DISCOVERY:
OUTFITTING DESTINY

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Mission Overview

New Crew, New Lab Racks to be Launched to ISS

A new International Space Station crew, the first flight of an Italian-built Multipurpose Logistics Module and the first scientific rack for the U.S. laboratory Destiny highlight the STS-102 mission of Discovery, scheduled for launch no earlier than March 8 from Kennedy Space Center in Florida. The crew changeout is the first for the ISS, and the logistical module, named Leonardo, is the first of three that will serve as pressurized moving vans, bringing equipment and supplies to the space station.

Aboard Leonardo will be the Human Research Facility scientific rack to be installed aboard Destiny, the scientific cornerstone of the ISS. Destiny is the most advanced and most versatile scientific research facility ever launched into space, and the Human Research Facility enables the U.S. laboratory to begin to fulfill the purpose and the promise for which it - and the entire International Space Station - is being created. The space station eventually will have six laboratories.

Leonardo will be lifted out of Discovery's payload bay and attached directly to Destiny for the unloading of its cargo, which includes half a dozen systems racks and the Human Research Facility experiment rack. The systems racks will provide electrical power and control of the station's robotic arm supplied by Canada, which will arrive on the next assembly mission. One rack will contain emergency crew health care equipment. Near the end of the shuttle's mission, the MPLM will be returned to the cargo bay and returned to Earth for refurbishment and reuse on a mission this summer. The MPLM is valued at $150 million.

James D. Wetherbee, commanding his fourth mission and making his fifth flight into space, leads the shuttle crew. He brings a unique management perspective to this operational role on this flight. He served as deputy director of the Johnson Space Center, and now is chief of Flight Crew Operations. Pilot James M. Kelly, a former Air Force test pilot, is making his first space flight. Australian-born Mission Specialist Andrew S.W. Thomas spent 141 days and 2,250 orbits aboard the Russian Mir space station. Mission Specialist Paul W. Richards, also making his first space flight, worked as a NASA engineer at the Goddard Space Flight Center, developing tools for space walkers for the Hubble Space Telescope Servicing Project before being selected as an astronaut in 1996.

Because of the space station crew replacement, three crews will be involved in the flight of Discovery. The orbiter will carry Expedition Two Commander Yury Vladimirovich Usachev, and Flight Engineers James S. Voss and Susan J. Helms to the ISS to replace the Expedition One crew, Commander William M. Shepherd and cosmonauts Soyuz Commander Yuri Pavlovich Gidzenko and Flight Engineer Sergei Konstantinovich Krikalev, who arrived aboard the station on Nov. 2, 2000. Expedition One crewmembers will come home in Discovery.

About 41 hours after its launch Discovery is scheduled to dock with the International Space Station. In addition to the new crew and the Multipurpose Logistics Module, Discovery also brings to the ISS the Integrated Cargo Carrier and two Assembly Power Converter Units (APCU's) in the orbiter's cargo bay, and ISS equipment and supplies in the Orbiter crew compartment. The Integrated Cargo Carrier carries the Pump and Flow Control Subassembly, the Lab Cradle Assembly, the External Stowage Platform, and the Rigid Umbilical which are attached or installed on the ISS during the two scheduled space walks.

A Quick Look at the STS-102 Mission

Discovery will spend almost eight days attached to the ISS. Transfer of equipment begins less than three hours after docking, which occurs during the crew's flight day three. Later in flight day three, hatches will be closed so pressure in Discovery's cabin can be lowered in preparation for a space walk.

The first of two space walks scheduled for flight day four will see Voss and Helms prepare for the relocation of one of the docking ports attached to the ISS Unity module to prepare for MPLM docking. Leonardo must be attached to the lower port of Unity to facilitate its unloading. The space walkers also will install a cradle keel mechanism on the roof of Destiny, which will be used later in the ISS assembly sequence to mount additional hardware. Voss and Helms also will install an umbilical cable tray on Destiny in preparation for the delivery of the ISS' robotic arm in April.

A highlight of flight day five will be installation of Leonardo to Unity using the orbiter's robotic arm. Once Leonardo is attached to Unity half a dozen power, data and fluid connecters will be hooked up. The following day the ISS crew will begin transferring systems racks from Leonardo to the U.S. lab Destiny, while Discovery crewmembers focus on the mission's second space walk. During this space walk, Thomas and Richards will install a stowage bin to the truss and deliver a replacement pump system that would be used to help ammonia flow to critical avionics on the ISS, if required.

Italian-built Leonardo brings to the new U.S. laboratory Destiny six system racks. Two are DC-to-DC Converter Unit (DDCU) racks to convert power into a suitable form for ISS experiments and other station activities. Two are robotic workstation racks for control of the station's Canadian robotic arm and its four cameras, starting on Mission 6A. The Avionics No. 3 Rack has the hardware to activate the Ku-Band and some orbital replacement units for other systems. The Temporary Crew Health System Rack contains emergency medical equipment, including a defibrillator. Leonardo also is bringing equipment and supplies to the ISS in three resupply stowage racks and four resupply stowage platforms. Leonardo can transport as many as 16 racks in its 2,698 cubic feet.

The arrival aboard Leonardo of the first scientific rack for the U.S. laboratory is significant in that it is a major step toward the beginning of scientific research aboard the space station. The Human Research Facility is a milestone, which will mark the beginning of major scientific research capability aboard the space station.

Destiny, installed on the STS-98 mission of Atlantis in February, has slots for 24 of the interchangeable racks (six on the top, six on the bottom and six on each side). Eleven are systems racks, and one slot has Destiny's 20-inch-diameter, optical-quality window. Remaining slots are available for scientific racks.

Flight day seven will focus on transfer of equipment and supplies to the station from Discovery and from Leonardo, as well as stowage of equipment from the station to Leonardo. Several hours are allotted for handover sessions with the Expedition One and Expedition Two crews.

Crew transfer is a carefully thought out and choreographed process carried out one replacement at a time. As a member of the Expedition Two crew formally transfers from the shuttle to the ISS, that crewmember’s custom-designed seat liner, called an Individual Equipment Liner Kit, is installed in the Soyuz spacecraft docked to the station. The seat liner of the replaced crewmember is removed from the Soyuz, and that individual then becomes a member of the shuttle crew. Usachev and Gidzenko make the switch on flight day three, Krikalev and Voss on flight day five and Shepherd and Helms on flight day seven.

Equipment and supply transfer operations are scheduled during flight day eight. Transfer activities continue on flight day nine.

The crew will leave Leonardo and deactivate the MPLM on flight day 10. Loaded with unneeded equipment and refuse from the ISS, it will be returned to Discovery's cargo bay to be taken back to the Kennedy Space Center.

Discovery departs the space station on the crew's flight day 11 and is scheduled to land at Kennedy Space Center a little more than two days later, no earlier than March 20.

STS-102 is the eighth space shuttle mission in support of space station assembly, the 29th mission of Discovery and the 103rd flight in shuttle program history.

Expedition One Crew Return Plans

Concluding a four-month stay in space, the first resident crew of the International Space Station will feel the effects of gravity for the first time as Discovery touches down at the Kennedy Space Center.

In space, many of the body's systems, which were designed for the one-gravity environment of Earth, are subjected to fewer demands than normal. The heart is not required to work as hard to pump blood through the body; bones and muscles are not used as intensively; and the brain must learn to adapt to altered input as the inner ear, eyes, muscles and joints no longer have the constant of gravity as an indicator of position and orientation. Living in a microgravity environment, astronauts learn to modify the way they eat, move, and operate equipment, and how to respond to the internal changes experienced by their bodies.

Living in such an environment since their Oct. 31 launch from the Baikonur Cosmodrome, Expedition One Commander Bill Shepherd, Pilot Yuri Gidzenko and Flight Engineer Sergei Krikalev observed a strict regimen of exercise designed to maintain both cardiovascular health and muscle and bone strength. Exercise is an effective countermeasure to the physiological effects of microgravity and can reduce the amount of time required for an astronaut to readapt.

When the Expedition One crew returns on board Discovery, they will spend several weeks readjusting to life on Earth. Just as they had to respond to altered sensory inputs in space, they will need to readjust their bodies back to the sensation of gravity. The time required to readapt is related to the duration of the mission.

American and Russian flight surgeons, and strength, conditioning and rehabilitation specialists, will work with the crewmembers to ensure their adaptation and begin a period of rehabilitation to restore bone and muscle strength. Researchers also will gather data on the three crewmembers to expand the existing knowledge of the effects of long-term flight on the human body.

Shepherd, Gidzenko and Krikalev will be seated in specially-designed recumbent seats on Discovery's middeck for entry and landing. Returning to Earth in this reclined position, allows the g-forces experienced during re-entry and landing to be distributed more evenly through the astronaut's body, allowing them to adapt more gradually to the presence of gravity.

Returning astronauts, including Shepherd, Gidzenko and Krikalev, may experience orthostatic intolerance, a feeling of light headedness or fainting when standing in an upright posture, as they return to Earth. Returning to Earth in these recumbent seats, rather than sitting in an upright position, reduces the effects of orthostatic intolerance. The light headedness occurs when gravity pulls fluids downward, away from the heart and head. Recovery is generally rapid and there are no requirements for the Expedition One crew to be removed from Discovery in a reclining position.

The crew will not be medically monitored during the re-entry, but will undergo routine post-flight evaluations by flight surgeons shortly after landing. Shepherd, Gidzenko and Krikalev then will join their STS-102 crew mates in the crew quarters building at the Kennedy Space Center for a brief reunion with their families before undergoing more extensive physical exams.

One day after landing, the combined STS-102 and Expedition One crews will return to Houston.

The Expedition One crewmembers will begin a rehabilitation and medical observation period of approximately 45 days, as flight surgeons and rehabilitation specialists work with them to assist in their readaptation to life on Earth. Gidzenko and Krikalev will continue their rehabilitation program following their return to Russia, within a few weeks after landing.

The rehabilitation program is highly individualized for each crew member. The length, duration and intensity of the rehabilitation sessions will be influenced by feedback from each crewmember, the rehabilitation specialist and the attending crew surgeon. In general, the program begins with massage, assisted walking, stretching and mild resistance exercise, water exercise and manual resistance exercise.

The following table outlines the basic rehabilitation plan for the first seven days:

R+1 Assisted Walking 0-100 steps
Total Body PNF (hold/relax/stretch) 1 set: 2 seconds concentric
4 seconds eccentric
Massage/Sauna/Whirlpool

R+2 Crew Day Off
Suggest assisted walking & flexibility

R+3 Assisted or Unassisted Walking 100 steps - 1 mile
Total Body PNF (hold/relax/stretch 2 sets: 2 seconds concentric
4 seconds eccentric
Massage/Sauna/Whirlpool

R+4 Water Exercise Therapy Warmup/Flexibility
Cardio Workout
Strength Training
Cool Down/Flexibility

R+5 Cardio Workout: 12-15 minutes
(recumbent bike, orbiter treadmill, etc)
Flexibility Total Body
Strength Training 1-3 sets x 12-15 reps
Massage/Flexibility

R+6 Water Exercise Therapy Warmup/Flexibility
Cardio Workout
Strength Training
Cool Down/Flexibility

R+7 Cardio Workout: 15-20 minutes
Flexibility Total Body
Strength Training 1-3 sets x 12-15 reps
Massage/Flexibility

Mission Objectives

Discovery OV103
Launch: Thursday, March 08, 2001
6:42 AM (eastern time)

Discovery's STS-102 (5A.1) flight is focused on outfitting the International Space Station (ISS), particularly the new U.S. laboratory, Destiny. It also will bring to the station the new Expedition Two crew, to replace the Expedition One crew which will come home on Discovery.

The crew transfer, the first for the station, is among the mission's top priorities. Expedition One Commander Bill Shepherd, Soyuz Commander Yuri Gidzenko and Flight Engineer Sergei Krikalev will be replaced by Expedition Two Commander Yury Usachev and Expedition Two flight engineers Susan Helms and Jim Voss.

The transfer will take place in a carefully orchestrated, one-at-a-time process that ensures three current members of the station crew will be able to come home, at any time during the switch, aboard the Soyuz spacecraft attached to the station. Expedition Two crewmembers officially join the station when they install their seat liners in the Soyuz.

Equipment transfer to the ISS and outfitting Destiny for the arrival of the Space Station Remote Manipulator System (SSRMS), the space station's robotic arm scheduled to be launched on STS-100 (6A) no earlier than April, also is among the major priorities of Discovery's flight. Much of that equipment will be transferred from the Multi-Purpose Logistics Module (MPLM), a pressurized moving van module designed to be taken into orbit, attached to the space station, and then, after unloading, brought back to the orbiter's cargo bay for return to Earth.

The Italian-built MPLM, named Leonardo, will be attached to the nadir, or Earth-facing, berthing port of the Unity node. Before that can happen a docking port, Pressurized

Mating Adaptor 3 (PMA 3), must be removed from that berthing port. It will be attached to an adjacent berthing port on Unity's left side.

Leonardo brings six systems racks to the station. Among them are two robotic workstation racks for control of the station's robotic arm and the four cameras mounted on it. Two are DC-to-DC Converter Units (DDCUs) which convert electrical power from the station's solar arrays to a form usable by station systems and experiments. One is the U.S. Lab Avionics 3 rack with components supporting both the Ku-Band communications system and the command and control system. The sixth is a Crew Health Care System rack.

The Ku-Band is used for high data rate communications, including downlink of television pictures. The command and control system is operated from the U.S. laboratory and controls the attitude or orientation in space of the station, using four 800-pound gyroscopes mounted in the Z-1 Truss of the ISS.

The PMA 3 move will be made during a space walk by Voss and Helms on Flight Day 4. The space walk will be preceded by transfer of a spacesuit and two Simplified Aids for EVA Rescue (SAFER) devices from the station to the shuttle shortly after docking on Flight Day 3.

Once outside Discovery's airlock, Voss and Helms will disconnect PMA 3 cables and then Mission Specialist Andy Thomas, operating the shuttle's robotic arm, will move it to its new location.

The space walkers subsequently will take the Lab Cradle Assembly from Discovery's cargo bay and install it atop Destiny. Its first application will be to support the Launch Deployment Assembly of the SSRMS. Later in the space walk they will take the Rigid Umbilical from the cargo bay and install it onto Destiny. It is designed to provide power, data and video links between the SSRMS and Destiny.

Leonardo is to be attached to the station on Flight Day 5 and the ISS crew will begin unloading it the following day. Hatches will be closed between the shuttle and the station in preparation for the mission's second space walk by Thomas and Mission Specialist Paul Richards. During that space walk they will take an External Stowage Platform from the cargo bay and install it onto Destiny, then hook up power cables for the orbital replacement units, spares, to be stowed on it. They will stow the first of those spares, a Pump and Flow Control Subassembly for ammonia coolant.

Among racks to be transferred by the ISS crew will be the Human Research Facility, the first scientific rack to be brought to the station. While it is significant in that it marks the beginning of major research capability on the station, its transfer is a lower priority than transfer of the six systems racks, the three resupply stowage racks and the four resupply stowage platforms from Leonardo -- indeed it will be the last of the racks to be transferred. While the experiment rack will be activated and checked out, the Ku-Band and a communications outage recorder must be working to support data recording and downlink.

After transfer of the Human Research Facility, transfer of materials into Leonardo will begin. Such materials -- batteries at the end of their designed lives, used filters, packing materials and garbage are examples -- will be returned to Earth.

Other priorities include activation and checkout of transferred racks, operation of the IMAX camera by the station crew, a series of tests supporting station assembly, ISS reboost if adequate propellant is available and a fly-around of the ISS by the orbiter after undocking to photograph and videotape the station.

STS-102

Crew

Commander:	James D. Wetherbee
Pilot:	James M. Kelly
Mission Specialist 1:	Andrew S.W. Thomas
Mission Specialist 2:	Paul W. Richards
Mission Specialist 3:	Sergei Krikalev (down)
Mission Specialist 3:	James S. Voss (up)
Mission Specialist 4:	William M. Shepherd (down)
Mission Specialist 4:	Susan J. Helms (up)
Mission Specialist 5:	Yuri P. Gidzenko (down)
Mission Specialist 5:	Yury V. Usachev (up)

Launch

Orbiter:	Discovery OV103
Launch Site:	Kennedy Space Center Launch Pad 39B
Launch Window:	2.5 to 5 Minutes
Altitude:	122 Nautical Miles
Inclination:	51.6 Degrees
Duration:	11 Days 19 Hrs. 20 Min.

Vehicle Data

Shuttle Liftoff Weight:	4,522,944 lbs.
Orbiter/Payload Liftoff Weight:	198,507 lbs.
Orbiter/Payload Landing Weight:	219,363 lbs.

Payload Weights

Leonardo	9,000 pounds (almost 4.1 metric tons)

Software Version: OI-28

Space Shuttle Main Engines: *(1 MB pdf)*

SSME 1: 2048 **SSME 2:** 2053 **SSME 3:** 2045

External Tank: 107 (Super Light Weight Tank)

SRB Set: BI-106PF

Shuttle Aborts

Abort Landing Sites

RTLS: Kennedy Space Center Shuttle Landing Facility
TAL: Zaragoza
AOA: Edwards Air Force Base, California

Shuttle Abort History

Landing

Landing Date:	03/20/01
Landing Time:	2:02 AM (eastern time)
Primary Landing Site:	Kennedy Space Center Shuttle Landing Facility

Payloads

Cargo Bay

Leonardo -- A Space Age Moving Van

Crew Members

Commander: James D. Wetherbee

Jim Wetherbee (Capt., USN), 48, makes his fifth flight into space as commander of Discovery. Wetherbee, who brought Discovery to within 37 feet of the Russian Mir space station in 1995 in the first rendezvous of the Shuttle-Mir Phase One program, and who commanded a mission which docked to the Mir in 1997, will be responsible for linking Discovery to the International Space Station (ISS) on the second shuttle mission of the year. Wetherbee will be in charge of the overall safety and success of the mission, and will help in the activation of the Leonardo Multi-Purpose Logistics Module, which is carrying supplies and racks of experiments to the station. Once docked to the ISS, Wetherbee will also transfer bags of water to the orbital outpost for use by its resident crewmembers. After serving a stint as Deputy Director of the Johnson Space Center, Wetherbee currently serves as the Director of Flight Crew Operations.

Previous Space Flights:
Wetherby is making his fifth flight into space. STS-102 is Wetherbee's fourth command. He previously flew as pilot on STS-32 in 1990, and as commander on STS-52 in 1992, STS-63 in 1995 and STS-86 in 1997.

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

Pilot: James M. Kelly

Jim Kelly (Lt. Col., USAF), 36, will be in charge of monitoring critical Shuttle systems during Discovery's ascent to orbit and its reentry for landing. Kelly will be responsible for the operation of many of Discovery's navigational tools during its rendezvous with the International Space Station (ISS) and will serve as one of the two robot arm operators during the mission's space walks and the movement of the Leonardo module from Discovery's cargo bay to the ISS for cargo transfer. Kelly will also be at the controls for Discovery's flyaround of the ISS following its undocking.

Previous Space Flights:
Making his first flight into space, Kelly is a former Air Force test pilot.

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

Mission Specialist 1: Andrew S.W. Thomas

Andy Thomas, Ph.D., 49, is Mission Specialist 1 (MS 1) on STS-102. Thomas, who will ride on Discovery's flight deck during launch and on the middeck for landing to assist the returning Expedition One crewmembers, will serve as one of two space walkers on the second space walk of the flight along with Paul Richards to install new equipment on the International Space Station (ISS). Born in Australia, Thomas will be the prime robotic arm operator during the mission for the first space walk of the flight by Jim Voss and Susan Helms and the movement of the Leonardo module from Discovery's cargo bay for attachment to the Unity module of the ISS. He will also be in charge of cargo transfer from Leonardo to the ISS as well as Earth observation photography during the mission.

Previous Space Flights:
Thomas is making his third trip into space. He was the last American to live and work aboard the Russian Mir Space Station in 1998, launching on STS-89 and landing on STS-91 for a total of 141 days in orbit. His first flight was STS-77 in 1996.

Ascent Seating: Flight Deck - Starboard Aft
Entry Seating: Mid Deck - Port
EV3

Mission Specialist 2: Paul W. Richards

Paul Richards, 36, is Mission Specialist 2 (MS 2) on STS-102. He will serve as flight engineer on the flight deck of Discovery during launch and landing and will accompany Andy Thomas on the second space walk of the flight. Richards will be responsible for the operation of all of Discovery's computers, and will be the choreographer for the first space walk of the flight by Jim Voss and Susan Helms, operating from Discovery's aft flight deck.

Previous Space Flights:
Richards is making his first flight into space. Before being selected as an astronaut, Richards was the lead engineer for the design and development of space-walking tools which were used during the Hubble Space Telescope servicing missions.

Ascent Seating: Flight Deck - Center Aft
Entry Seating: Flight Deck - Center Aft
EV4

Mission Specialist 3: Sergei Krikalev (down)

Sergei Krikalev, 42, Krikalev served as flight engineer on Expedition One, responsible for activating and testing ISS module systems and the in-flight maintenance of station hardware.

Previous Space Flights:
Krikalev is wrapping up his fifth flight into space after completing his second trip to the International Space Station as a member of the Expedition One crew. By the time he lands while seated on Discovery's middeck, Krikalev will have accumulated more than 600 days in space, making him the fourth most experienced space traveler in human spaceflight history. Krikalev previously flew on two long-duration missions to Mir and two space shuttle flights, STS-60 in 1994 and STS-88 in 1998, the first flight to begin assembly of the International Space Station.

Entry Seating: Mid Deck - Port

Mission Specialist 3: James S. Voss (up)

Jim Voss (Col., USA, Ret.), 52, will return to the International Space Station (ISS) for a second time as both Mission Specialist 3 (MS 3) on the STS-102 crew and as Flight Engineer-1 for the second long-duration, or Expedition Two, crew, which will spend four months on the orbital complex. He will be seated on the middeck during Discovery's climb to orbit. Voss will join Susan Helms, another Expedition Two crewmember, for the first space walk of the STS-102 mission, and is scheduled to conduct at least one space walk during his stay on the ISS. Voss will be among those responsible for transferring cargo from the Leonardo Multi-Purpose Logistics Module to the ISS, and will trade places with Expedition One Flight Engineer Sergei Krikalev during crew transfer operations while Discovery is docked to the station. During his four months on the ISS, Voss will work with Helms in the operation of the new Canadian-built Space Station Remote Manipulator System (SSRMS), conduct checkouts of the soon-to-be installed U.S. Airlock and perform experiments on the first science racks in the U.S. Laboratory Destiny.

Previous Space Flights:
Voss is making his fifth flight into space. He previously flew on STS-44 in 1991, STS-53 in 1992, STS-69 in 1995 and STS-101 (his previous mission to the space station) in 2000.

Ascent Seating: Mid Deck - Port
EV1

Mission Specialist 4: William M. Shepherd (down)

Bill Shepherd (Capt., USN), 51, has served as the first commander of the International Space Station since he and his Expedition One crewmates were launched on a Soyuz rocket from the Baikonur Cosmodrome in Kazakhstan on Oct. 31, 2000. Shepherd will return to Earth on Discovery's middeck. During Expedition One, Shepherd led his colleagues in the setup and activation of key systems in the Zvezda living quarters and the Destiny laboratory and the checkout of the large U.S. solar arrays. He was also responsible for the operation of computer systems and hardware maintenance and replacement on board the orbital outpost. Shepherd will have played host to three visiting crews during his historic tenure as Commander. Before being assigned to lead the first resident crew on the ISS, Shepherd served as Deputy Space Station Program Manager in charge of the redesign of the project.

Previous Space Flights:
Shepherd will have spent 160 days in space on his four flights at the time he lands.
He previously flew on STS-27 in 1988, STS-41 in 1990 and STS-52 in 1992.

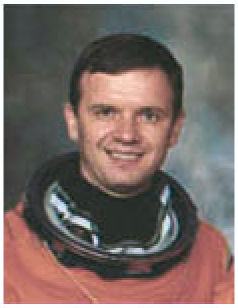
Entry Seating: Mid Deck - Starboard

Mission Specialist 4: Susan J. Helms (up)

Susan Helms (Col., USAF), 43, is one of three crewmembers to return to the International Space Station on Discovery's flight. She will be seated on the middeck for launch. During STS-102, Helms will serve as Mission Specialist 4 (MS 4) and will join Jim Voss for the flight's first space walk. She will also act as the choreographer for the mission's second space walk, to be performed by Andy Thomas and Paul Richards, operating from Discovery's aft flight deck. Helms will be the last Expedition Two crewmember to swap orbiting homes with an Expedition One crewmember, moving over to the ISS to trade places with Expedition One Commander Bill Shepherd. In addition, Helms will be responsible for the transfer of vital systems racks from the Leonardo module to the ISS for installation in the U.S. Laboratory Destiny. During her four-month stay on the ISS, Helms will serve as Flight Engineer-2. She'll conduct checkouts with and the operation of the new Canadian-built Space Station Remote Manipulator System (SSRMS), use the SSRMS to move the U.S. Airlock from the shuttle's cargo bay to the ISS and will perform experiments on the first science racks in Destiny.

Previous Space Flights:
Helms is making her fifth flight into space. She previously flew on STS-54 in 1993, STS-64 in 1994, STS-78 in 1996 and STS-101 to the space station in 2000.

Ascent Seating: Mid Deck - Center
EV2



Mission Specialist 5: Yuri P. Gidzenko (down)

Yuri Gidzenko (Lt. Col., Russian Air Force) will turn 39 a few days after he returns to Earth aboard Discovery to wrap up his second flight into space. Gidzenko has served as the Expedition One pilot, guiding his Soyuz capsule to a docking to the International Space Station on Nov. 2, 2000, two days after he and his crewmates were launched to the ISS from the Baikonur Cosmodrome in Kazakhstan. Gidzenko was also responsible for the manual docking of a Progress resupply vehicle to the ISS in November and its redocking in December. He flew the Soyuz from the aft docking port of the Zvezda module to the nadir docking port of Zarya in February to clear the way for the arrival of a new Progress ship. Gidzenko will return to Earth on Discovery's middeck. During more than four months onboard the ISS, Gidzenko was primarily responsible for the maintenance and operation of systems in the Zvezda and Zarya modules.

Previous Space Flights:
Gidzenko's return to Earth will complete a mission which will bring his total time in space to 320 days. He previously flew as commander of a long-duration mission to the Mir space station in 1995-1996.

Entry Seating: Mid Deck - Center

Mission Specialist 5: Yury V. Usachev (up)

Yury Usachev, 43, will be the first Russian commander of the International Space Station during the four-month increment of the Expedition Two crew. During STS-102, Usachev will be designated Mission Specialist 5 (MS 5). Usachev has logged 386 days in space and six space walks. Usachev, who will be seated on Discovery's middeck for launch, will be the first Expedition Two crewmember to move into the ISS, a few hours after docking. He will trade places with Expedition One Pilot Yuri Gidzenko to insure that a Soyuz vehicle expert will be available to fly the craft home in the event of a contingency. He will officially become Expedition Two commander of the ISS at the end of docked operations. During his four months on the ISS, Usachev will be responsible for the safety of his crew and the success of the mission, is scheduled to conduct at least one space walk with Voss and will assist Voss and Helms in the checkout and operation of the Canadian-built Space Station Remote Manipulator System after it is delivered to the ISS this spring.

Previous Space Flights:
Usachev is making his fourth flight into space on the STS-102 mission. He flew as a flight engineer during two long-duration missions to the Mir space station in 1994 and 1996 and was a mission specialist during the STS-101 mission of Atlantis in 2000 along with crewmates Jim Voss and Susan Helms.

Ascent Seating: Mid Deck - Starboard

Flight Plan

Flight Day Summary

DATE TIME (EST)	DAY	MET	EVENT
03/08/01 6:42:00 AM	1	000/00:00	Launch
03/08/01 8:07:00 AM	1	000/01:25	Payload Bay Door Opening
03/09/01 10:16:00 PM	3	001/15:34	TI Burn
03/10/01 12:32:00 AM	3	001/17:50	Docking
03/10/01 2:42:00 AM	3	001/20:00	ISS Hatch Open
03/10/01 11:37:00 PM	4	002/16:55	EVA 1 Start
03/11/01 5:47:00 AM	4	002/23:05	EVA 1 End
03/11/01 9:42:00 PM	5	003/15:00	MPLM Grapple
03/11/01 10:32:00 PM	5	003/15:50	MPLM Installation
03/12/01 2:42:00 AM	5	003/20:00	MPLM Vestibule Outfitting
03/12/01 3:57:00 AM	5	003/21:15	MPLM Activation
03/12/01 11:37:00 PM	6	004/16:55	EVA 2 Start
03/13/01 3:47:00 AM	6	004/21:05	EVA 2 End
03/16/01 11:47:00 PM	10	008/17:05	MPLM Grapple/Separation from ISS
03/17/01 1:57:00 AM	10	008/19:15	MPLM/Discovery Berthing
03/17/01 8:27:00 PM	11	009/13:45	ISS Hatch Close
03/17/01 10:57:00 PM	11	009/16:15	ISS Undock
03/17/01 11:07:00 PM	11	009/16:25	Flyaround Begins
03/20/01 12:59:00 AM	13	011/18:17	Deorbit Burn
03/20/01 2:02:00 AM	13	011/19:20	Landing

Rendezvous

Rendezvous and Docking Overview

Rendezvous and Docking

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 nine statute miles behind the station, the starting point for a final approach to the station.

About two and a half hours before the scheduled docking time on Flight Day Three, Discovery will reach the point about nine statute miles -- 48,600 feet -- behind the ISS. At that time, Discovery's engines will be fired in a Terminal Intercept (Ti) burn to begin the final phase of the rendezvous. Discovery will close the final miles to the station during the next orbit of Earth. As Discovery closes in, the shuttle's rendezvous radar system will continue to track the station and provide range and closing rate information to the crew. During the approach toward the station, the shuttle will have an opportunity to conduct four, small mid-course corrections at regular intervals. Just after the fourth correction is completed, Discovery will reach a point about a half-mile below the station. At that time, about an hour before the scheduled docking, Commander Jim Wetherbee will take over manual control of the approach.

Wetherbee will slow Discovery's approach and fly to a point about 600 feet directly below the station, from which he will begin a quarter-circle of the station, slowly moving to a position in front of the complex, in line with its direction of travel. During the rendezvous, Wetherbee will be assisted by Pilot James Kelly in controlling Discovery's approach. Mission Specialists Andy Thomas and Paul Richards also will play key roles in the rendezvous, with Thomas operating the shuttle's docking mechanism and Richards assisting with the rendezvous navigation. Thomas and Richards will use a handheld laser pointed through the shuttle windows to provide supplemental information on the station's range and the shuttle's closing rate.

Wetherbee will fly the quarter-circle of the station, starting at a point 600 feet below, while slowly closing in on the complex, stopping at a point a little over 300 feet directly in front of the station. From that point, he will begin slowly closing in on the station -- moving at a relative speed of about a tenth of a foot per second. Using a view from a camera mounted in the center of Discovery's docking mechanism as a key alignment aid, Wetherbee will precisely center the docking ports of the two spacecraft. Wetherbee will fly to a point where the docking mechanisms are 30 feet apart, and pause briefly to check the alignment.

For Discovery's docking, Wetherbee will maintain the shuttle's speed relative to the station, and keep the docking mechanisms aligned to within three inches of one another. 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 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, Thomas will command the docking ring on Discovery's mechanism to retract, closing latches in the mechanism to firmly secure the shuttle to the station.

Undocking, Separation and Fly-Around

Once Discovery is ready to undock, Thomas will send a command that will release the docking mechanism. The initial separation of the spacecraft will be performed by springs in the docking mechanism that will gently push the shuttle away from the station. Both Discovery's 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, Kelly will turn the steering jets back on and fire them to begin very slowly moving away. From the aft flight deck, Kelly will manually control Discovery within a tight corridor as he separates from the ISS, essentially the reverse of the task performed by Wetherbee when Discovery docked.

Discovery will continue away to a distance of about 450 feet, where Kelly will begin a close flyaround of the station, circling the complex one and a half times. Kelly will first cross a point directly above the station, then behind, then underneath, then in front and, when he reaches a point directly above the station for the second time, Kelly will fire Discovery's jets to separate from the Station. The flyaround is expected to be completed a little over an hour after undocking.

EVA

Space Walks Continue to Grow the Space Station

Overview

Astronauts Jim Voss and Susan Helms will make the first of two space walks on Discovery's flight day four to help relocate a Pressurized Mating Adaptor and install an attachment fixture atop the U.S. laboratory Destiny. Voss is designated EV1 and will wear the spacesuit with the solid red stripes. Helms is EV2 and will wear the solid white spacesuit.

A second space walk, by astronauts Andy Thomas, EV3, and Paul Richards, EV4, will follow on flight day six. They will install a stowage platform outside Destiny and hook up power cables to power devices that will be stowed there. They also will place a pump on the stowage platform. Finally they will test latches on the attachment fixture installed by Voss and Helms. Thomas will wear the spacesuit with broken stripes, while Richards will wear the suit with diagonal stripes. Both space walks are scheduled to last about six hours.

Flight Day Four: The First Space walk

Voss and Helms will help relocate Pressurized Mating Adaptor 3 (PMA-3) from the lower berthing port on the Unity node to an adjacent berthing port on Unity's left side. That is being done so the Multipurpose Logistics Module (MPLM) can be docked to the common berthing mechanism of the lower port.

Voss and Helms will start their space walk jobs by preparing for the PMA-3 move. This includes moving a gap spanner tether and disconnecting eight cables. Next, Voss removes the port Early Communications System antenna from the port side of the Unity Node and takes it to the airlock.

Voss, on the end of Discovery's robotic arm being operated by Thomas (who shares arm duties with Pilot Jim Kelly), and Helms then remove the Lab Cradle Assembly (LCA) from the Integrated Cargo Carrier in Discovery's cargo bay and install it on the U.S. laboratory Destiny's aft zenith trunnion. During STS-100 (6A) later this year, the 300-pound, four-foot-square LCA will be used to secure the Launch Deployment Assembly of the station's robotic arm. On STS-110 (8A) it will be used to permanently secure the S0 truss segment to Destiny, and will become the structural interface between the station and the main truss. The space walkers run cables to Destiny for power and data and remove a thermal cover from the LCA.

They then swap places, with Helms moving to the foot support on the arm and Voss becoming the free-floater. They return to the Integrated Cargo Carrier pallet and remove the Rigid Umbilical, a wiring harness to take power, data and video between Destiny and the station's robotic arm. They transfer and install the RU to the forward, lower side of Destiny near the Power & Data Grapple Fixture, an attachment point on Destiny for the station arm. There they remove a protective shield and connect cables.

Finally, they will do standard post-space walk cleanup. They will wait in the airlock, to see if they are needed to help with the PMA-3 move.

Flight Day Six: Second Space Walk

Thomas and Richards will remove the External Stowage Platform (ESP) from the Integrated Cargo Carrier pallet in the cargo bay and install it on the port aft trunnion on Destiny. With Kelly on the arm, they hook up cables that provide heater power to orbital replacement units - spares stowed on the ESP and available to replace vital equipment. Thomas then maneuvers back to the pallet and removes the Pump and Flow Control Subassembly, the first of such spares to be left on the ESP. He transfers it to the ESP and installs it there. The Pump and Flow Control Subassembly is a 250-pound device that pumps and controls valves for ammonia coolant flow.

Meanwhile, Richards turns his attention to the LCA installed on the first space walk. He performs a ready-to-latch indicator test on each of the four indicators on the LCA. Richards then closes two circuit interrupt devices to bring power to the DC-to-DC Conversion Units inside Destiny.

Richards then begins a photo-documentation survey of the worksite, before he and Thomas do the post-space walk cleanup and go back into the airlock.

Additional tasks were being considered for the second space walk.

EVA Timeline for Space Walks Continue to Grow the Space Station

Time	Event
2/16:55	EVA 1 Start
2/17:20	EVA 1 Setup
2/17:45	EVA 1 PMA 3 Umbilicals
2/18:45	EVA 1 Remove ECOMM
2/18:45	EVA 1 LCA Prep
2/19:15	EVA 1 LCA Transfer
2/20:15	EVA 1 TTHR
2/20:25	EVA 1 RU Remove Inst
2/21:05	EVA 1 RU Connect
2/21:55	EVA 1 Cleanup
2/23:05	EVA 1 End
4/16:55	EVA 2 Start
4/17:25	EVA 2 Setup
4/18:05	EVA 2 ESP Remove & Install
4/19:00	EVA 2 PFCS Remove & Install
4/19:30	EVA 2 Cleanup
4/20:45	EVA 2 End

Payloads

Leonardo -- A Space Age Moving Van

Payload Bay
9,000 pounds (almost 4.1 metric tons)

Overview

The Leonardo Multi-Purpose Logistics Module (MPLM), which was built by the Italian Space Agency (ASI), is the first of three such pressurized modules that will serve as the International Space Station's "moving vans," carrying laboratory racks filled with equipment, experiments and supplies to and from the International Space Station aboard the space shuttle.

Construction of ASI's Leonardo module began in April 1996 at the Alenia Aerospazio factory in Turin, Italy. Leonardo was delivered to Kennedy from Italy in August 1998 by a special Beluga cargo aircraft. The cylindrical module is about 6.4 meters (21 feet) long and 4.6 meters (15 feet) in diameter. It weighs about 9,000 pounds (almost 4.1 metric tons). It can carry up to 20,000 pounds (9.1 metric tons) of cargo packed into 16 standard space station equipment racks.

Although built in Italy, Leonardo and two additional MPLMs are owned by the U.S. They were provided in exchange for Italian access to U.S. research time on the station.

The unpiloted, reusable logistics module functions as both a cargo carrier and a space station module when it is flown. In order to function as an attached station module as well as a cargo transport, Leonardo contains components that provide some life support, fire detection and suppression, electrical distribution and computer functions. Eventually, the modules also will carry refrigerator freezers for transporting experiment samples and food to and from the station.

On this mission, Leonardo will be mounted in the space shuttle's payload bay for launch and remain there until after docking. Once the shuttle is docked to the station, the shuttle's robotic arm will remove Leonardo from the payload bay and berth it to the Unity Module on the ISS. During its berthed period to the station, system racks and individual components will be transferred to the ISS.

After Leonardo is unloaded, used equipment and trash will be transferred to it from the station for return to Earth. The Leonardo logistics module will then be detached from the station and positioned back into the shuttle's cargo bay for the trip home. When in the cargo bay, Leonardo is independent of the shuttle cabin, and there is no passageway for shuttle crewmembers to travel from the shuttle cabin to the module.

Leonardo will be filled with equipment and supplies to outfit the U.S. laboratory Destiny, which was carried to the International Space Station on STS-98 in February 2001. Of the 16 racks the module can carry, this mission brings six ISS system racks, three resupply stowage racks, four resupply stowage platforms, and the first scientific experiment rack.

Of the six systems racks, two racks contain power distribution equipment to support laboratory payloads. This equipment includes DC-to-DC Conversion Units (DDCU) and Remote Power Control Modules (RPCM). Two of the racks contain the Robotic Work Station (RWS) required for controlling the space station robotic arm which is scheduled to arrive on Flight 6A. One rack contains the remaining hardware required to activate the Ku-Band Communication system and additional avionics to support the computer system. The sixth rack contains crew health care equipment including a defibrillator and a respirator support pack.

The first experiment rack called HRF#1 (Human Research Facility #1) is also contained within Leonardo. This rack contains the first experiments to be performed on the ISS. The HRF rack will be used to conduct human life science investigations. Although the rack will be mounted in its permanent location during the mission, it will remain inactive until after the shuttle leaves.

There are also 7 Resupply Stowage Racks (RSR) and Resupply Stowage Platforms (RSP) within the MPLM. These 7 racks contain equipment required for crew rotation, components to augment existing ISS systems, spare parts for systems already on the station, in addition to food and supplies to support the crew. Resupply Stowage Racks, and Resupply Stowage Platforms use Cargo Transfer Bags (CTB) to carry components to the ISS but the racks, platforms, and bags themselves remain in the Leonardo module and are returned to Earth with the shuttle.

Payloads

Integrated Cargo Carrier

Overview

The Integrated Cargo Carrier is a two-part structure consisting of a waffle-like aluminum box-beam pallet and keel-yoke assembly. It is installed in the cargo bay of the space shuttle orbiter, to expand the shuttle's capacity to transport unpressurized cargo.

SPACEHAB's Integrated Cargo Carrier is 8 feet long, 15 feet wide and 10 inches thick. It has a capacity of up to 6,000 pounds of attached payload. Cargo can be attached to both the top and bottom of the pallet.

Participating Contractors are RSC-Energia, maker of the Unpressurized Cargo Pallet. Astrium GmbH is the maker of the Keel Yoke Assembly (KYA) that anchors the UCP in the Shuttle cargo bay and is SPACEHAB's mission integration and operations support prime contractor.

STS-102 Specifics:

Launch Weight of the Integrated Cargo Carrier on STS-102 is 3,438 pounds. Both sides of the Unpressurized Cargo Pallet (UCP) are being used to transport cargo to the International Space Station.

ISS Cargo Compliment: Lab Cradle Assembly with Module Truss Structure Attach System installed; Pump Flow Control Subassembly with attached Flight Support Equipment; External Stowage Platform; and the Rigid Umbilical.

The Lab Cradle Assembly will be installed on the U.S. laboratory Destiny's aft zenith trunnion on the mission's first space walk. During STS-100 (6A) later this year, the 300-pound, four-foot-square LCA will be used to secure the Launch Deployment Assembly of the station's robotic arm. On STS-110 (8A) it will be used to permanently secure the S0 truss segment to Destiny. It will become the structural interface between the station and the main truss.

The External Stowage Platform will be installed during the second space walk on the port aft trunnion on Destiny. It is a temporary home for orbital replacement units - spares stowed on the ESP and available to replace vital equipment. Space walking astronauts also will hook up cables to provide power to the orbital replacement units stowed there.

The Pump Flow Control Subassembly will be the first of those orbital replacement units on the External Stowage Platform. It is a 250-pound device that pumps and controls valves for ammonia coolant flow.

The Rigid Umbilical is a wiring harness to take power, data and video between Destiny and the Space Station Remote Manipulator System, the station's robotic arm. During the first space walk, it will be installed on the forward, lower side of Destiny near the Power & Data Grapple Fixture, an attachment point on Destiny for the station arm.

Payloads

Passive Dosimeter System

Overview

Monitoring radiation exposure in space is important both to crew health and to future scientific research on the International Space Station.

The STS-102 mission will transport the Passive Dosimeter System (PDS) to the ISS, where it will serve as a flexible and easy-to-use radiation monitor that will be available for use by any experimenter.

The PDS hardware consists of two kinds of radiation dosimeters and an electronic "reader." The dosimeters can be placed anywhere in the ISS to provide an accurate point measurement of the radiation at their locations.

One of the radiation dosimeters is a thermoluminescent detector, or TLD. Each TLD, which resembles a fat fountain pen, contains calcium sulfate crystals inside an evacuated glass bulb. These crystals absorb energy from incident ionizing radiation (protons, neutrons, electrons, heavy charged particles, gamma and x-rays) as the radiation passes through them. This process results in a steady increase in the energy level of the electrons in the crystal.

To read the accumulated radiation dose, an astronaut aboard the ISS removes the crystal-containing dosimeter from its measurement location and places it into the electronic reader. A component inside the reader heats the crystals. As the crystals are heated they emit a glow of light that is proportional to the amount of radiation they have been exposed to. This glow is measured by a photomultiplier tube in the reader. The reader stores the measured dose on a memory card that can be returned to Earth for further analysis. After the crystals have emitted all their stored energy, they are ready to begin accumulating a dose again and the TLD is ready to be reused.

The other dosimeter is a set of Plastic Nuclear Track Detectors (PNTDs). The PNTDs are thin sheets of plastic, similar to the material used for some eyeglass lenses. As heavy charged ions pass through the PNTDs, the surface becomes pitted with tiny craters. When the PNTDs are subsequently returned to Earth, the plastic is etched to enlarge the craters. Then the craters are counted and their shapes and sizes are analyzed using a microscope. This information is used to improve the accuracy of the radiation dose the TLDs have recorded and to improve the estimate of the biological effects of the radiation.

The complete set of 48 TLDs and the reader will be carried into orbit on STS-102. They will remain on the ISS indefinitely to support a variety of future scientific experiments. A set of 12 PNTDs will be carried to the ISS on STS-100 later this year. The combined dosimeters will be used to measure radiation as part of the DOSMAP experiment, which is being conducted by the NASA Human Research Facility on the ISS. The exposed PNTDs will be returned to Earth for analysis by the STS-105 mission.

Understanding the radiation environment on the ISS will be useful in helping scientists explain experimental results that otherwise might be unaccounted for. The radiation measurements can help scientists determine whether a given effect is due to microgravity, radiation or something else.

The Passive Dosimeter System is the first ISS hardware from NASA's Ames Research Center, Moffett Field, Calif. The Hungarian Space Office provided the thermoluminescent detectors, which are a third-generation version of dosimeters that flew previously on the Russian space stations Salyut 7 and Mir, and on the Space Shuttle. The Hungarian Space Office also provided the compact radiation reader, which is smaller than a typical shoebox. The Plastic Nuclear Track Detectors are provided and analyzed by ERIL Research Company in San Rafael, CA.

Ames' role has led efforts to verify and certify the dosimeters for safety, and to package them in one of four transport containers, which resemble insulated lunch bags. One container holds a reader and 12 TLDs with associated power and data cables. Two additional kits each hold 18 TLDs. The final kit holds 12 PNTDs and two memory cards for the reader.

Payloads

Space Experiment Module Carrier System

Overview

The Space Experiment Module (SEM) 09 Carrier System in Discovery's cargo bay contains educational experiments.

--The "Microgravity Rainbow" of Beaver Run Elementary, Salisbury, Md., involved 45 first and second grade students who mixed 44 vials of Kool-aid. Twenty two will be flown and colors will be compared with samples and with paint color swatches after the flight.

--The "Ponds" experiment of Woodland Middle School, East Meadow, N.Y., involved two teachers and 210 sixth graders from two schools. They will fly samples from natural and manmade ponds, other water and related samples.

--The "Sunflower Seeds in Space" experiment of Coyote Valley Elementary School, Middletown, Calif., is an effort by fourth graders to determine effects of space travel on sunflower seeds. Flown and control samples will be planted and compared after the flight.

--"Operation Cheese Mold" is an experiment of Rostraver Middle School, Belle Vernon, Pa. Various cheese samples will be flown and later compared for mold growth with control samples.

--"The Effect of Cosmic Radiation on Lichens" experiment of the Delta Cyber School in Delta Junction, Alaska, contains two sets of eleven space capsules containing lichens. One set will be exposed to cosmic radiation and the other shielded. When the lichens return, the sets will be compared for structure or growth changes.

--"Coco for Coconauts" is an experiment of the Congress Math/Science/Technology Middle School Magnet Team, Boynton Beach, Fla. Pupils in grades six to eight will place coconut samples in vials for the flight. They will be exposed to radiation and after return examined for changes.

--"A Seed for a Larger Service" experiment of the Country Center 4-H Space Science Project, Sacramento, Calif., will use a hybrid grass material to look at how spaceflight affects it at a molecular level. They will compare results to an experiment flown on STS-101.

--"The Ultra Fluffy Outcome" experiment of Virginia Space Academy 2000 in Newport News, Va. compares effects of radiation and temperature on cotton candy samples flown in space to control samples.

--"MISE" (Materials in Space Experiments) of the Young Valley Scientists in Santa Ynez, Calif., will test how the space environment affects various materials, including natural materials and materials made using old and new technologies. Also, the experiment will explain how microgravity and radiation affect materials made by old and new technologies.

--SSM -- Anne Arundel County Schools, Anne Arundel County, Md., students from five schools will investigate effects of the space environment on a variety of commonly used materials, including common school supplies, food samples, fabrics, shampoos, perfumes, and soaps.

History/Background

The Space Experiment Module (SEM) Carrier System is a self-contained assembly of subsystems that function together to provide structural support, power, experiment, command and data storage capabilities. The SEM-09 carrier system is a five-foot 'canister' that contains 10 experiment modules.

The SEM software is required for active experimentation. The software application helps the experimenter describe the experiment, enter power consumption, parts, materials, timeline, control and command data. Also, the software is used to analyze the data for SEM compatibility and post-flight reports.

The active modules are powered by one 12-Volt battery independent of the shuttle power supply. Each powered module has an integrated programmable control circuit board or Module Electronic Unit (MEU) for data sampling and storage. The MEU processes the student-devised flight operations timeline. A Ground Module Electronic Unit is provided to selected active experimenters for development and testing of their active experiment.

The SEM canister is generally installed three months before launch in the Space Shuttle cargo bay. During the early state of the shuttle flight, astronauts activate the SEM canister via the Payload and General Support Computer. For active experiments (using battery power) the MEU's carry out the programmed timeline defined by the experimenters.

Payloads

Wide-band Shuttle Vibration Force Measurement

Overview

The Wide-band Shuttle Vibration Force Measurement (WSVFM) experiment is a part of the payload-to- Space Shuttle Program and is managed by the Jet Propulsion Laboratory. WSVFM is a standard secondary payload that will be integrated using the Get-Away Special (GAS) Carrier Payload Integrated Plan.

The WSVFM experiment will obtain flight measurements of the vibration forces acting between a space vehicle payload and its mounting structure and complementary acceleration data at high and low frequencies. Also, the project will provide measurements of the vibration forces generated by the shuttle engines and transmitted to the onboard equipment. These measurements will enable the future evaluation of models used to derive force limits for a new, more realistic vibration test method that is used to qualify flight hardware.

The WSVFM payload is self-supporting (the payload is battery powered and the data is recorded within the payload) and does not require crew interface. The payload will be activated automatically by the shuttle's main engine ignition vibration and will operate for about 270 seconds. After landing, the data will be retrieved from the recorders using a personal computer.

History/Background

The primary purpose of the WSVFM and precursor SVF experiments is to validate a new, cost-effective method of conducting laboratory vibration tests, which are routinely performed to qualify aerospace equipment for flight.

The WSVFM payload will be in a sealed, standard 5-cubic-foot GAS canister. The payload weighs 260 pounds -- 160 pounds for the canister and 100 pounds for the experiment and ballast structure.

Payloads

Get-Away Special Canister 783

Overview

The GAS (Get-Away Special) canister G-783, also known as Aria-2, is an educational project that encourages K-12 St. Louis area students to use hands-on science experimentation in an exciting environment. Students for the Aria-2 project design, build, and fly experiments in space. The Aria-2 project introduces students to science, engineering and technology, and fosters their involvement in hands-on space science before they make long-term career decisions. Aria-2 carries 124 passive science experiments from more than 1,700 kindergarten through 12th-grade students from 19 St. Louis area schools, one school in Washington, D.C., and one school in Palo Alto, Calif. Individual teachers provided instruction in the following areas: preparing hypotheses, designing experiments, collecting materials, creating flight articles, and analyzing the results after flight. All of the Aria-2 experiments are "fly and compare" experiments that contain two samples. Both samples are packaged identically. One sample is flown on board STS-102 and the other is kept on the ground. After the mission samples will be compared and the differences are noted.

Students will look at effects of microgravity, radiation, magnetism, and other possible circumstances experienced in a low-Earth-orbit environment. Each school is responsible for its own student organization and participation. Some organized clubs and others integrated the experiments into their curriculum.

History/Background

The Washington University St. Louis School of Engineering and Applied Science sponsored the Aria-2 project. Twenty undergraduate Washington University students designed, built, and tested the primary GAS structure and packaging systems. Keith Bennett, Department of Computer Science, and Dr. Michael Swartwout, Department of Mechanical Engineering, provided instruction to the undergraduate students. The project is co-sponsored by the St. Louis Area Junior Achievement which aided in contacting area schools, communicating the project opportunity, and linking interested schools with Washington University and the Aria-2 project.

DTO/DSO/RME

Monitoring Latent Virus Reactivation and Shedding in Astronauts
DSO 493

Overview

The premise of this DSO is that the incidence and duration of latent virus reactivation in saliva and urine will increase during space flight. The objective is to determine the frequency of induced reactivation of latent viruses, latent virus shedding, and clinical disease after exposure to the physical, physiological, and psychological stressors associated with space flight.

History/Background

Spaceflight-induced alterations in the immune response become increasingly important on long missions, particularly the potential for reactivation and dissemination (shedding) of latent viruses. An example of a latent virus is Herpes Simplex Type 1 (HSV-1), which infects 70 to 80% of all adults. Its classic manifestations are cold sores, pharyngitis, and tonsillitis; and it usually is acquired through contact with the saliva, skin, or mucous membranes of an infected individual. However, many recurrences are asymptomatic, resulting in shedding of the virus. Twenty subjects have been studied for Epstein-Barr virus. Three additional viruses will be examined in an expanded subject group.

DTO/DSO/RME

Individual Susceptibility to Post-Spaceflight Orthostatic Intolerance
DSO 496

Overview

Susceptibility to postflight orthostatic intolerance - lightheadedness or fainting upon return to Earth - is highly individual. Some astronauts are little affected, while others have severe symptoms. Women are more often affected than men. The goal of this DSO is to discover the mechanisms responsible for these differences in order to customize countermeasure protocols.

History/Background

It has been well documented that spaceflight significantly alters cardiovascular function. One of the most important changes from a crew safety standpoint is postflight loss of orthostatic tolerance, which causes astronauts to have difficulty walking independently and induces lightheadedness or fainting. These may impair their ability to leave the orbiter after it lands.

This DSO will perform a flight-related study, designed to clarify preflight and postflight differences in susceptible and nonsusceptible astronauts. There are no on-orbit activities associated with this DSO.

DTO/DSO/RME

Spaceflight and Immune Functions
DSO 498

Overview

Astronauts face an increasing risk of contracting infectious diseases as they work and live for longer periods in the crowded conditions and closed environments of spacecraft such as the International Space Station. The effects of spaceflight on the human immune system, which plays a pivotal role in warding off infections, is not fully understood. Understanding the changes in immune function caused by exposure to microgravity will allow researchers to develop countermeasures to minimize the risk of infection.

History/Background

The objective of this DSO is to characterize the effects of spaceflight on neutrophils, monocytes, and cytotoxic cells, which play an important role in maintaining an effective defense against infectious agents. The premise of this study is that the space environment alters the essential functions of these elements of human immune response.

Researchers will conduct a functional analysis of neutrophils and monocytes from blood samples taken from astronauts before and after the flight. They will also assess the subjects' pre- and postflight production of cytotoxic cells and cytokine.

This study will complement previous and continuing immunology studies of astronauts' adaptation to space.

DTO/DSO/RME

Crosswind Landing Performance
DTO 805

Overview

The purpose of this DTO is to demonstrate the capability to perform a manually controlled landing in the presence of a crosswind. The testing is done in two steps.

1. Prelaunch: Ensure planning will allow selection of a runway with Microwave Scanning Beam Landing System support, which is a set of dual transmitters located beside the runway providing precision navigation vertically, horizontally, and longitudinally with respect to the runway. This precision navigation subsystem helps provide a higher probability of a more precise landing with a crosswind of 10 to 15 knots as late in the flight as possible.

2. Entry: This test requires that the crew perform a manually controlled landing in the presence of a 90-degree crosswind component of 10 to 15 knots steady state.

During a crosswind landing, the drag chute will be deployed after nose gear touchdown when the vehicle is stable and tracking the runway centerline.

History/Background

This DTO has been manifested on 63 previous flights.

DTO/DSO/RME

International Space Station On-Orbit Loads Validation
DTO 261

Overview

This DTO will use the shuttle's aft primary reaction control system jets to measure the structural dynamics (natural frequencies, modal amplitudes, and structural dampening) of the ISS and use the results to validate critical areas of the on-orbit loads prediction models. Tests will obtain photogrammetric measurements of the radiator.

History/Background

This is the third flight of DTO 261.

DTO/DSO/RME

Shuttle Automatic Reboost Tuning
DTO 263

Overview

Shuttle reboost of the space station using the automatic reboost software requires jet-firing separation to avoid excitation of the joined shuttle/ISS structural natural frequencies. Accurate specification of this jet-firing separation requires measurement of the on-orbit joined structure natural frequencies. A brief execution of the reboost software using benign parameters, such as burn length, will allow acquisition of structural dynamics data to validate the preflight estimate of the structural natural frequencies and damping and, thus, the jet-firing separation time.

The structural natural frequencies can be measured using the shuttle inertial measurement unit downlinked data, and the jet-firing separation time can be implemented by display inputs by the crew. This DTO is appropriate for shuttle flights to the ISS between availability of OI-28 reboost software and availability of the vernier jet reboost capability and which have a significant structural configuration difference from previous flights.

History/Background

This is the second flight of DTO 263.

DTO/DSO/RME

Single-String Global Positioning System
DTO 700-14

Overview

The purpose of the Single-String Global Positioning System (GPS) is to demonstrate the performance and operation of the GPS during orbiter ascent, on orbit, entry, and landing phases using a modified military GPS receiver processor and the existing orbiter GPS antennas. GPS data may be downlinked during all mission phases.

History/Background

This is the 15th flight of DTO 700-14.

DTO/DSO/RME

Structural Dynamics Model Validation
DTO 257

Overview

This DTO will fire a sequence of primary reaction control system (RCS) jets and observe the effects on the structural dynamics of the mated Shuttle and International Space Station complex. The test is designed to confirm that primary reaction control system jet firings are acceptable for use if vernier reaction control system jets are not available.

History/Background

This is the fifth flight of DTO 257.

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.

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 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.

Shuttle Reference and Data

Space Shuttle Rendezvous Maneuvers

COMMON SHUTTLE RENDEZVOUS MANEUVERS

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

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

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

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

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

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

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

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

Shuttle Reference and Data

Space Shuttle Solid Rocket Boosters

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The SRB nose caps and nozzle extensions are not recovered.

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

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

HOLD-DOWN POSTS

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

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

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

SRB IGNITION

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

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

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

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

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

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

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

ELECTRICAL POWER DISTRIBUTION

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

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

HYDRAULIC POWER UNITS

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

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

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

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

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

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

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

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

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

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

THRUST VECTOR CONTROL

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

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

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

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

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

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

SRB RATE GYRO ASSEMBLIES

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

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

SRB SEPARATION

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

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

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

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

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

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

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

Shuttle Reference and Data

Space Shuttle Super Light Weight Tank (SLWT)

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

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

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

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

A ACRONYMS AND ABBREVIATIONS

A/A	Air-to-Air
A/G	Air-to-Ground
AAA	Avionics Air Assembly
AAC	Aft Access Closure
ABC	Audio Bus Controller
ABOLT	Acquire Bolt Load
AC	Assembly Complete
ACBM	Active Common Berthing Mechanism
ACC	Antenna Controller Card
ACO	Assembly Checkout Officer
ACS	Assembly Contingency System
	Atmosphere Control and Supply
	Atmosphere Control Supply
	Attitude Control System
ADF	Air Diffuser
AFD	Aft Flight Deck
AIO	Analog Input/Output
ALS	Advanced Life Support
ALSP	Advance Life Support Pack
AMP	Ambulatory Medical Pack
AOH	Assembly Operations Handbook
AOS	Acquisition of Signal
APAS	Androgynous Peripheral Attachment System
APCU	Assembly Power Converter Unit
	Auxiliary Power Converter Unit
APFR	Articulating Portable Foot Restraint
APS	Automated Payload Switch
	Auxiliary Power Supply
ARIS	Active Rack Isolation System
ARS	Air Revitalization System
	Atmosphere Revitalization System
ASC	Aisle Stowage Container
ASCR	Assured Safe Crew Return
ASL	Atmosphere Sampling Line
ASV	Air Selector Valve
ATCS	Active Thermal Control System
ATU	Audio Terminal Unit
AVU	Artificial Vision Unit
AUAI	ACD/UHF Audio Interface
AVV	Accumulator Vent Valve
	Air Vent Valve
BBOLTCK	Berthing Bolt Check
BC	Bolt Controller
	Bus Controller

BCDU	Battery Charge/Discharge Unit
BCU	Backup Control Unit
BDT	Binary Data Transfer
BG	Beta Gimbal
BGA	Beta Gimbal Assembly
BGDTS	Beta Gimbal Deployment Transition Structure
BGHS	Beta Gimbal Housing Subassembly
BIC	Bus Interface Card
BIT	Built-In Test
BMRRM	Bearing Motor and Roll Ring Module
BP/ECG	Blood Pressure/Electrocardiogram
BSP	Baseband Signal Processor
C&C	Command and Control
C&DH	Command and Data Handling
C&M	Control and Monitor
C&T	Communications and Tracking
C&W	Caution and Warning
CADU	Channel Access Data Units
CAM	Centrifuge Accommodations Module
CBM	Common Berthing Mechanism
CCAA	Common Cabin Air Assembly
CCC	CTP Controller Card
CCH	Crew Communications Headset
CCHA	Crew Communications Headset Assembly
CCPK	Crew Contamination Protection Kit
CCS	Command and Control Software
CCSDS	Consultative Committee for Space Data Systems
CCT	Cold Cathode Transducer
CCTV	Closed-Circuit Television
CDDT	???6-1
CDMK	Carbon Dioxide Monitoring Kit
CDRA	Carbon Dioxide Removal Assembly
CDS	Command and Data Software
CEVIS	Cycle Ergometer with Vibration Isolation and Stabilization
CHeCS	Crew Health Care System
CHX	Condensing Heat Exchanger
CID	Circuit Interrupt Device
CIR	Cargo Integration Review
CLA	Capture Latch Assembly
CMG	Control Moment Gyro
CMO	Crew Medical Officer
CMRS	Crew Medical Restraint System
COAS	Crew Optical Alignment System
COTS	Commercial-Off-The-Shelf
CPA	Controller Panel Assembly
CPDS	Crew Passive Dosimetery System

CPS	Cabin Pressure Sensor
CSA-CP	Compound Specific Analyzer-Combustion Products
CSCI	Computer Software Configuration Item
CSI	Common Structural Interface
CSV	CO_2 Selector Valve
CTP	Command and Telemetry Processor
CVIU	Common Video Interface Unit
CVT	Current Value Table
CVV	CO_2 Vent Valve
CWC	Contingency Water Collection
DA	Depressurization Assembly
DAIU	Docked Audio Interface Unit
DAK	Double-Aluminized Kapton
DBBOLTCK	Deberthing Bolt Check
DCP	Display and Control Panel
DCSU	Direct Current Switching Unit
DDCU	DC-to-DC Converter Unit
DIO	Discrete Input/Output
DMCU	Docking Mechanism Control Unit
DSP	Digital Signal Processor
EA	Electronics Assembly
EAS	Early Ammonia Servicer
ECG	Not called out
ECLSS	Environmental Control and Life Support System
ECM	Embedded Control Module
ECS	Early Comm Subsystem
	Early Communications Subsystem
ECU	Electronics Control Unit
EELS	Emergency Egress Lighting System
EETCS	Early External Thermal Control System
EIA	Electrical Interface Assembly
EIB	Electronic Interface Box
ELS	Emergency Lighting Strip
EMA	Engagement Mechanism Assembly
EMI	Electromagnetic Interference
EMU	Extravehicular Mobility Unit
EPS	Electrical Power System
ESA	External Sampling Adapter
ESP	External Stowage Platform
ETI	Elapsed Time Indicator
EUE	Experiment Unique Equipment
EVA	Extravehicular Activity
EXPRESS	EXpedite the PRocessing of Experiments to the Space Station

FBOLT	Final Bolt Load
FC	Fuel Cell
FCC	Flat Collector Circuit
FCT	Flight Control Team
FCV	Flow Control Valve
FDI	Fault Detection and Isolation
FDIR	Fault Detection, Isolation and Recovery
FDS	Fire Detection and Suppression
FET	Field Effect Transistors
FGB	Functional Cargo Block
FMC	Fan Motor Controller
FMK	Formaldehyde Monitor Kit
FO	Fiber Optic
FQDC	Fluid Quick Disconnect Coupling
FRGF	Flight Releasable Grapple Fixture
FSE	Flight Support Equipment
FSS	Fluid Servicer System
GFE	Government-Furnished Equipment
GFI	Ground Fault Interrupter Ground Fault Interruption
GLA	General Lighting Assembly
GLONASS	Global Navigational Satellite System
GNC	Guidance Navigation and Control
GPC	General Purpose Computer
GPS	Global Positioning System
GSE	Ground Support Equipment
HAB	Habitation
HCA	Hollow Cathode Assembly
HCU	Headset Control Unit Heater Control Unit
HDR	High Data Rate
HEC	Headset Extension Cable
HEPA	High Efficiency Particulate Air
HGA	High Gain Antenna
HIC	Headset Interface Cable
HLA	High Level Analog
HRD	High Rate Dosimeter
HRDL	High Rate Data Lines
HRF	Human Research Facility
HRFM	High-Rate Frame Multiplexer
HRM	Heart Rate Monitor High Rate Modem
I/O	Input/Output
IAC	Internal Audio Controller

IAS	Internal Audio Subsystem
IBOLT	Initial Bolt Load
	Intermediate Bolt
ICC	Integrated Cargo Carrier
ICD	Interface Control Document
IDA	Integrated Diode Assembly
IEA	Integrated Equipment Assembly
IELK	Individual Equipment Liner Kits
IFHX	Interface Heat Exchanger
IMCA	Integrated Motor Controller Assembly
IMS	Inventory Management System
IMV	Intermodule Ventilation
IOCU	Input/Output Control Unit
	Input/Output Controller Unit
iRED	Interim Resistive Exercise Device
IRED	Isolated Resistive Exercise Device
ISA	Internal Sampling Adapter
ISOV	Intermodule Ventilation Shutoff Valve
ISPR	International Standard Payload Rack
ISS	International Space Station
ISSP	International Space Station Program
ISSSH	International Space Station System Handbook
ITCS	Internal Thermal Control System
IVA	Intravehicular Activity
IV-CPDS	Intravehicular-Charged Particle Directional Spectrometer
IVSU	Internal Video Switch Unit
JOP	Joint Operations Panel
KBAR	Knee Brace Assembly Replacement
KYA	Keel Yoke Assembly
LAN	Local Area Network
LB	Local Bus
LBOLT	Loosen Bolt Load
LC	Latch Controller
LCA	Lab Cradle Assembly
	Load Control Assembly
	Loop Crossover Assembly
LDA	Launch Deployment Assembly
LDI	Local Data Interface
LDR	Low Data Rate
LED	Light Emitting Diode
LFDP	Load Fault Detection Protection
LGA	Low Gain Antenna
LiOH	Lithium Hydroxide
LLA	Low Level Analog

LNS	Lab Nitrogen System
LON	Launch On Need
LOS	Loss of Signal
LRU	Line Replaceable Unit
LT	Low Temperature
LTL	Low Temperature Loop
LVLH	Local Vertical/Local Horizontal
MA	Mechanical Assembly
MAS	Microbial Air Sampler
MBE	Metal Bellows Expander
MBM	Manual Berthing Mechanism
MC	Mid Course Correction
MCA	Major Constituent Analyzer
MCC	Mission Control Center
MCC-H	Mission Control Center-Houston
MCDS	Multifunction CRT Display System
MCOR	Medium Rate Comm Outage Recorder
MCS	Motion Control System
MDA	Motor Drive Assembly
MDM	Multiplexer/Demultiplexer
MDPS	Meteoroid and Debris Protection System
MEC	Medical Equipment Computer
MFCV	Manual Flow Control Valve
MIL-STD	Military Standard
MIP	Mission Integration Plan
MLE	Middeck Locker Equivalent
MLI	Multi-Layer Insulation
MM/OD	Micrometeoroid Orbital Debris
MOD	Mission Operations Directorate
MPEV	Manual Pressure Equalization Valve
MPLM	Mini Pressurized Logistics Module Multipurpose Logistics Module
MPM	Manipulator Positioning Mechanism
MPR	Manual Pulmonary Resuscitator
MPSD	Multipurpose Support Drive
MPV	Manual Procedures Viewer
MRDL	Medium Rate Data Lines
MRL	Manipulator Retention Latch
MSD	Mass Storage Device
MSFC	Marshall Space Flight Center
MT	Moderate Temperature
MTL	Moderate Temperature Loop
MTSAS	Module-to-Truss Segment Attach System
MTSAS-A	Module-to-Truss Segment Attach System-Active
MTSAS-P	Module-to-Truss Segment Attach System-Passive

NASA	National Aeronautics and Space Administration
NATC	NASA Threaded Coupling
NBLC	NASA Breech Lock Coupling
NCC	Nominal Corrective Combination
NCG	Non-Condensable Gas
NCS	Node Control Software
	Node Control Software
NIA	Nitrogen Interface Assembly
NIV	Nitrogen Introduction Valve
NPRA	Negative Pressure Relief Assembly
NPRV	Negative Pressure Relief Valve
NZGL	NASA Zero-G Lever
NZGW	NASA Zero-G Wing
OCA	Orbiter Communications Adapter
ODA	Orbiter Disconnect Assembly
ODF	Operations Data File
ODM	Orbiter Drive Mechanism
ODS	Orbiter Docking System
OIU	Orbiter Interface Unit
	On-Orbit Replaceable Unit
OMS	Orbital Maneuvering System
OP	Overhead Port
OPS LAN	Operations Local Area Network
ORU	Orbital Replacement Unit
	Orbiter Replaceable Unit
OS	Overhead Starboard
OSE	Orbital Support Equipment
OSO	Operations Support Officer
OSTP	Onboard Short-Term Plan
OSVS	Orbiter Space Video System
OTD	ORU Transfer Device
P&S	Pointing and Support
P/T	Pressure/Temperature
PA	Pressurized Adapter
PAV	Process Air Valve
PBA	Portable Breathing Apparatus
PBIT	Passive Built-In-Test
PCA	Pressure Control Assembly
PCBM	Passive Common Berthing Mechanism
PCC	Power Converter Controller
PCMCIA	Personal Computer Memory Card International Association
PCP	Pressure Control Panel
PCR	Portable Computer Receptacle
PCS	Portable Computer System
PCT	Post Contact Thrust

PCU	Plasma Contactor Unit
PD	Port Deck
PDA	Payload Disconnect Assembly
PDB	Power Distribution Box
PDGF	Power Data Grapple Fixture
PDI	Payload Data Interface
PDS	Passive Dosimetery System
PDU	Power Distribution Unit Power Drive Unit
PEHG	Payload Ethernet Hub Gateway
PEV	Pressure Equalization Valve
PFCS	Pump and Flow Control Subassembly
PFE	Portable Fire Extinguisher
PFMC	Pump/Fan Motor Controller
PGSC	Payload General Support Computer
PGT	Pirini Gage Transducer
PHP	Perimeter Hole Pattern
PL	Payload
PL PRI	Primary Payload
PMA	Pressurized Mating Adapter
PMC	Pump Motor Controller
PMCU	Power Management Control Unit
POIC	Payload Operations Integration Center
PPA	Pump Package Assembly
PPL	Pre-Positioned Load
PPRA	Positive Pressure Relief Assembly
PPRV	Positive Pressure Relief Valve
PRC	PORTCOM Receiver Card
PRLA	Payload Retention Latch Assembly
PSP	Payload Signal Processor
PT	Pressure Transducer
PTC	PORTCOM Transmit Card
PTCS	Passive Thermal Control System
PUI	Program Unique Identifiers
PV	Photovoltaic
PVCA	Photovoltaic Controller Application
PVCE	Photovoltaic Controller Elements
PVCU	Photovoltaic Controller Unit
PVM	Photovoltaic Module
PVR	Photovoltaic Radiator
PVTCS	Photovoltaic Thermal Control System
QD	Quick Disconnect
R&MA	Restraint and Mobility Aid
R&R	Removal and Replacement
R-S	Reed-Solomon

R/F	Refrigerator/Freezer
RAB	Rack Attachment Block
RAC	Remote Antenna Controller
RAIU	Russian Audio Interface Unit
RAM	Radiation Area Monitor Random Access Memory
RAMV	Rheostat Air Mix Valve
RBI	Remote Bus Isolator
RBOLT	Remove Bolt Load
RCU	Remote Control Unit
REMA	Restraint and Mobility Aids
RF	Radio Frequency
RFCA	Rack Flow Control Assembly
RFG	Radio Frequency Group
RFPDB	Radio Frequency Power Distribution Box
RGA	Rate Gyro Assembly
RHC	Rotational Hand Controller
RHX	Regenerative Heat Exchanger
RM	Research Module
RMS	Remote Manipulator System
ROEU	Remotely Operated Electrical Umbilical
ROFU	Remotely Operated Fluid Umbilical
ROS	Russian On-orbit Segment
RPC	Remote Power Controller
RPCM	Remote Power Controller Module
RPDA	Remote Power Distribution Assembly
RPS	Rack Power Switch
RSA	Russian Space Agency
RSP	Respiratory Support Pack Resupply Stowage Platform
RSR	Resupply Storage Rack
RSTS	Rack Standalone Temperature Sensor
RT	Remote Terminal
RTAS	Rocketdyne Truss Attachment System
RTD	Resistive Thermal Device
RTL	Ready-to-Latch
RU	Rigid Umbilical
RWS	Remote Workstation Robotic Workstations
S&M	Structures and Mechanisms
SAFER	Simplified Aid for EVA Rescue
SASA	S-band Antenna Support Assembly
SAW	Solar Array Wing
SCA	Switchgear Controller Assembly
SCI	Signal Conditioning Interface
SCSI	Serial Command and Monitoring Interface

SD	Starboard Deck
SDS	Sample Delivery System
	Sample Distribution System
SEM	Shunt Electronics Module
SFCA	System Flow Control Assembly
SGANT	Space-to-Ground Antenna
SGI	Square Grid Interface
SGTRC	Space-to-Ground Transmitter/Receiver Controller
SLP	Spacelab Pallet
SM	Service Module
	System Monitoring
SMA	Sensor Module Assembly
SMCC	Service Module Central Computers
SOC	State of Charge
SOV	Shutoff Valve
SPD	Serial Parallel Digital
SPDA	Secondary Power Distribution Assembly
SPEC	Specialist Function
SPG	Single Point Ground
SPP	Science Power Platform
SRMS	Shuttle Remote Manipulator System
SSA	S-band Single Access
SSAF	S-band Single Access Forward
SSAR	S-band Single Access Return
SSC	Station Support Computer
SSK	Surface Sampler Kit
SSOV	Sample Line Shutoff Valve
SSP	Standard Switch Panel
SSRMS	Space Station Remote Manipulator System
SSSR	S-band Single Access Return
SSU	Sequential Shunt Unit
STCR	Starboard Thermal Control Radiator
STIPL	Standard Interface Plate
SW	Software
TA	Thruster Assist
TB	Talkbacks
TC	Terminal Computer
TCCS	Trace Contaminant Control Subassembly
TCCV	Temperature Control and Check Valve
TCS	Thermal Control Subsystem
	Thermal Control System
TDRSS	Tracking and Data Relay Satellite System
TEA	Torque Equilibrium Attitude
TEPC	Tissue Equivalent Proportional Counter
TERA	Temporary Equipment Restraint Aid
TFL	Telemetry Format List

THA	Thermostat Housing Assembly
THC	Temperature and Humidity Control Translational Hand Controller
TI	Transition Initiation
TMA	Torque Motor Assembly
TOCA	Total Organic Carbon Analyzer
TPS	Total Pressure Sensors
TTCR	Trailing Thermal Control Radiator
TTL	Transfer Tracking Log
TVIS	Treadmill with Vibration Isolation System
TWMV	Three-Way Mixing Valve
UCP	Unpressurized Cargo Pallet
UDG	User Data Generation
UDM	Universal Docking Module
UDMH	Unsymmetrical Dimethylhydrazine
UIP	Utility Interface Panel
UOP	Utility Outlet Panel
USOS	United States On-orbit Segment
UTAS	Universal Trunnion Attach System
VAJ	Vacuum Access Jumper
VAP	Vacuum Access Port
VBSP	Video Baseband Signal Processor
VDS	Video Distribution Subsystem
VES/VRS	Vacuum Exhaust/Resource System
VIS	Vibration Isolation System
VMDS	Valve Motor Drive Switch
VRA	Vent Relief Assembly
VRCV	Vent and Relief Control Valve
VRIV	Vent and Relief Isolation Valve
VSC	Video Signal Conditioner
VSU	Video Switching Unit
VTR	Video Tape Recorder
VTS	Video Teleconferencing System
WIF	Worksite Interface
WMK	Water Microbiology Kit
WOV	Water ON/OFF Valve
WPP	Water Pump Package
WRM	Water Recovery and Management
WS	Water Separator
WSA	Water Sampler and Archiver
WVA	Water Vent Assembly
XPDR	Standard TDRSS Transponder
XPOP	X-Axis Perpendicular to Orbital Plane
ZSR	Zero-G Stowage Rack

Media Assistance

NASA Television Transmission

NASA Television is available through the GE2 satellite system which is located on Transponder 9C, at 85 degrees west longitude, frequency 3880.0 MHz, audio 6.8 MHz.

The schedule for television transmissions from the orbiter and for mission briefings will be available during the mission at Kennedy Space Center, 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 Human Space Flight Web, part of the World Wide Web. This site contains information on the crew and its mission and will be updated regularly with status reports, photos and video clips throughout the flight. The NASA Shuttle Web’s address is:

http://spaceflight.nasa.gov

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

http://www.nasa.gov

or

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

Shuttle Pre-Launch Status Reports

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

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

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

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

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

Resources for educators can be found at the following address:

http://education.nasa.gov

Access by Compuserve

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

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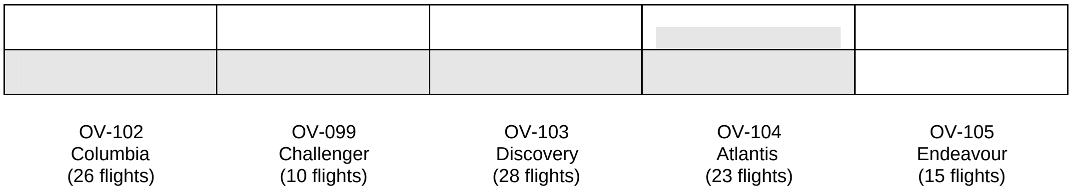
OV-102
Columbia
(26 flights)
OV-099
Challenger
(10 flights)
OV-103
Discovery
(28 flights)
OV-104
Atlantis
(23 flights)
OV-105
Endeavour
(15 flights)