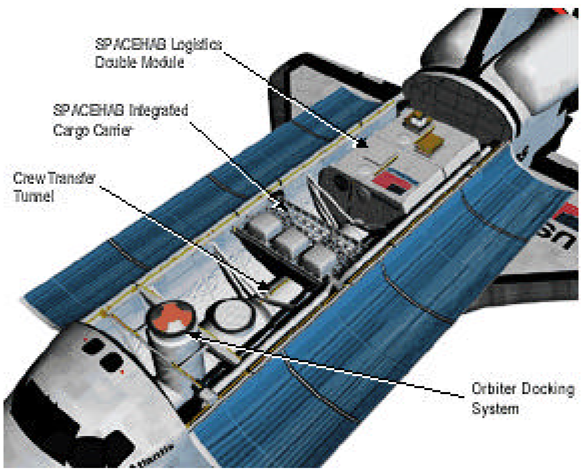
Payload Bay

16072 lbs. lbs.

Prime: Ellen Ochoa

Backup: Julie Payette

Overview



Shuttle With SPACEHAB Logistics Double Module

U.S. and Russian hardware for the International Space Station will be carried in the SPACEHAB double module, a pressurized laboratory in the shuttle's cargo bay that is connected to the middeck area of the orbiter. Crew access is through a tunnel system located between the orbiter middeck and the SPACEHAB module.

Designed to augment the shuttle orbiter's middeck, the SPACEHAB double module has a total cargo capacity of up to 10,000 pounds and contains systems necessary to support astronauts, such as ventilation, lighting, and limited power.

Generally, two crew members are required for SPACEHAB operations. The SPACEHAB environmental control system is designed to nominally accommodate two crew members on a continuous basis. Additional crew members can be accommodated for brief periods at the expense of reduced cabin air heat rejection capability.

Microgravity Research Program

Working in partnership with the scientific community and commercial industry, NASA's Microgravity Research Program strives to increase understanding of the effects of gravity on biological, chemical, and physical systems.

Using both space flight- and ground-based experiments, researchers throughout the nation, as well as international partners, are working together to benefit economic, social, and industrial aspects of life for the United States and the entire Earth. U.S. universities, designated by NASA as commercial space centers, share these space advancements with U.S. industry to create new commercial products, applications, and processes.

Under the NASA Headquarters' Office of Life and Microgravity Sciences and Application, the Microgravity Research Program supports NASA's strategic plan in the Human Exploration and Development of Space Enterprise.

Microgravity research has been performed by NASA for more than 25 years. The term *microgravity* means a state of very little gravity. The prefix micro comes from the Greek word *mikros* ("small"). In metric terms, the prefix means one part in a million (0.000001).

Gravity dominates everything on Earth, from the way life has developed to the way materials interact. But aboard a spacecraft orbiting the Earth, the effects of gravity are barely felt. In this microgravity environment, scientists can conduct experiments that are all but impossible to perform on Earth. In this virtual absence of gravity as we know it, space flight gives scientists a unique opportunity to study the states of matter (solids, liquids, and gases) and the forces and processes that affect them.

Marshall Space Flight Center in Huntsville, Ala., is the lead center for NASA's Microgravity Research Program. The program manages Microgravity Science and Applications Project Offices at the Lewis Research Center in Cleveland, Ohio, and the Jet Propulsion Laboratory in Pasadena, Calif., and project offices at Marshall.

Under the project offices, the Microgravity Research Program is divided into nine major areas: five science disciplines, three research infrastructure programs, and the Space Products Development Office.

The science disciplines include biotechnology, fluid physics, materials science, combustion science and fundamental physics. The infrastructure activities include acceleration measurement, advanced technology, and the Glovebox Flight Program.

Marshall manages the Biotechnology Program and Material Science Program as well as the Glovebox Flight Program and the Space Products Development Office. Lewis Research Center manages the Fluid Physics, Combustion Science and Acceleration Measurement programs, while the Jet Propulsion Laboratory manages the Fundamental Physics and the Advanced Technology Development Program. As an element of the Biotechnology Program, Johnson Space Center manages bioreactor research in cell tissue growth.

In addition to the U.S. and Russian hardware for the International Space Station carried within the SPACEHAB module, additional unpressurized equipment for transfer to the space station will be carried on the new SPACEHAB integrated cargo carrier. The ICC, a cross-bay carrier that can accommodate 6,000 pounds of cargo, will be carrying a Russian cargo crane known as STRELA, the SPACEHAB Oceaneering Space System Box, and a U.S.-built crane called the orbital replacement unit transfer device.

History/Background

Early in the shuttle program, it became evident that the orbiter middeck is the best place to conduct crew-tended experiments in space. Each shuttle orbiter has 42 middeck lockers, but most are used to stow crew gear for a typical seven-day mission, leaving only seven or eight for scientific studies. But SPACEHAB, the first crew-tended commercial payload carrier, has initiated a new era of space experimentation.

The basic SPACEHAB module, which takes up a quarter of the orbiter's payload bay, is like a second middeck. The 10-foot-long pressurized module adds 1,100 cubic feet of pressurized work space that can hold 61 lockers or experiment racks or a combination of the two. The lockers are sized and equipped like those in the shuttle middeck so that experiments can be moved from one location to the other. The lockers accommodate up to 60 pounds of experiment hardware in about 2 cubic feet. A rack, which can be single or double, takes the space of ten lockers. Double racks are similar in size and design to those planned for the space station so that they can serve as test beds for future projects. A single rack can carry 655 pounds of hardware in 22.5 cubic feet.

A new double module, developed specifically for shuttle missions to Mir, will be used on STS-96. The double module, which can accommodate nearly 10,000 pounds of cargo, was created by joining two single modules.

The astronauts enter the module through a modified Spacelab tunnel adapter. SPACEHAB can accommodate two crew members on a continuous basis, but additional crew members can work in the module for brief periods. Power, command and data services, cooling, vacuum, and other utilities are supplied by orbiter crew cabin and payload bay resources.

SPACEHAB was privately developed and is privately operated by SPACEHAB, Inc., of Arlington, Va. STS-96 is the 13th flight of SPACEHAB.

The first flight of the SPACEHAB research laboratory was on STS-57 in June 1993. All systems operated as expected, and the 21 NASA-sponsored experiments met more than 90% of the criteria for mission success. SPACEHAB 2 was flown on STS-60 in February 1994 and carried 13 experiments. More than 20 experiments were performed as part of SPACEHAB 3 on STS-63 in February 1995.

On STS-76, in March 1996, SPACEHAB carried 37 materials processing, microgravity, Earth sciences, biology, life sciences, and ISS risk mitigation experiments and logistics to Mir. Ten commercial space product development payloads in the areas of biotechnology, electronic materials, polymers, and agriculture were part of the SPACEHAB mission on STS-77 in May 1996. SPACEHAB carried additional stowage bags, experiments, and other logistics to Mir on STS-79 in September 1996, STS-81 in January 1997, STS-84 in May 1997, STS-86 in September 1997, STS-89 in January 1998, STS-91 in June 1998, and STS-95 in November 1998.

Benefits

Using both space flight- and ground-based experiments, researchers throughout the nation, as well as international partners, are working together to benefit economic, social, and industrial aspects of life for the United States and the entire Earth. U.S. universities, designated by NASA as commercial space centers, share these space advancements with U.S. industry to create new commercial products, applications, and processes.

Updated: 05/11/1999

Payloads

Student-Tracked Atmospheric Research Satellite for Heuristic International Networking Equipment (STARSHINE)

353 lbs. lbs.

Principal Investigator: Professor R. Gilbert Moore, Utah State University

Overview

Twenty-five thousand students scattered across the United States and around the world are set to watch for their own twinkling satellite to sweep across the sky in the morning and evening twilight hours. The students polished nearly 900 aluminum mirrors that completely cover the beachball-sized satellite's outer surface. The spacecraft, which was designed and built by the Naval Research Laboratory in Washington, D.C., will be ejected from the space shuttle Discovery and placed in a circular orbit 220 miles above the Earth.

As STARSHINE orbits the Earth this summer and into early winter, sunlight reflecting off its mirrors will be visible during twilight hours to observers on the ground as far north as central Canada and the northern tip of Scotland and as far south as the southern tip of South America, Africa and New Zealand. Teams of elementary, middle and high school students will visually track the satellite and note the times that it passes between selected pairs of targeted stars.

The students will enter their observations on the STARSHINE project's Internet site at http://www.azinet.com/starshine, and NRL and the U.S. Space Command will use the measurements to calculate the satellite's orbit. The German Space Operations Center in Oberpfaffenhafen, Germany, will use the orbital data to issue sighting predictions so the students will know where and when to look for STARSHINE's next appearance over their observation sites. As the project progresses, high school students will be taught how to calculate the orbits on their personal computers.

Throughout the mission, students will measure the daily change in the time it takes STARSHINE to circle the Earth. The students will use this information to calculate the density of the Earth's upper atmosphere. During its six-month lifetime, STARSHINE will gradually lose altitude because of the aerodynamic drag caused by the atmosphere's density and eventually will burn up like a flaming meteor approximately 60 miles above the Earth.

Students will also look at daily solar images on the STARSHINE Web site and count the sunspots on the solar surface. They will plot the daily number of sunspots against the rate of change of STARSHINE's orbital period to learn how solar storms heat and expand the Earth's upper atmosphere, causing variations in its density and producing aerodynamic drag.

At the end of the mission, the students will attempt to photograph the satellite's fiery reentry, and the best picture will win a prize.

The STARSHINE spacecraft is an 86.6-pound hollow aluminum sphere that is 19 inches in diameter. It is covered with 878 polished aluminum mirrors that are 1 inch in diameter. The mirrors were machined by Utah high school technology students and shipped to schools in Argentina, Austria, Australia, Belgium, Canada, China, Denmark, England, Finland, Japan, Mexico, New Zealand, Pakistan, South Africa, Spain, Turkey, the United States, and Zimbabwe for polishing.

On the day before landing, the satellite will be deployed from its hitchhiker getaway special canister in Discovery's payload bay by a spring ejection system at an altitude of 205 nautical miles. A combination of spring rotation and tipoff will cause it to rotate about its pitch and yaw axes at a rate of one revolution per minute. This angular motion, combined with STARSHINE's orbital translation rate of 2 degrees per second, will produce flashes of sunlight from its mirrors every few seconds.

Project STARSHINE plans to launch one satellite per year over an 11-year solar cycle. Just as soon as STARSHINE 1 gets into orbit and begins its twinkling trek across the twilight sky, project officials plan to push ahead with preparations for STARSHINE 2. The basic spacecraft structure for STARSHINE 2 has already been built by NRL, and Utah high school technolgy students are working on the mirror blanks.

Benefits

The principal objectives of Project STARSHINE are educational and motivational. If students help "build" the spacecraft (by polishing its mirrors), they should be more excited about tracking it and using it to measure upper atmospheric density and the response of that region of the atmosphere to solar storms.

Project STARSHINE is giving precollege students a chance to work with real space hardware and learn how to do precision work on elements of that hardware. They also learn about satellite orbits and Earth's upper atmosphere and the interaction between the Earth's and sun's atmospheres and magnetospheres. The participants use the Internet to obtain knowledge, report their measurements, and communicate as team members with students in other countries. They are taught how to make precision optical measurements and use precision timing systems to make those measurements, and they learn something about observational astronomy and amateur radio. In short, they learn that science and engineering and technology can be fun and still produce useful results.

The project has received overwhelmingly positive responses from teachers and students around the world--before the satellite leaves the ground. When the satellite completes its six months in orbit, project officials believe that they will have built up a cadre of student participants who will be interested in becoming even more involved in future projects of this nature.

If Project STARSHINE is able to fly a satellite every year throughout an 11-year solar cycle, as presently planned, generations of students will learn the basic principles of solar-terrestrial physics. To further this end, the project plans to post daily white-light, ground-based images of the sun on its Web site as well as satellite images in other wavelengths and will link to other solar activity indices in Boulder, Colo. In the fall, the project will begin posting auroral images as well.

Besides educating and motivating students, Project STARSHINE may have scientific benefits. If enough students do serious tracking of the spacecraft to get good orbits, especially during the terminal phase of the flight, the project might be able contribute to the pool of knowledge of the average density of the atmosphere in the 60- to 120-mile altitude regime. Since STARSHINE is spherical, it has a much more unifom drag coefficient than spacecraft with solar arrays and helical antennas and other structures protruding from them, so the density measurements that will be made from tracking STARSHINE will be more precise than those from tracking other reentering spacecraft.

Updated: 05/11/1999

DTO/DSO/RMEs

Heat Exchange Unit Evaluation
DTO 686

Prime: Daniel Barry
Backup: Julie Payette

Overview

This DTO will evaluate a commercial portable heat exchange unit that uses water as the refrigerant and identify possible uses on the space shuttle.

Chilling is caused by the evaporation of the water in the unit under reduced pressure obtained from the vacuum of space. Since water and vacuum are abundant resources on the shuttle, the unit has a potentially extensive chilling capacity. The heat exchange unit also has a unique internal feature that controls the water vaporization rate while maximizing the heat exchange during the process. The system performed well in demonstrations under gravity conditions, and in theory, should perform equally as well in microgravity.

Beverages, ice cream, and other items are chilled by exposing them to the outer surface of the heat exchange unit, which is smaller than a beverage can. The vacuum for operating the device is provided by the orbiter's waste control system vacuum port or the waste water overboard dump system. The unit can operate for up to 12 hours.

This is the first of three planned flights of DTO 686.

Updated: 05/11/1999

DTO/DSO/RMEs

Resource Transfer Line Capability Evaluation
DTO 1214

Prime: Kent Rominger
Backup: Rick Husband

Overview

The major objective of this DTO is to verify the installation and operation of resource transfer bundle (RTB) drag-through lines for transferring nitrogen, oxygen, and water from the space shuttle orbiter to the International Space Station before their required first use. It is not cost-effective to complete the end-to-end verification of the resource transfer lines on the ground. This DTO will enhance the RTB design evaluation process and supplement the ground verification program with actual flight experience.

In addition to evaluating the handling qualities of the RTB, this DTO will demonstrate the installation of the three drag-through lines and verify the installation procedures, evaluate the RTB's operating characteristics, verify procedures for disconnecting the lines in an emergency, and evaluate on-orbit stowage conditions.

The nitrogen and oxygen transfer lines will remain on the space station. The water line will be returned.

This is the first of at least two planned flights for this DTO.

Updated: 05/11/1999

DTO/DSO/RMEs

Single-String Global Positioning System
DTO 700-14

Prime: Daniel Barry

Overview

The purpose of this DTO is to evaluate the performance and operation of the Global Positioning System as a shuttle navigation aid during the ascent, on-orbit, entry and landing phases of the mission. A modified military GPS receiver processor and the orbiter's existing GPS antenna will be used for this evaluation.

This is the eighth of eight planned flights for DTO 700-14. It was last flown on STS-88.

Updated: 05/11/1999

DTO/DSO/RMEs

Solid-State Star Tracker Size Limitations
DTO 847

Overview

The objective of this DTO is to characterize the performance of the orbiter's solid-state star tracker with a large and bright target-the International Space Station. Laboratory tests show that the SSST can track significantly larger and brighter objects than the orbiter's other star tracker-the image-dissecting tracker. Since the ISS will reach a size very early in the assembly sequence that could prohibit IDT operations under certain conditions, it may be necessary to use the SSST to track the space station during orbiter passes.

At a minimum, the SSST should be verified to accurately track ISS up to 22.6 arcminutes, which is the largest size tested in the lab and the number that was used in analyzing potential problems because of the size of the ISS. If possible, the absolute upper limit in the size of an object that the SSST can track will be determined.

This DTO will be performed when the orbiter separates from the ISS but only if specific lighting conditions exist.

This is the first of three planned flights.

Updated: 05/11/1999

DTO/DSO/RMEs

Space Integrated Global Positioning System/Inertial Navigation System

DTO 700-15

Prime: Kent Rominger

Backup: Rick Husband

Overview

The space integrated Global Positioning System/inertial navigation system is intended to replace the shuttle's onboard tactical navigation system and, eventually, its inertial measurement units. The DTO will evaluate the system's performance in space flight to reduce the technical and schedule risks associated with applying this new technology to the shuttle navigation systems.

In addition to demonstrating the new navigation system's performance in a realistic space vehicle environment during all mission phases, DTO 700-15 will prove the ability of the modified commercial military-grade unit to accurately perform all required functions in the harsh environment of space and determine if any changes of the unit are needed to support navigation in space.

This is the fifth flight of DTO 700-15. It was last flown on STS-88. Fourteen flights are planned.

Updated: 05/11/1999

DTO/DSO/RMEs

Urine Collection Device
DTO 690

Overview

This DTO will evaluate several sizes and types of manual urine collection devices and their adapters (anatomical interface) in microgravity for fit, leakage, hygiene (residual urine on adapter), and ease of use.

An improved UCD would have two primary benefits. Used as a backup for the orbiter's waste collection system, it would allow a mission to continue if the WCS failed. Currently, missions must be cut short if the WCS fails. Second, an improved UCD would allow women to participate in scientific studies requiring the collection of urine. Female subjects have not been able to use existing UCDs successfully.

Male astronauts have also experienced problems with the existing UCDs in the areas of leakage, fit, and urine remaining in the dead volume. Therefore, a secondary objective of this study will be to design and evaluate improvements of the male interface.

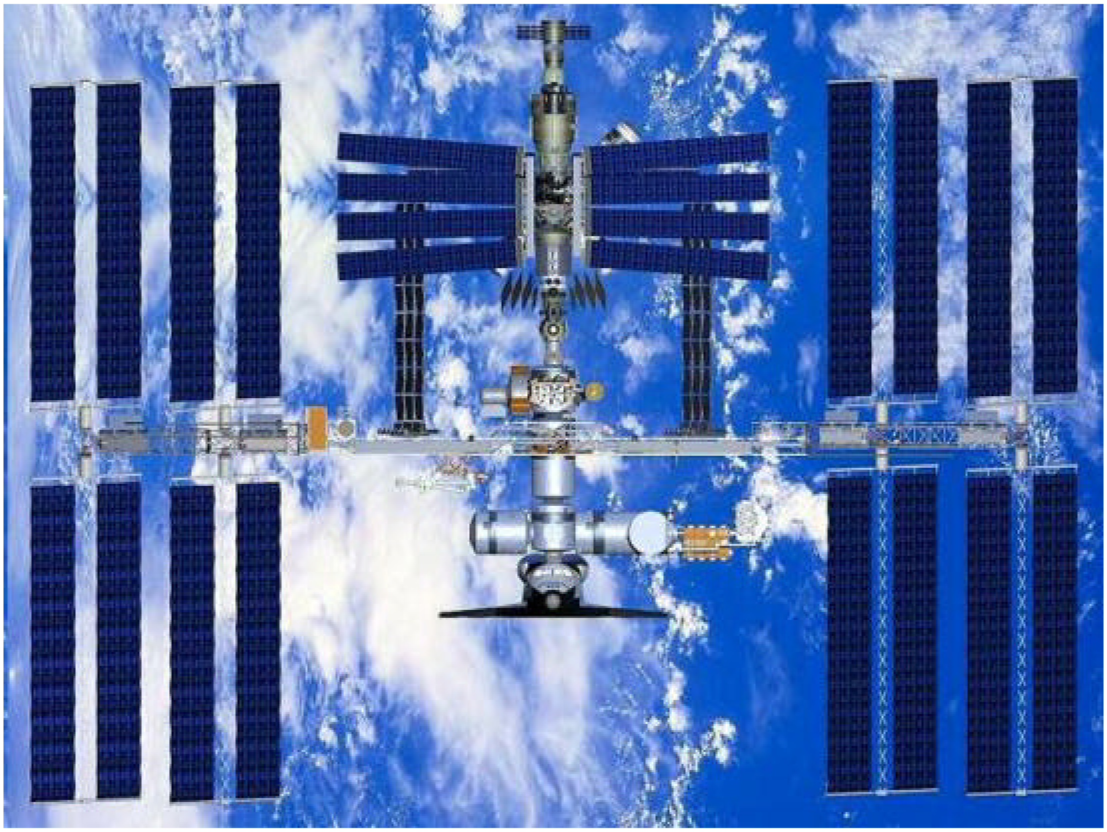
The final designs will be flown on all missions that require the collection of urine samples as either the primary method of collection or as a backup to an automated urine collection system that has been proposed for the space station.

This is the second of eight planned flights for this DTO. Its first flight was on STS-91.

Updated: 05/11/1999

International Space Station

The International Space Station



The International Space Station is the largest and most complex international scientific project in history. And when it is complete just after the turn of the century, the the station will represent a move of unprecedented scale off the home planet. Led by the United States, the International Space Station draws upon the scientific and technological resources of 16 nations: Canada, Japan, Russia, 11 nations of the European Space Agency and Brazil.

More than four times as large as the Russian Mir space station, the completed International Space Station will have a mass of about 1,040,000 pounds. It will measure 356 feet across and 290 feet long, with almost an acre of solar panels to provide electrical power to six state-of-the-art laboratories.

The station will be in an orbit with an altitude of 250 statute miles with an inclination of 51.6 degrees. This orbit allows the station to be reached by the launch vehicles of all the international partners to provide a robust capability for the delivery of crews and supplies. The orbit also provides excellent Earth observations with coverage of 85 percent of the globe and over flight of 95 percent of the population. By the end of this year, about 500,000 pounds of station components will be have been built at factories around the world.

U.S. Role and Contributions

The United States has the responsibility for developing and ultimately operating major elements and systems aboard the station. The U.S. elements include three connecting modules, or nodes; a laboratory module; truss segments; four solar arrays; a habitation module; three mating adapters; a cupola; an unpressurized logistics carrier and a centrifuge module. The various systems being developed by the U.S. include thermal control; life support; guidance, navigation and control; data handling; power systems; communications and tracking; ground operations facilities and launch-site processing facilities.

International Contributions

The international partners, Canada, Japan, the European Space Agency, and Russia, will contribute the following key elements to the International Space Station:

· Canada is providing a 55-foot-long robotic arm to be used for assembly and maintenance tasks on the Space Station.

· The European Space Agency is building a pressurized laboratory to be launched on the Space Shuttle and logistics transport vehicles to be launched on the Ariane 5 launch vehicle.

· Japan is building a laboratory with an attached exposed exterior platform for experiments as well as logistics transport vehicles.

· Russia is providing two research modules; an early living quarters called the Service Module with its own life support and habitation systems; a science power platform of solar arrays that can supply about 20 kilowatts of electrical power; logistics transport vehicles; and Soyuz spacecraft for crew return and transfer.

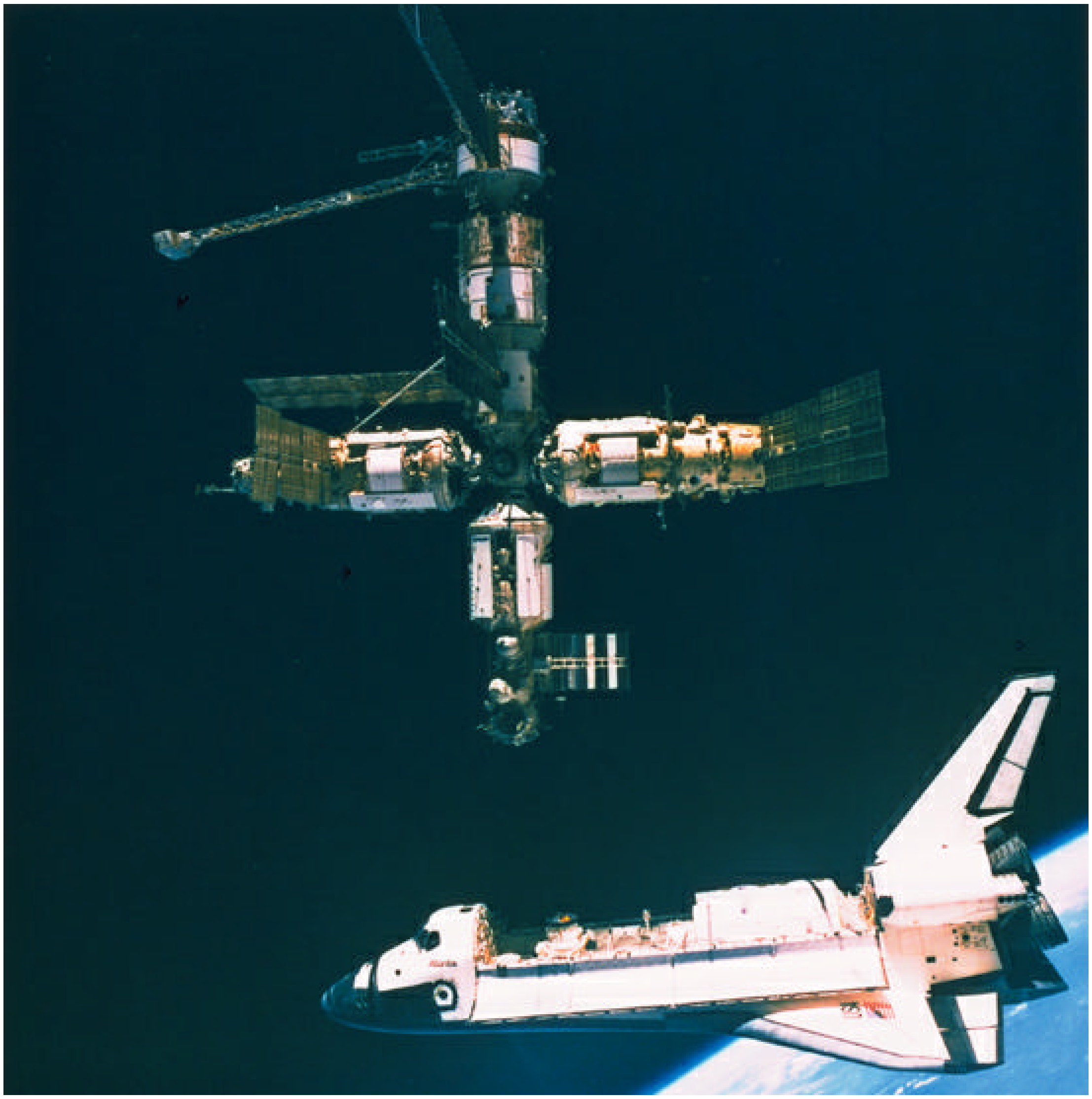
In addition, Brazil and Italy are contributing some equipment to the station through agreements with the United States.

ISS Phase One: The Shuttle-Mir Program

The first phase of the International Space Station, the Shuttle-Mir Program, began in 1995 and involved more than two years of continuous stays by astronauts aboard the Russian Mir Space Station and nine Shuttle-Mir docking missions. Knowledge was gained in technology, international space operations and scientific research.

Seven U.S. astronauts spent a cumulative total of 32 months aboard Mir with 28 months of continuous occupancy since March 1996. By contrast, it took the U.S. Space Shuttle fleet more than a dozen years and 60 flights to achieve an accumulated one year in orbit. Many of the research programs planned for the International Space Station benefit from longer stay times in space. The U.S. science program aboard the Mir was a pathfinder for more ambitious experiments planned for the new station.

For less than two percent of the total cost of the International Space Station program, NASA gained knowledge and experience through Shuttle-Mir that could not be achieved any other way. That included valuable experience in international crew training activities; the operation of an international space program; and the challenges of long duration spaceflight for astronauts and ground controllers. Dealing with the real-time challenges experienced during Shuttle-Mir missions also has resulted in an unprecedented cooperation and trust between the U.S. and Russian space programs, and that cooperation and trust has enhanced the development of the International Space Station.



Research on the International Space Station

The International Space Station will establish an unprecedented state-of-the-art laboratory complex in orbit, more than four times the size and with almost 60 times the electrical power for experiments — critical for research capability — of Russia's Mir. Research in the station's six laboratories will lead to discoveries in medicine, materials and fundamental science that will benefit people all over the world. Through its research and technology, the station also will serve as an indispensable step in preparation for future human space exploration.

Examples of the types of U.S. research that will be performed aboard the station include:

· Protein crystal studies: More pure protein crystals may be grown in space than on Earth. Analysis of these crystals helps scientists better understand the nature of proteins, enzymes and viruses, perhaps leading to the development of new drugs and a better understanding of the fundamental building blocks of life. Similar experiments have been conducted on the Space Shuttle, although they are limited by the short duration of Shuttle flights. This type of research could lead to the study of possible treatments for cancer, diabetes, emphysema and immune system disorders, among other research.

· Tissue culture: Living cells can be grown in a laboratory environment in space where they are not distorted by gravity. NASA already has developed a Bioreactor device that is used on Earth to simulate, for such cultures, the effect of reduced gravity. Still, these devices are limited by gravity. Growing cultures for long periods aboard the station will further advance this research. Such cultures can be used to test new treatments for cancer without risking harm to patients, among other uses.

· Life in low gravity: The effects of long-term exposure to reduced gravity on humans – weakening muscles; changes in how the heart, arteries and veins work; and the loss of bone density, among others – will be studied aboard the station. Studies of these effects may lead to a better understanding of the body’s systems and similar ailments on Earth. A thorough understanding of such effects and possible methods of counteracting them is needed to prepare for future long-term human exploration of the solar system. In addition, studies of the gravitational effects on plants, animals and the function of living cells will be conducted aboard the station. A centrifuge, located in the Centrifuge Accommodation Module, will use centrifugal force to generate simulated gravity ranging from almost zero to twice that of Earth. This facility will imitate Earth’s gravity for comparison purposes; eliminate variables in experiments; and simulate the gravity on the Moon or Mars for experiments that can provide information useful for future space travels.

· Flames, fluids and metal in space: Fluids, flames, molten metal and other materials will be the subject of basic research on the station. Even flames burn differently without gravity. Reduced gravity reduces convection currents, the currents that cause warm air or fluid to rise and cool air or fluid to sink on Earth. This absence of convection alters the flame shape in orbit and allows studies of the combustion process that are impossible on Earth, a research field called Combustion Science. The absence of convection allows molten metals or other materials to be mixed more thoroughly in orbit than on Earth. Scientists plan to study this field, called Materials Science, to create better metal alloys and more perfect materials for applications such as computer chips. The study of all of these areas may lead to developments that can enhance many industries on Earth.

· The nature of space: Some experiments aboard the station will take place on the exterior of the station modules. Such exterior experiments can study the space environment and how long-term exposure to space, the vacuum and the debris, affects materials. This research can provide future spacecraft designers and scientists a better understanding of the nature of space and enhance spacecraft design. Some experiments will study the basic forces of nature, a field called Fundamental Physics, where experiments take advantage of weightlessness to study forces that are weak and difficult to study when subject to gravity on Earth. Experiments in this field may help explain how the universe developed. Investigations that use lasers to cool atoms to near absolute zero may help us understand gravity itself. In addition to investigating basic questions about nature, this research could lead to down-to-Earth developments that may include clocks a thousand times more accurate than today's atomic clocks; better weather forecasting; and stronger materials.

· Watching the Earth: Observations of the Earth from orbit help the study of large-scale, long-term changes in the environment. Studies in this field can increase understanding of the forests, oceans and mountains. The effects of volcanoes, ancient meteorite impacts, hurricanes and typhoons can be studied. In addition, changes to the Earth that are caused by the human race can be observed. The effects of air pollution, such as smog over cities; of deforestation, the cutting and burning of forests; and of water pollution, such as oil spills, are visible from space and can be captured in images that provide a global perspective unavailable from the ground.

· Commercialization: As part of the Commercialization of space research on the station, industries will participate in research by conducting experiments and studies aimed at developing new products and services. The results may benefit those on Earth not only by providing innovative new products as a result, but also by creating new jobs to make the products.

Assembly in Orbit

By the end of this year, most of the components required for the first seven Space Shuttle missions to assemble the International Space Station will have arrived at the Kennedy Space Center. The first and primary fully Russian contribution to the station, the Service Module, is scheduled to be shipped from Moscow to the Kazakstan launch site in February 1999.

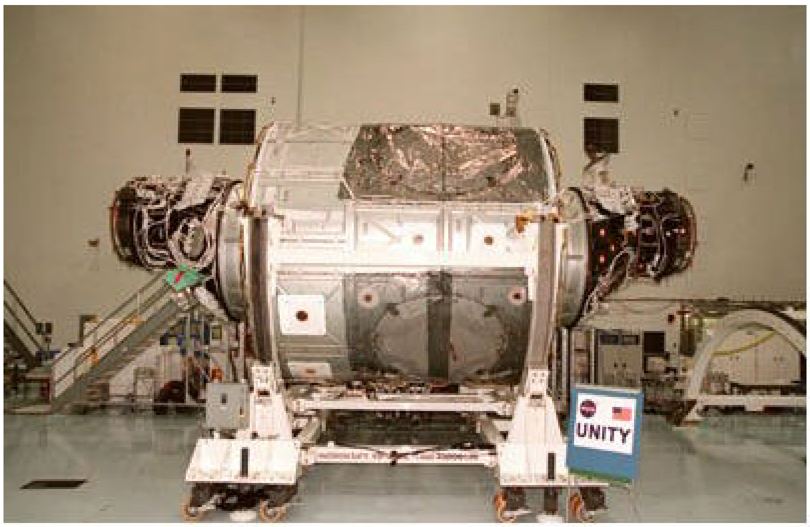
Orbital assembly of the International Space Station will begin a new era of hands-on work in space, involving more spacewalks than ever before and a new generation of space robotics. About 850 clock hours of spacewalks, both U.S. and Russian, will be required over five years to maintain and assemble the station. The Space Shuttle and two types of Russian launch vehicles will launch 45 assembly missions. Of these, 36 will be Space Shuttle flights. In addition, resupply missions and changeouts of Soyuz crew return spacecraft will be launched regularly.

The first crew to live aboard the International Space Station, commanded by U.S. astronaut Bill Shepherd and including Russian cosomonauts Yuri Gidzenko as Soyuz Commander and Sergei Krikalev as Flight Engineer, will be launched in early 2000 on a Russian Soyuz spacecraft. They, along with the crews of the first five assembly missions, are now in training. The timetable and sequence of flights for assembly, beyond the first two, will be further refined at a meeting of all the international partners in December 1998. Assembly is planned to be complete by 2004.

Updated: 05/13/1999

ISS Element

Unity



Unity Connecting Module: Cornerstone for a Home in Orbit

The first U.S.-built component of the International Space Station, a six-sided connecting module and passageway, or node, named Unity, was the primary cargo of Space Shuttle mission STS-88, the first mission dedicated to assembly of the station.

The Unity connecting module, technically referred to as node 1, created a foundation for all future U.S. International Space Station modules with six berthing ports, one on each side, to which future modules will be attached. Built by The Boeing Company at a manufacturing facility at the Marshall Space Flight Center in Huntsville, Alabama, Unity is the first of three such connecting modules that will be built for the station. Sometimes referred to as Node 1, the Unity module measures 15 feet in diameter and 18 feet long.

Carried to orbit aboard the Space Shuttle Endeavour, Unity was mated with the already orbiting Zarya control module, or Functional Cargo Block (Russian acronym FGB), a U.S.-funded and Russian-built component that was launched earlier aboard a Russian Proton rocket from Kazakhstan. In addition to connecting to the Zarya module, Unity eventually will provide attachment points for the U.S. laboratory module; Node 3; an early exterior framework, or truss for the station; an airlock; and a multi-windowed cupola.

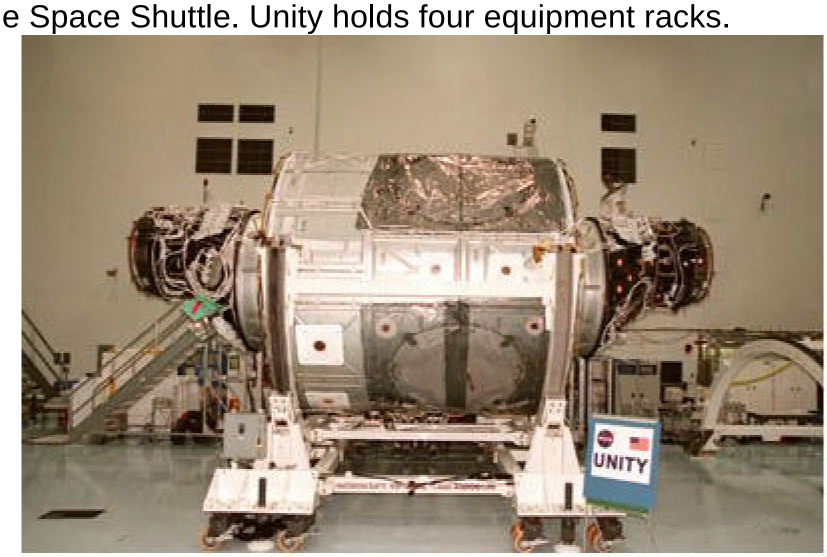
Essential space station resources such as fluids, environmental control and life support systems, electrical and data systems are routed through Unity to supply work and living areas.

More than 50,000 mechanical items, 216 lines to carry fluids and gases, and 121 internal and external electrical cables using six miles of wire were installed in the Unity node. The detailed and complex hardware installation required more than 1,800 drawings. The node is made of aluminum.

Two conical docking adapters will be attached to each end of Unity prior to its launch aboard Endeavour. The adapters, called pressurized mating adapters (PMAs), allow the docking systems used by the Space Shuttle and by Russian modules to attach to the node's hatches and berthing mechanisms. One of the conical adapters attached Unity to the Zarya, while the other will serve as a docking port for the Space Shuttle. The Unity node with the two mating adapters attached, the configuration it was in for launch, is about 36 feet long and weighs about 25,600 pounds.

Attached to the exterior of one of the pressurized mating adapters are computers, or multiplexer-demultiplexers (MDMs), which will provide early command and control of the Unity node. Unity was outfitted with an early communications system that allows data, voice and low data rate video with Mission Control, Houston, to supplement Russian communications systems during the early station assembly activities.

The two remaining nodes are being built by the European Space Agency (ESA) for NASA in Italy by Alenia Aerospazio. Nodes 2 and 3 will be slightly longer than the Unity node, measuring almost 21 feet long, and each will hold eight standard space station equipment racks in addition to six berthing ports. ESA is building the two additional nodes as partial payment for the launch of the ESA Columbus laboratory module and other equipment on the Space Shuttle. Unity holds four equipment racks.



ISS Element

Zarya

The Zarya control module, also known by the technical term Functional Cargo Block and the Russian acronym FGB, was the first component launched for the International Space Station and is providing the station's initial propulsion and power. The 44,000-pound pressurized module was launched on a Russian Proton rocket on Nov. 20 1998 from the Baikonur Cosmodrome, Kazakhstan.

Quick Look Facts: Zarya

Length (end-to-end) - 41.2 feet
Width (at widest point) - 13.5 feet
Gross launching weight - 53,020 pounds
Mass in orbit - 44,088 pounds
Launch vehicle - 3-stage Proton rocket
Launch site - Baikonur Cosmodrome, Kazakstan
Lifetime in orbit - 15 years
Inclination of orbit - 51.6 degrees
Preliminary orbit - 115 x 220 statute miles
Orbit at Rendezvous - 240 statute miles circular

Zarya Means "Sunrise"

The Zarya, which means Sunrise when translated to English, is actually a U.S. component of the station that was built by the Khrunichev State Research and Production Space Center (KhSC), in Moscow, under a subcontract to The Boeing Co. for NASA.

Zarya is providing orientation control, communications and electrical power while attached to Unity for several months before the launch of the third component, a Russian-provided crew living quarters and early station core known as the Service Module. The Service Module will enhance or replace many functions of the Zarya. Later in the station's assembly sequence, the Zarya module will be used primarily for its storage capacity and external fuel tanks.

Zarya's solar arrays and six nickel-cadmium batteries can provide an average of 3 kilowatts of electrical power. Each of the two solar arrays is 35 feet long and 11 feet wide. Using the Russian Kurs system, the Zarya will perform an automated and remotely piloted rendezvous and docking with the Service Module in orbit. Its docking ports will accommodate Russian Soyuz piloted spacecraft and unpiloted Progress resupply spacecraft. The module has been modified to allow it to be refueled by a Progress vehicle docked to its down-facing port if necessary. The module's 16 fuel tanks combined can hold more than 6 tons of propellant. The attitude control system for the module includes 24 large steering jets and 12 small steering jets. Two large engines are available for reboosting the spacecraft and making major orbital changes.

Updated: 05/14/1999

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, FL; Marshall Space Flight Center, Huntsville, AL; Dryden Flight Research Center, Edwards, CA; Johnson Space Center, Houston, TX; and NASA Headquarters, Washington, DC. The television schedule will be updated to reflect changes dictated by mission operations.

Status Reports

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

Briefings

A mission press briefing schedule will be issued 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 Shuttle 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.

Updated: 05/13/1999

Media Contacts

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Updated: 05/11/1999

SHUTTLE FLIGHTS AS OF MAY 1999

93 TOTAL FLIGHTS OF THE SHUTTLE SYSTEM -- 68 SINCE RETURN TO FLIGHT

OV-102 Columbia (25 flights)	**OV-099 Challenger (10 flights)**	**OV-103 Discovery (25 flights)**	**OV-104 Atlantis (20 flights)**	**OV-105 Endeavour (13 flights)**
STS-90 04/17/98 - 05/03/98		STS-95 10/29/98 - 11/07/98		
STS-87 11/19/97 - 12/05/97		STS-91 06/02/09 - 06/12/98		
STS-94 07/01/97 - 07/17/97		STS-85 08/07/97 - 08/19/97		
STS-83 04/04/97 - 04/08/97		STS-82 02/11//97 - 02/21/97		
STS-80 11/19/96 - 12/07/96		STS-70 07/13/95 - 07/22/95		
STS-78 06/20/96 - 07/07/96		STS-63 02/03/95 - 02/11/95	STS-86 09/25/97 - 10/06/97	
STS-75 02/22/96 - 03/09/96		STS-64 09/09/94 - 09/20/94	STS-84 05/15/97 - 05/24/97	
STS-73 10/20/95 - 11/05/95		STS-60 02/03/94 - 02/11/94	STS-81 01/12/97 - 01/22/97	
STS-65 07/08/94 - 07/23/94		STS-51 09/12/93 - 09/22/93	STS-79 09/16/96 - 09/26/96	
STS-62 03/04/94 - 03/18/94		STS-56 04/08/83 - 04/17/93	STS-76 03/22/96 - 03/31/96	
STS-58 10/18/93 - 11/01/93		STS-53 12/02/92 - 12/09/92	STS-74 11/12/95 - 11/20/95	
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STS-35 12/02/90 - 12/10/90	STS-51L 01/28/86	STS-31 04/24/90 - 04/29/90	STS-44 11/24/91 - 12/01/91	STS-72 01/11/96 - 11/20/96
STS-32 01/09/90 - 01/20/90	STS-61A 10/30/85 - 11/06/85	STS-33 11/22/89 - 11/27/89	STS-43 08/02/91 - 08/11/91	STS-69 09/07/95 - 09/18/95
STS-28 08/08/89 - 08/13/89	STS-51F 07/29/85 - 08/06/85	STS-29 03/13/89 - 03/18/89	STS-37 04/05/91 - 04/11/91	STS-67 03/02/95 - 03/18/95
STS-61C 01/12/86 - 01/18/86	STS-51B 04/29/85 - 05/06/85	STS-26 09/29/88 - 10/03/88	STS-38 11/15/90 - 11/20/90	STS-68 09/30/94 - 10/11/94
STS-9 11/28/83 - 12/08/83	STS-41G 10/05/84 - 10/13/84	STS-51-I 08/27/85 - 09/03/85	STS-36 02/28/90 - 03/04/90	STS-59 04/09/94 – 04/20/94
STS-5 11/11/82 - 11/16/82	STS-41C 04/06/84 - 04/13/84	STS-51G 06/17/85 - 06/24/85	STS-34 10/18/89 - 10/23/89	STS-61 12/02/93 - 12/13/93
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Table prepared by Richard W. Orloff, 02/2001