National Aeronautics and Space Administration

STS-118

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USA
United Space Alliance

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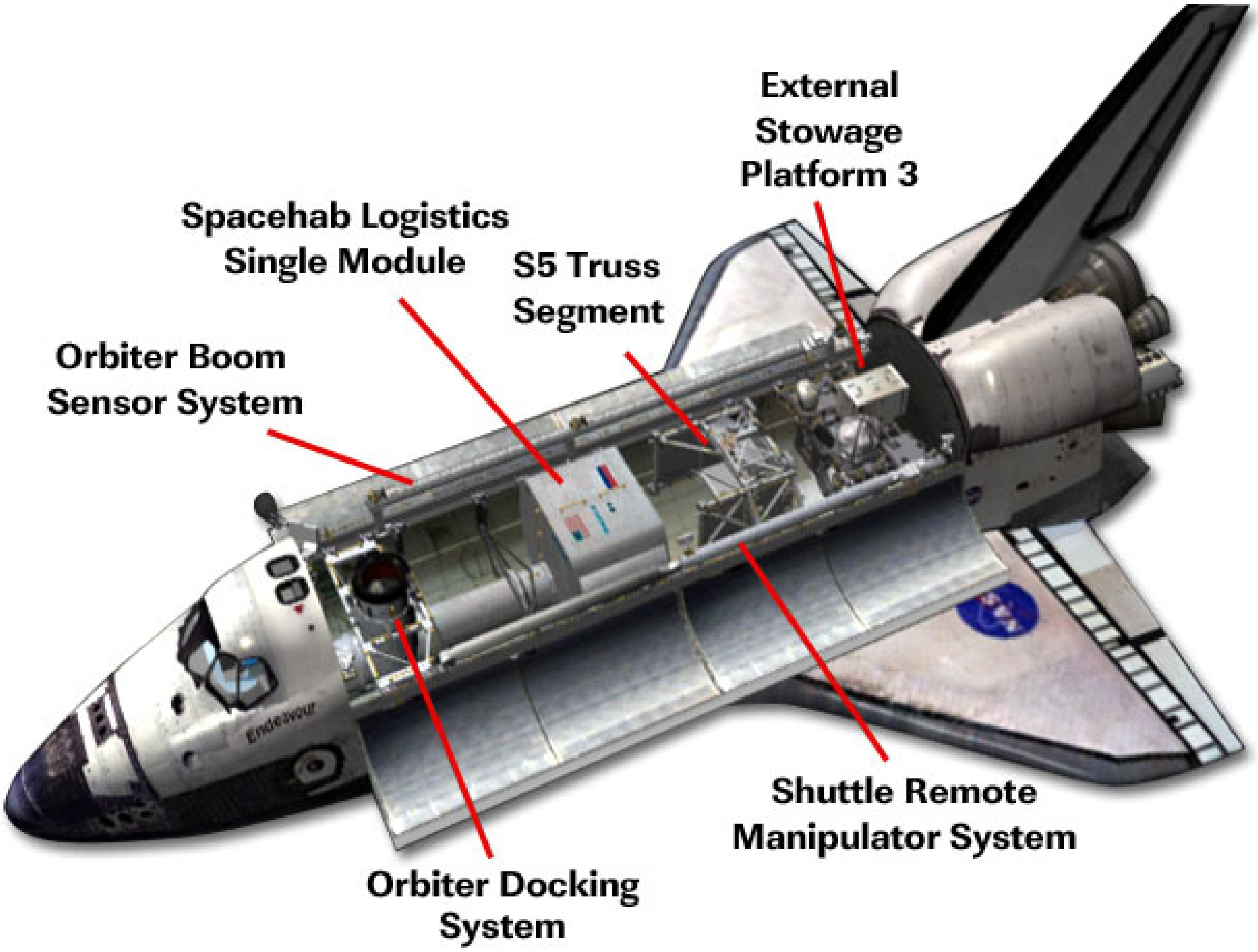
STS-118 MISSION OVERVIEW: BUILD THE STATION…BUILD THE FUTURE

Space Shuttle Endeavour is on Launch Pad 39-A and ready for launch. At far left is the rotating service structure, which can be rolled around to enclose the shuttle for access during processing. Behind the shuttle is the fixed service structure, topped by an 80-foot-tall lightning mast.



This graphic depicts the location of STS-118 payload hardware.

The space shuttle Endeavour is poised to blast off Aug. 7, carrying seven astronauts to orbit on a complex flight to continue the assembly of the International Space Station and fulfill a long-standing human spaceflight legacy.

The 119th flight in space shuttle history and the 22nd to the station is commanded by veteran astronaut Scott Kelly, a Navy commander, 43. Endeavour is scheduled to be launched from NASA's Kennedy Space Center's Launch Pad 39-A on an 11-day flight. During the mission, the crew will deliver a new segment for the station's backbone, install a spare parts platform and swap out a failed gyroscope used to orient the station.

Kelly, who is making his second flight into space, is joined by Pilot Charlie Hobaugh (HOE'baw), a Marine lieutenant colonel, 45, and mission specialists Tracy Caldwell, 37, Rick Mastracchio (Muh-STRACK'-ee-oh), 47, Dr. Dave Williams of the Canadian Space Agency, 53, Barbara R. Morgan, 55, and Alvin Drew, an Air Force colonel, 44.

Hobaugh, Mastracchio and Williams are all making their second flight into space. Caldwell, Morgan and Drew are all first-time fliers.

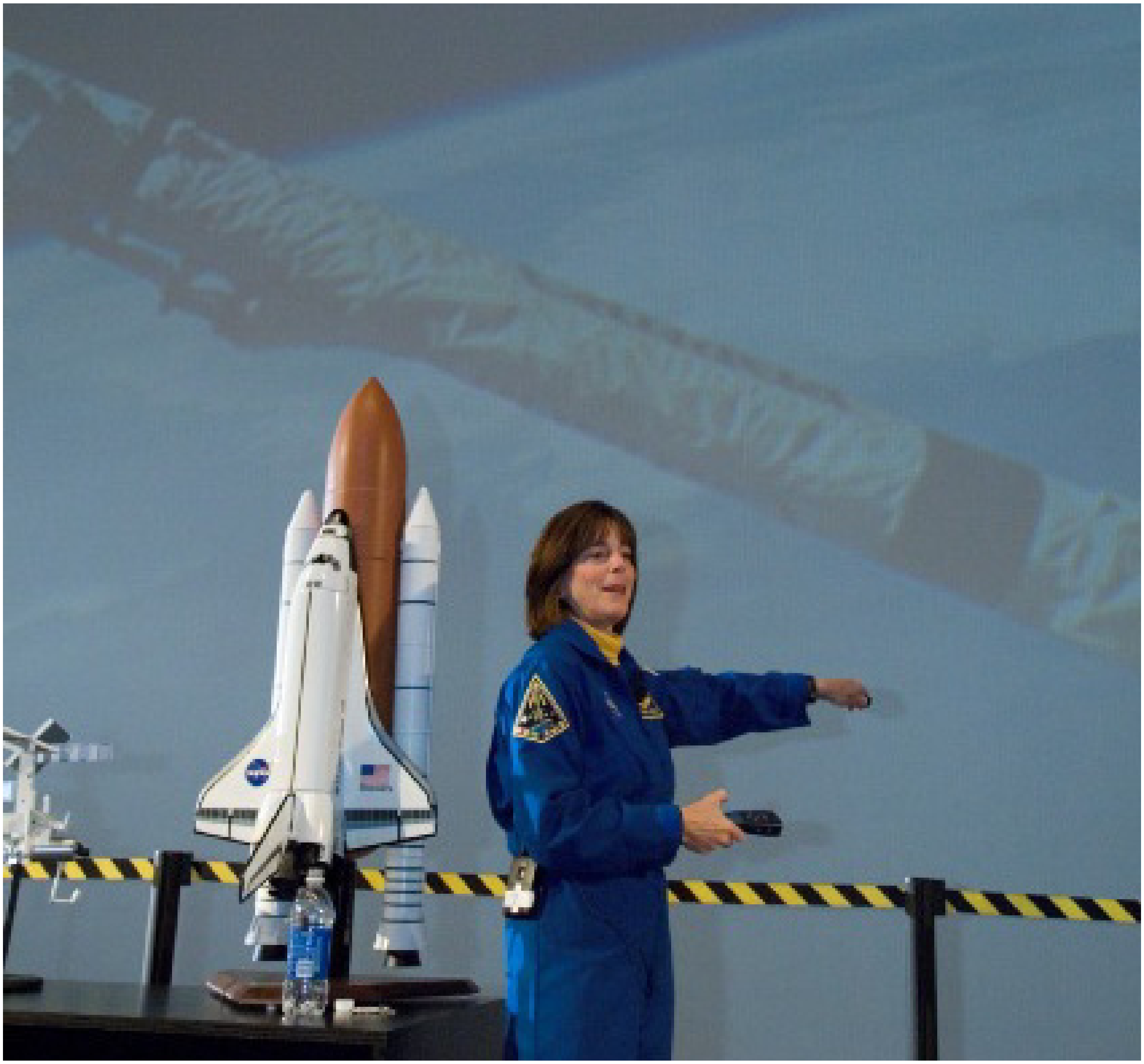
Seven astronauts pause for an informal crew portrait at the Johnson Space Center. Pictured from the left (front) are Canadian Space Agency astronaut Dave Williams, mission specialist; Scott Kelly, commander; and Tracy Caldwell, mission specialist. Back row, left to right, are Charlie Hobaugh, pilot; along with Rick Mastracchio, Barbara R. Morgan and Alvin Drew, all mission specialists.

Morgan is the first educator mission specialist, having served as the backup to payload specialist Christa McAuliffe in the Teacher in Space Project. McAuliffe and six fellow astronauts lost their lives in the Challenger accident on Jan. 28, 1986.

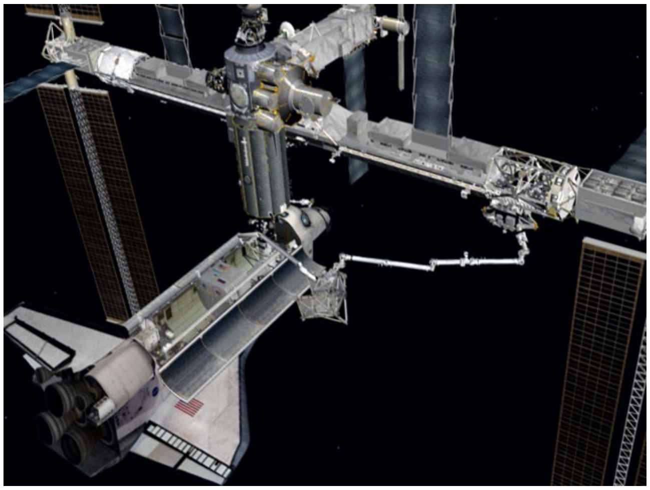
Morgan, who was an elementary school teacher in McCall, Idaho, before being selected as McAuliffe's backup, returned to teaching after the accident. She was selected to train as a mission specialist in 1998 and was named to the STS-118 crew in 2002.

She will be involved in at least one live, interactive educational in-flight event with students gathered in Boise, Idaho. If the mission is extended, she will participate in two other educational events with students in Alexandria, Va., and Lynn, Mass., to discuss her mission and the educational aspects of human spaceflight.

Endeavour is making its 20th flight, and first since the STS-113 mission in November 2002 that brought the first port side truss segment to the station. Endeavour underwent an extensive refurbishment after that mission to upgrade and modify its key systems.



Barbara R. Morgan speaks to an audience of students and media during a demonstration at Space Center Houston.



This computer graphic depicts how the S5 truss will be grappled by the station's robotic arm. It will be installed to the far right portion of the integrated truss system.

The prime objective of the mission is to install the Starboard 5 (S5) truss on the right side of the station's expanding truss structure. The two-ton S5 will be robotically attached and bolted to the S4 truss, which was delivered to the station on the STS-117 mission in June.

The S5 truss is 11 feet long, and will serve as a "spacer" to provide structural support for the outboard solar arrays that will be installed on the S6 truss next year and to provide sufficient space for clearance between those arrays and the S4 truss solar blankets.

A device called the External Stowage Platform-3 (ESP-3) will be installed on the station's P3 truss to house critical spare parts. ESP-3 joins two other stowage platforms attached to the station.

Another high priority task for Endeavour's astronauts will be the replacement of the failed Control Moment Gyroscope-3 (CMG-3) which experienced high electrical currents and erratic spin rates in October 2006 and was taken off line. Since then, the station has used the other three gyroscopes in the Zenith 1 (Z1) truss to maintain the station's orientation. The replacement work will be nearly identical to the replacement of CMG-1 on the STS-114 mission in 2005, but this failed CMG will be temporarily stowed on the new spare parts platform and will be returned to Earth on the STS-122 mission later this year.

The CMG replacement will occur during the second of three planned spacewalks. A fourth spacewalk will be added to the mission if the flight is extended. Mastracchio and Williams will conduct the first two spacewalks. Mastracchio and Expedition 15 Flight Engineer Clayton Anderson will be responsible for the third. Anderson would team up with Williams for the fourth spacewalk. Anderson will have conducted his first career spacewalk prior to STS-118 to jettison an obsolete ammonia reservoir and other equipment.

This computer graphic shows where the External Stowage Platform will be installed to the space station.

Cosmonauts Oleg V. Kotov and Fyodor Yurchikhin, Expedition 15 flight engineer and commander, respectively, representing Russia's Federal Space Agency; and astronaut Clayton C. Anderson, flight engineer, participate in a training session in the Space Vehicle Mockup Facility at Johnson Space Center before they were reunited at the space station.

Endeavour's astronauts will work with Anderson and his crewmates, Expedition 15 Commander Fyodor Yurchikhin (Fee-OH'-duhr YUR'-chee-kin) and Flight Engineer Oleg Kotov (AH'-leg KOH'-toff), during more than a week of joint docked operations.

The mission also will feature the first flight of the new Station-to-Shuttle Power Transfer System (SSPTS), a series of electrical converter units in the shuttle that draw electricity from the station's power system to supplement the normal electrical output from the shuttle's three cryogenic fuel cells. The new capability is designed to extend the shuttle's stay at the station to up to 12 days, if necessary, without depleting the finite electrical capability of the fuel cells themselves.

The SSPTS routes power through Pressurized Mating Adapter-2 (PMA-2), the docking port for Endeavour at the forward end of the station's Destiny Laboratory. SSPTS consists of two Power Transfer Units (PTUs) in the shuttle, containing three converters per unit, two Orbiter Power Conversion Units (OPCUs) and one Assembly Power Conversion Unit (APCU).

Each OPCU converts 124 volt direct current power from the station to 28 volt usable shuttle power. Each unit draws 2.2 kilowatts of station power and converts it to 2 kilowatts of power for shuttle systems.

Following Endeavour's docking to the station on flight day 3 and shortly after hatches are opened between the two vehicles, SSPTS will be activated as two of the four OPCUs are turned on. The system will be deactivated shortly before the first spacewalk on flight day 4 to enable the station's starboard solar arrays to be locked in place for the installation of the S5 truss. After that is completed, SSPTS will be reactivated until Endeavour is ready to undock and the other two OPCUs will be turned on and checked out.

Mission managers may elect to wait until flight day 5 to verify the performance of the new system before formally extending the flight three additional days to a 14-day mission.

Shuttles Endeavour and Discovery were outfitted during their most recent maintenance periods for SSPTS capability. Atlantis does not have SSPTS capability.

Right after arriving on orbit, Caldwell and Williams will capture video and digital stills of Endeavour's jettisoned external fuel tank for imagery analysis on the ground, the first in a series of iterative steps that will clear Endeavour's heat shield for a safe landing.

Endeavour's astronauts will then set up their tools and computers and open the ship's cargo bay doors. Morgan and Drew will activate the Spacehab module and open the hatch to the cargo carrier through a tunnel from Endeavour's lower deck. Caldwell and Mastracchio will unfurl and checkout the shuttle's robotic arm that will be used for various tasks throughout the mission.

This graphic illustrates the inspection Endeavour's astronauts will perform using the Orbiter Boom Sensor System.

The next day as Endeavour closes in on the International Space Station through a series of coordinated engine firings, Caldwell and Mastracchio will use the shuttle's robot arm to grapple the 50-foot-long Orbiter Boom Sensor System. The OBSS is an arm extension that uses cameras and laser sensors to map the leading edges of the wings and the nose cap of the shuttle in checking for any damage that may have occurred during Endeavour's climb to orbit.

Endeavour's orbital maneuvering system pod blankets will also be surveyed as part of the pre-planned surveys of the shuttle's heat protection system.

Morgan and Hobaugh will join Caldwell and Mastracchio during almost seven hours of survey work with the boom. As that work proceeds, Kelly, Williams and Drew will prepare the spacesuits that will be worn during the mission's spacewalks.

Before the crew goes to sleep to complete its second day in space, a camera will be mounted in the Orbiter Docking System to provide visual cues to Kelly and Hobaugh for the next day's docking with the station. The docking system's outer ring also will be extended in preparation for the following day's linkup.

On flight day 3, Kelly and Hobaugh will guide Endeavour through a series of engine firings to narrow the gap between the shuttle and the station, arriving about 400 feet directly below the ISS about an hour prior to docking. At that time, Kelly will execute a slow two-degree per second "backflip," called the Rendezvous Pitch Maneuver. This will enable station crew members to use digital cameras equipped with 400mm and 800mm lenses to photograph Endeavour's heat resistant tiles for analysis by imagery experts on the ground.

Once that is complete, Kelly will fly Endeavour to a point about 400 feet directly in front of the station for the last minutes of the approach for docking. Once the two vehicles are locked together and leak checks verify a tight seal between the two craft, hatches will be opened. Hobaugh will join Anderson at the robotics workstation in the Destiny Laboratory to operate the station's Canadarm2 robotic arm. They will accept the handoff of the S5 truss from Caldwell and Mastracchio who will operate the shuttle's robot arm from the aft flight deck of Endeavour.

While S5 spends the night attached to the end of Canadarm2, Mastracchio and Williams will prepare for the next day's spacewalk, the first for both of them. They will wear masks in the station's Quest airlock to prebreathe pure oxygen, cleansing nitrogen out of their bloodstreams as part of the protocol to prevent a condition known as the "bends" when they move out into the vacuum of space the next day. They will spend the night in Quest in the now familiar "campout" that precedes spacewalks that begin from the station's U.S. segment.

Scott Kelly, STS-118 commander, participates in a simulation exercise in the motion-base shuttle mission simulator in the Jake Garn Simulation and Training Facility at Johnson Space Center.

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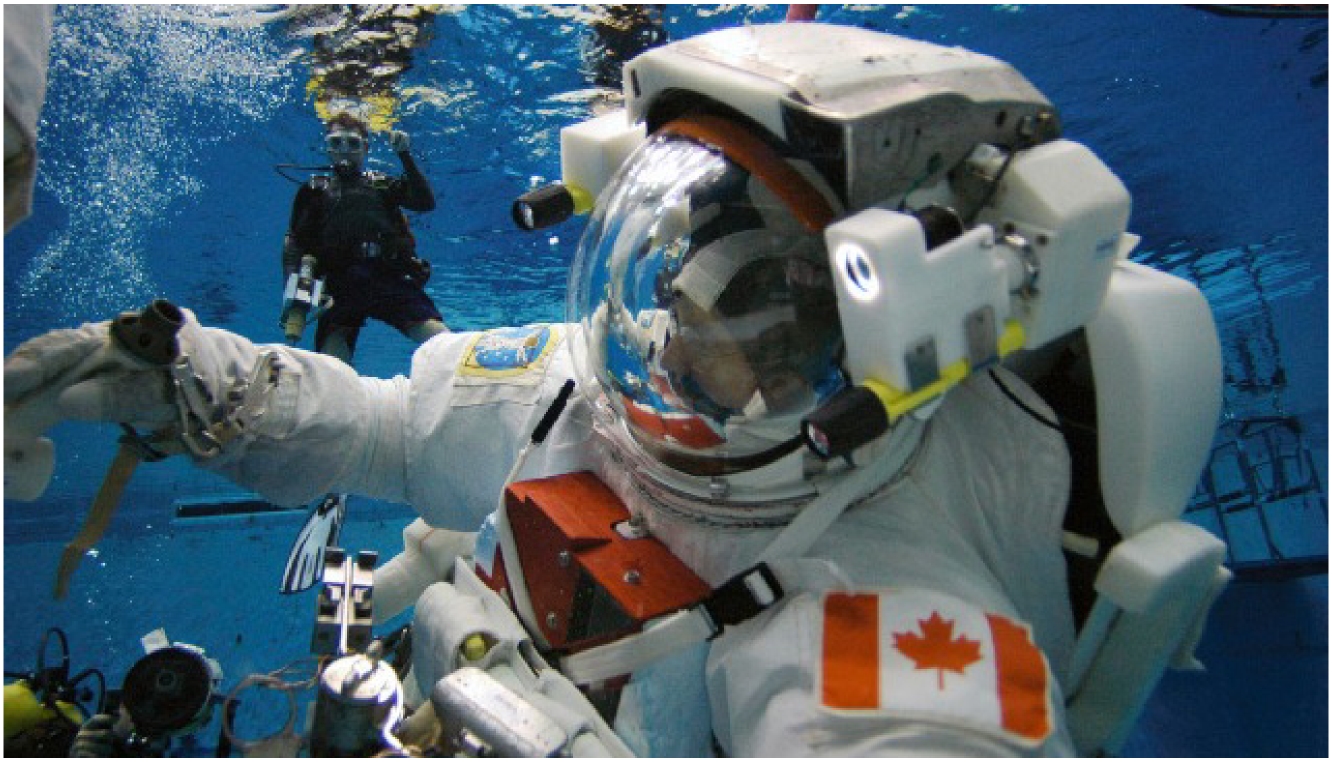
Rick Mastracchio dons a training version of his Extravehicular Mobility Unit (EMU) spacesuit prior to being submerged in the waters of the Neutral Buoyancy Laboratory (NBL) near Johnson Space Center. Tracy Caldwell assisted Mastracchio.

On flight day 4, while Morgan begins transferring cargo from the Spacehab module into the station, Hobaugh and Anderson will carefully maneuver the S5 truss to the end of the starboard truss segment of the complex. They will use visual cues from the spacewalkers to install the S5 to the recently arrived S4 solar array truss. A series of bolts will mechanically attach the two truss segments. Afterward Mastracchio and Williams will remove launch locks from the new truss, relocate the S5 grapple fixture to the truss' keel and connect electrical lines. If time permits, they will test a capture latch to be used later when the final starboard truss component, the S6, is mated outboard to the S5.

The last major task of the first spacewalk will be the retraction of the forward heat-rejecting radiator from the P6 truss. This is the final step toward that truss' relocation during the STS-120 mission later this year. The radiator will be tied down by Mastracchio and Williams and will be redeployed on STS-120 once the P6 is attached to the P5 truss on the port side of the station.

If mission managers determine that additional areas of Endeavour's thermal protection system should be inspected, this work would occur on flight day 5. Morgan, Kelly and Caldwell would take turns using the shuttle's robotic arm and the boom sensor system extension for such a survey. If no "focused" inspection is required, the day will be spent on cargo transfers. Mastracchio and Williams will move into the Quest airlock at the end of the day to prepare for their second spacewalk.



Dave Williams, STS-118 mission specialist representing the Canadian Space Agency, participates in an underwater simulation of EVA in the Neutral Buoyancy Laboratory (NBL) near Johnson Space Center. SCUBA-equipped divers are in the water to assist Williams in his rehearsal, intended to help prepare him for his STS-118 spacewalks.

On flight day 6, Mastracchio and Williams' spacewalk will be devoted to the replacement of CMG-3 that was removed from operational use on Oct. 10, 2006. Mastracchio and Williams will remove the failed CMG from its slot in the Z1 truss, temporarily park it on the truss, and install its replacement. The failed CMG will be stowed on an external spare parts platform attached to the Quest airlock and will be brought home on the STS-122 mission later this year. Cargo transfer will continue during the spacewalk.

On flight day 7, Morgan and Caldwell will be at the controls of the shuttle's robotic arm as they lift the third External Stowage Platform out of Endeavour's cargo bay and hand it over to Hobaugh and Anderson, who will operate the station's Canadarm2. Hobaugh and Anderson will then install the ESP-3 onto a cargo attachment device on the P3 truss, where capture bolts will lock it down.

Later in the day, Morgan will conduct an in-flight educational event with students gathered at the Discovery Center of Idaho in Boise, a 20-minute interactive event to discuss the progress of the flight.

Before the crew goes to sleep, Mastracchio and Anderson will move into the Quest airlock to prepare for the third spacewalk of the mission.

On flight day 8, Mastracchio and Anderson will perform the third spacewalk to upgrade the station's S-band communication system. They will remove the S-band antenna from the P6 truss and relocate it to the P1 truss and install a new signal processor and transponder for better performance.

Mastracchio and Anderson also will monitor the movement of the station's Canadarm2 as Hobaugh and Kotov use it to move two equipment carts to the starboard side of the Mobile Transporter rail car. That will clear the port side of the truss for the P6 relocation later this year. Mastracchio and Anderson also will retrieve a pair of suitcase-size experiments from temporary locations on the Quest airlock. The experiments have been collecting data on the effect of the microgravity environment on various materials. The spacewalk will wrap up with the retrieval of a transponder on the P6 truss and the engagement of gimbal locks on the Z1 truss' S-band antenna.

On flight day 9, if the mission is not extended, the two crews will complete final cargo transfers, conduct a joint crew news conference and enjoy a few hours of off-duty time together before they say farewell and close hatches between the two spacecraft.

On flight day 10, Hobaugh will be at the aft flight deck of Endeavour to supervise the shuttle's undocking from the station and a flyaround of the newly expanded complex. Once a final engine firing sends Endeavour away from the station, Caldwell and Mastracchio will be joined by Hobaugh and Morgan to conduct a final "late" inspection of Endeavour's wings and nose cap using the boom sensor system one last time. That survey will verify that no micrometeoroid debris damage has occurred during the flight to prevent a safe landing.

On flight day 11, the crew will prepare for landing the following day as Kelly and Hobaugh conduct the traditional test of Endeavour's flight control surfaces and the test-firing of the ship's 33 reaction control system jets to insure full controllability of Endeavour during its high-speed return to Earth. The crew will pack up Endeavour, close out the Spacehab module and deactivate its systems in advance of landing.

After deorbit preparations are complete and its cargo bay doors are closed, Endeavour will return to Earth on Flight Day 12, gliding to an afternoon landing at the Kennedy Space Center to complete the second shuttle mission of the year. This will mark the first time that NASA has used a three-string Global Positioning System to give the shuttle's position during entry and landing.

If the flight is extended to 14 days as is expected thanks to the new Station-to-Shuttle Power Transfer System, the flight plan will be altered slightly after flight day 8:

Flight day 9 – Cargo transfers, crew off-duty time, spacewalk preparations, the joint crew news conference and a second Morgan educational in-flight event with students at the Challenger Center for Space Science Education in Alexandria, Va.

Flight day 10 – Fourth spacewalk by Williams and Anderson to install a mounting bracket on two trunnions on the zenith side of the S1 truss. This will enable the boom sensor system to be left on the station on a later mission when it cannot fit on the starboard sill of the shuttle's payload bay for the flight to deliver the "Kibo" pressurized science module to the station. Williams and Anderson also will install two wireless instrumentation antennas on the Destiny Lab, retrieve a failed Global Positioning System antenna from the S0 truss, install wireless video system equipment on the S3 truss, relocate a tool bag from the P6 truss to Destiny and permanently secure protective debris shields on Destiny and the Unity connecting node that are temporarily tied down.

Flight day 11 – Cargo transfer work.

Flight day 12 – Final cargo transfers, a third educational in-flight event for Morgan with students at the Robert L. Ford NASA Explorer School in Lynn, Mass., and final crew farewells and hatch closure.

Flight day 13 – Undocking, flyaround, final separation and late inspection of Endeavour's heat shield.

Flight day 14 – Flight Control System checkout, reaction control system hot-fire test, cargo stowage.

Flight day 15 – Deorbit preparations, deorbit engine firing, landing at the Kennedy Space Center.

Charlie Hobaugh, STS-118 pilot, takes part in a simulation at JSC's Jake Garn Simulation and Training Facility.

TIMELINE OVERVIEW

NOTE

The mission is baselined as an 11-day flight spanning 12 flight days. After the new Station-to-Shuttle Power Transfer System (SSPTS) is activated and checked out, the flight will be extended to 14 days with landing on flight day 15. The first eight flight days of the mission will be identical with or without an extension. This timeline reflects how the mission changes with an extension.

11-DAY MISSION

Flight Day 1

- Launch
- Payload Bay Door Opening
- Spacehab Activation
- Shuttle Robot Arm Power Up
- External Tank Video and Still Photography Downlink

Flight Day 2

- Orbiter Boom Sensor System (OBSS) Survey of Shuttle Wings and Nose Cap
- Spacesuit Checkout
- Shuttle Robotic Arm Checkout of Shuttle's Orbital Maneuvering System Pods
- Orbiter Docking System Checkout and Ring Extension
- Rendezvous Tool Checkout

Flight Day 3

- Rendezvous Operations
- Rendezvous Pitch Maneuver
- Docking to the International Space Station
- Hatch Opening and Welcoming Ceremony
- Shuttle Robotic Arm Grapple and Unberth of S5 Truss
- Handoff of S5 Truss to Station Robotic Arm (Canadarm2)
- Station-to-Shuttle Power Transfer System (SSPTS) Activation and Checkout
- EVA 1 Campout (Mastracchio and Williams)

Flight Day 4

- SSPTS Deactivation Prior to EVA 1
- S5 Installation to S4 Truss Segment
- Extravehicular Activity (EVA) 1 (Mastracchio and Williams; S5 Installation, P6 Truss Forward Radiator Retraction)
- Cargo Transfer Operations
- SSPTS Reactivation After EVA 1

Flight Day 5

- Canadarm2 Grapple of Boom Sensor System for Focused Inspection (if necessary)
- Focused Inspection of Endeavour's Thermal Heat Shield (if necessary)
- Cargo Transfer Operations
- EVA 2 Campout (Mastracchio and Williams)
- Perform EPO Kit-C video

Flight Day 6

- EVA 2 (Mastracchio and Williams; Control Moment Gyroscope-3 Replacement on Z1 Truss)
- Deactivate External Stowage Platform-3 (ESP-3) Power Connection.
- Cargo Transfer Operations

Flight Day 7

- External Stowage Platform-3 Unberth from Endeavour's Payload Bay and Installation on P3 Truss
- Destiny Lab Window Scratch Pane Replacement
- Cargo Transfer Operations
- Educational Event
- U.S. PAO Event
- EVA 3 Campout (Mastracchio and Anderson)

Flight Day 8

- EVA 3 (Mastracchio and Anderson; P6 S-Band Antenna Subassembly Relocation to P1 Truss, P1 Truss Baseband Signal Processor and transponder Installation, Canadarm2 relocation of two Crew and Equipment Translation Aid (CETA) carts to starboard truss for P6 Relocation clearance, retrieve the P6 transponder, engage the gimbal locks on the Z1 S-band Antenna Subassembly, retrieve Materials on the International Space Station Experiment (MISSE) 3 and 4 payload packages)
- Cargo Transfer OperationsFlight Day 9
- Final Cargo Transfers
- Joint Crew News Conference
- Crew Off Duty Period
- Farewells and Hatch Closure

Flight Day 9

- Final Cargo Transfers
- Joint Crew News Conference
- Crew Off Duty Period
- Farewells and Hatch Closure

Flight Day 10

- Final SSPTS Deactivation (for an 11-day mission)
- Undocking from the International Space Station and Flyaround
- Final Separation Maneuver
- Late Inspection of Endeavour's Wings and Nose Cap

Flight Day 11

- Cabin Stowage
- Flight Control System Checkout
- Reaction Control System Hot-Fire Test
- Deorbit Procedures Review
- Ku-Band Antenna Stowage
- Crew Off Duty Period
- Canadian Space Agency PAO Event
- U.S. PAO Event

Flight Day 12

- Deorbit Preparations
- Payload Bay Door Closing

- Deorbit Burn
- KSC Landing

14-DAY MISSION

(First eight days are the same as the 11-day mission)

Flight Day 9

- Cargo Transfer Operations
- Joint Crew News Conference
- Crew Off Duty Period
- EVA 4 Campout (Williams and Anderson)
- Educational Event

Flight Day 10

- EVA 4 (Williams and Anderson; Secure Lab1 C2-03 and Nod1 C2-02 MMOD Shields, verify integrity of remaining P6 radiator push in pull (PiP) pins along translation paths, install EWIS antennas (2) on Lab, install OBSS berthing support equipment on S1 Truss zenith trunnions, install wireless TV equipment on S3 Camera Port 1, other get-ahead tasks)
- Perform Cycle Ergometer with Vibration Isolation and Stabilization (CEVIS) Remove and Replace
- Perform Treadmill Vibration Isolation System (TVIS) Skirt Remove and Replace

Flight Day 11

- Cargo Transfer Operations
- Perform DAUI Troubleshooting and Replace (if necessary)
- U.S. PAO Event
- Educational Event

Flight Day 12

- Final Cargo Transfers
- Crew Off Duty Period
- Educational Event
- Farewells and Hatch Closure

Flight Day 13

- Final SSPTS Deactivation
- Undocking from the International Space Station and Flyaround
- Final Separation Maneuver
- Late Inspection of Endeavour’s Wings and Nose Cap

Flight Day 14

- Cabin Stowage
- Flight Control System Checkout
- Reaction Control System Hot-Fire Test
- Stow Cabin and Prepare Spacehab for Entry
- Deorbit Procedures Review
- Ku-Band Antenna Stowage
- Crew Off Duty Period
- Canadian Space Agency PAO Event

Flight Day 15

- Deorbit Preparations
- Payload Bay Door Closing
- Deorbit Burn
- KSC Landing

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MISSION PROFILE

CREW

Commander:	Scott Kelly
Pilot:	Charlie Hobaugh
Mission Specialist 1:	Tracy Caldwell
Mission Specialist 2:	Rick Mastracchio
Mission Specialist 3:	Dave Williams
Mission Specialist 4:	Barbara R. Morgan
Mission Specialist 5:	Alvin Drew

LAUNCH

Orbiter:	Endeavour (OV-105)
Launch Site:	Kennedy Space Center Launch Pad 39A
Launch Date:	No earlier than Aug. 7, 2007
Launch Time:	7:02 p.m. EDT (Preferred In-Plane launch time for 8/7)
Launch Window:	5 Minutes
Altitude:	122 Nautical Miles (140 Miles) Orbital Insertion; 184 NM (212 Miles) Rendezvous
Inclination:	51.6 Degrees
Duration:	10 Days, 19 Hours, 27 Minutes

VEHICLE DATA

Shuttle Liftoff Weight:	4,520,773 pounds
Orbiter/Payload Liftoff Weight:	268,574 pounds
Orbiter/Payload Landing Weight:	222,398 pounds
Software Version:	OI-30

Space Shuttle Main Engines:

SSME 1:	2047
SSME 2:	2051
SSME 3:	2045
External Tank:	ET-117
SRB Set:	BI-130
RSRM Set:	97

SHUTTLE ABORTS

Abort Landing Sites

RTLS:	Kennedy Space Center Shuttle Landing Facility
TAL:	Primary – Zaragoza, Spain. Alternates – Moron, Spain and Istres, France
AOA:	Primary – Kennedy Space Center Shuttle Landing Facility; Alternate – White Sands Space Harbor

Landing

Landing Date:	No earlier than Aug. 18, 2007
Landing Time:	2:29 p.m. EDT
Primary landing Site:	Kennedy Space Center Shuttle Landing Facility

PAYLOADS

Integrated Truss Segment (ITS) - Starboard 5 (S5)

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MISSION PRIORITIES

1. Install integrated truss segment (ITS) S5 to ITS S4
2. Transfer water and transfer and stow critical cargo items
3. Deploy External Stowage Platform-3 (ESP-3) from payload bay and stow it on P3
4. Disconnect ESP-3 LTA heater power and reconfigure for PDU power
5. Transfer mission success cargo items
6. Perform Port S-band communications system upgrade
7. Relocate two Crew and Equipment Translation Aid (CETA) carts to the starboard side in preparation for P6 relocation
8. Cinch the P6 photovoltaic thermal control system forward photovoltaic radiator
9. Transfer Control Moment Gyroscope (CMG) orbital replacement unit and flight support equipment from ESP-3 to ESP-2
10. Engage Z1 S-band antenna structural assembly (SASA) gimbal locks
11. Retrieve the P6 transponder
12. Perform remove and replace CMG-3 and stow failed CMG on ESP-2
13. Retrieve materials international space station experiment (MISSE) 3 and 4
14. Secure Lab MMOD Shield Lab1 C2-03
15. Secure Node 1 MMOD Shield Nod1 C2-02
16. Verify integrity of suspect P6 radiator push in pull pins along translation paths
17. Transfer remaining cargo items per 13A.1 Transfer Priority List
18. Transfer nitrogen from shuttle to ISS Airlock High Pressure Gas Tanks (HPGT)
19. Perform daily station payload status checks
20. Perform daily middeck activities to support payloads
21. The following tasks, in priority, fit within existing spacewalks:
    - (a) Install EWIS antennas (2) on Destiny Lab
    - (b) Install OBSS on the 2 S1 zenith trunnions
    - (c) Retrieve failed GPS antenna assembly No. 4 and install caps
    - (d) Relocate P6 auxiliary tools bags
    - (e) Install Wireless Video System External Transceiver Assembly (WETA) No. 3 on cold plate (CP) 1
22. Perform the intravehicular tasks
    - (a) Perform trouble-shooting of Docked Audio Interface Unit (DAUI) and replace, if needed

   (b) Remove and replace Cycle Ergometer with Vibration Isolation and Stabilization (CEVIS)

   (c) Remove and replace Destiny Lab window scratch pane

   (d) Remove and replace TVIS Skirt

23. Perform Detailed Test Objective 853 In-flight evaluation for areas of CO2 concentration

24. Perform ISS payload research operation tasks

   (a) Activate CGBA-5 for CSI-02 specimen conditioning

25. Perform imagery survey of station during flyaround

26. Perform payload operations to support MAUI and RAMBO (payload of opportunity-undock ops)

27. Perform spacewalk get-ahead tasks, if possible

   (a) Connect S5 to S4 umbilicals

   (b) Remove S5 to S6 RTAS LL

   (c) Open the S5 RTAS Capture Latch Assembly (CLA)

   (d) Release Node 2 EATCS Loop A and B Fluid Tray Bolts (1-6, 8,9,11 & 12)

   (e) Torque CMG FSE Shim bolts to final pre-load

   (f) Deploy S3 Upper Outboard PAS and S3 Upper Inboard PAS

   (g) Deploy P3 nadir Unpressurized Cargo Carriers Attachment System (UCCAS)

   (h) Retrieve 3/8" Drive Ratches SN 1011 & 1012 from the ETSD boxes for IVA inspection

   (i) Return General Purpose Cutter to A/L Toolbox #2 (-303 version)

   (j) Install S1-S3 Ammonia Fluid Lines

   (k) Install P1-P3 Ammonia Fluid Lines

   (l) Close P1 Radiator Beam Valve Module (RBVM) Thermal Bootie F151

28. Reboost the station with the shuttle, if mission resources allow and are consistent with ISS trajectory analysis and planning

29. Transfer oxygen from the shuttle to the station, as consumables allow

30. Perform SDTO 13005-U

   (a) Shuttle docking

   (b) Station reboost

   (c) Shuttle undocking

   (d) S5 install

MISSION PERSONNEL

KEY CONSOLE POSITIONS FOR STS-118

	Flt. Director	CAPCOM	PAO
Ascent	Steve Stich	Chris Ferguson Jim Dutton (Weather)	Rob Navias
Orbit 1 (Lead)	Matt Abbott	Steve Robinson	Rob Navias (Lead)
Orbit 2	Richard Jones Mike Sarafin	Shane Kimbrough	Kyle Herring
Planning	Mike Moses Paul Dye	Shannon Lucid	John Ira Petty
Entry	Steve Stich	Chris Ferguson Jim Dutton (Weather)	Kylie Clem
Shuttle Team 4	Rick LaBrode	N/A	N/A
ISS Orbit 1	Kwatsi Alibaruho	Tony Antonelli	N/A
ISS Orbit 2 (Lead)	Joel Montalbano	Shannon Walker	N/A
ISS Orbit 3	Ginger Kerrick	Lucia McCullough	N/A
Station Team 4	Derek Hassmann	N/A	N/A

JSC PAO Representative at KSC for Launch – Nicole Cloutier-Lemasters
KSC Launch Commentator – Mike Curie (Fueling), George Diller (Launch)
KSC Launch Director – Mike Leinbach
NASA Launch Test Director – Jeff Spaulding

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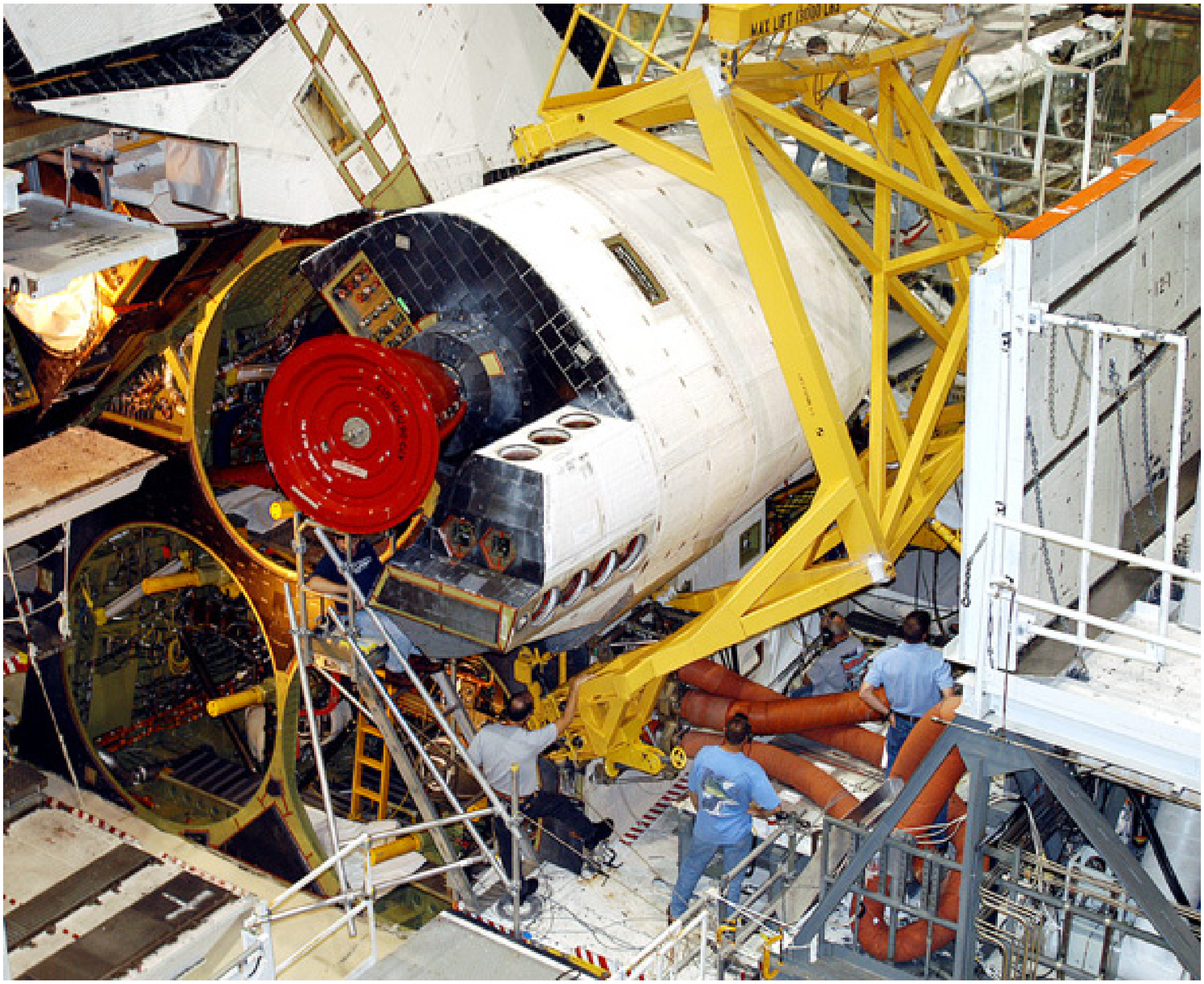
STS-118 ENDEAVOUR PROCESSING MILESTONES

Space shuttle Endeavour is moments away from touch down on runway 33 at the Shuttle Landing Facility on Dec. 7, 2002, bringing to a close the 13-day, 18-hour, 48-minute, 5.74-million mile STS-113 mission to the International Space Station.

Endeavour (OV-105) Horizontal Processing

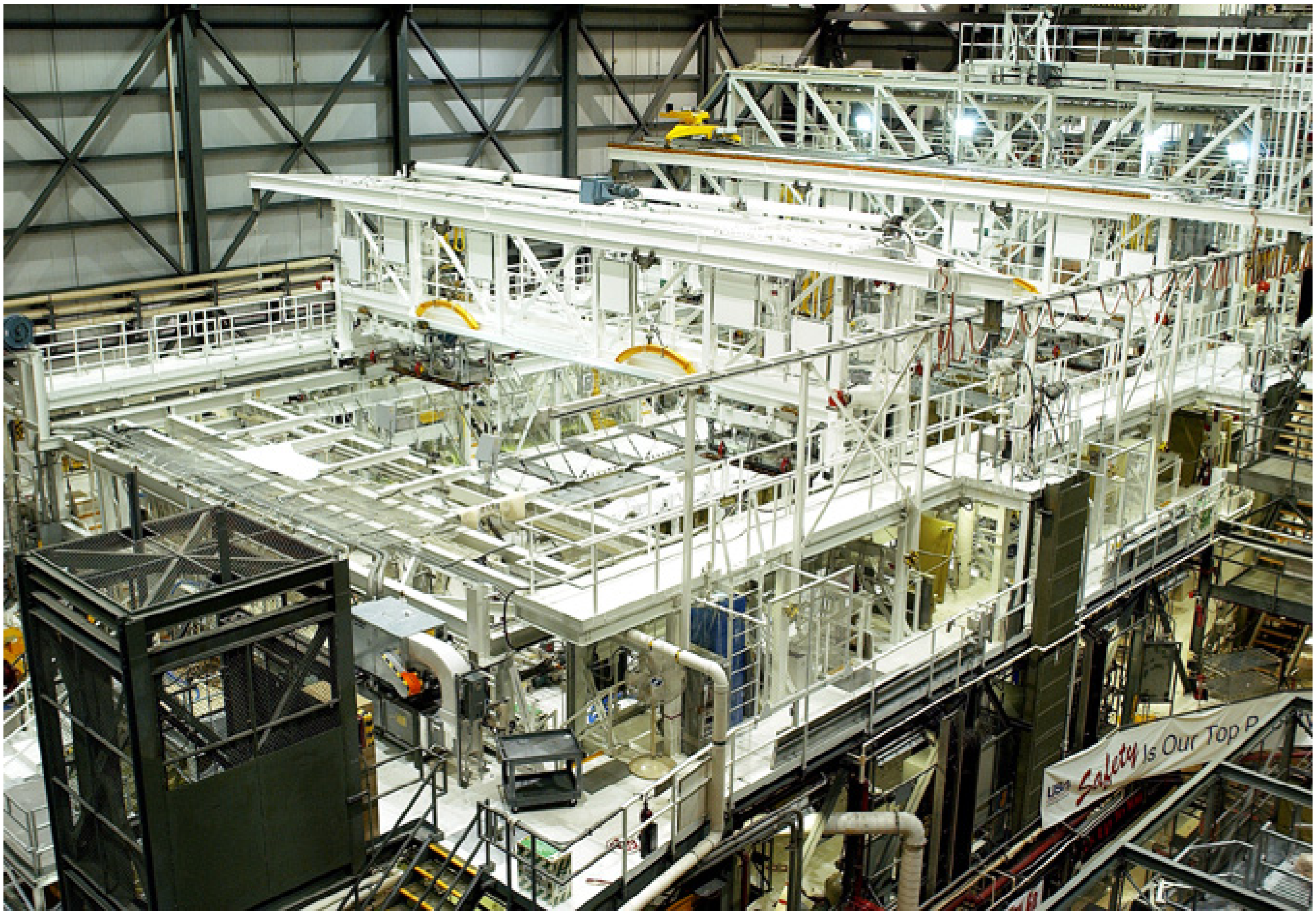
- STS-113 Landing 12/7/02
- Space Shuttle Program Approval for Orbiter Major Modification 6/16/03
- Orbiter Major Modification Start Date 12/1/03
- Orbiter Power Up 9/27/05
- Rollover to Vehicle Assembly Building 7/2/07
- Orbiter Processing Facility Processing – 1,665 days



Workers in the Orbiter Processing Facility prepare to remove one of two Orbiter Maneuvering System (OMS) pods from Endeavour during its Orbiter Major Modification. The OMS pods are attached to the upper aft fuselage left and right sides.

External Tank/Solid Rocket Booster Processing

- Solid Rocket Booster Start Stack 5/23/07
- ET/SRB Mate 6/17/07



Workstands at various levels surround the shuttle Endeavour in the Orbiter Processing Facility (OPF). The OPF provides postflight servicing and checkout, as well as vehicle modifications.

Integrated Processing

- Orbiter/ET mate 7/2/07
- Payload Delivery to Launch Pad (39A) 7/09/07
- Rollout to Launch Pad (39A) 7/11/07
- Terminal Countdown Demonstration Test 7/19/07
- STS-118 Launch 8/7/07

In Orbiter Processing Facility bay 2, United Space Alliance technician Loralee Woodbury monitors the lighted display in space shuttle Endeavour's cockpit after full power up in September 2005, the first time the orbiter had been powered up after nearly two years.

Orbiter Maintenance and Modification Period

- Modifications -194 completed
- Mission Action Requests (Chits) - 205 completed
- Operational Maintenance Requirements and Specifications (OMRS) -13156 completed to date
- Intensive Structural and Wire Inspections

STS-118 ENDEAVOUR CREW

The STS-118 patch represents Space Shuttle Endeavour on its mission to help complete the assembly of the International Space Station (ISS), and symbolizes the pursuit of knowledge through space exploration. The flight will accomplish its ISS 13A.1 assembly tasks through a series of spacewalks, robotic operations, logistics transfers, and the exchange of one of the three long-duration expedition crew members. On the patch, the top of the gold astronaut symbol overlays the starboard S-5 truss segment, highlighting its installation during the mission. The flame of knowledge represents the importance of education, and honors teachers and students everywhere. The seven white stars and the red maple leaf signify the American and Canadian crew members, respectively, flying aboard Endeavour.

These seven astronauts take a break from training to pose for the STS-118 crew portrait. Pictured from the left are astronauts Rick Mastracchio, mission specialist; Barbara R. Morgan, mission specialist; Charlie Hobaugh, pilot; Scott Kelly, commander; Tracy Caldwell, Canadian Space Agency's Dave Williams, and Alvin Drew, all mission specialists. The crewmembers are attired in training versions of their shuttle launch and entry suits.

STS-118 CREW BIOGRAPHIES

Scott Kelly

A commander in the U.S. Navy, Scott Kelly will lead the STS-118 crew on its mission to the International Space Station. This will be the second spaceflight for Kelly, who has 191 hours of spaceflight experience after serving as the pilot for STS-103 in 1999, a mission to the Hubble Space Telescope.

Kelly will be responsible for the execution of the mission and oversee all crew and vehicle activities. As commander, he will fly Endeavour during the rendezvous pitch maneuver, a flip that allows the station crew to photograph the shuttle's heat shield as Endeavour approaches the station. He also will fly the shuttle during the actual docking and the landing back on Earth.

Kelly was selected as an astronaut candidate in April 1996, and has held many technical positions in the Astronaut Office. These include serving as NASA’s director of operations in Star City, Russia, Astronaut Office Space Station Branch chief and back-up crew member for the station's Expedition 5 mission.

Charlie Hobaugh

Joining Kelly in Endeavour's cockpit will be Charlie Hobaugh, serving as the pilot. This also will be Hobaugh's second spaceflight. His first was STS-104 in 2001, during which he acquired 306 hours and 35 minutes in space. His roles throughout the STS-118 mission include undocking the shuttle from the station and operating the station's robotic arm.

A lieutenant colonel in the U.S. Marine Corps, Hobaugh has more than 3,000 flight hours in more than 40 different aircraft.

Hobaugh joined NASA in April 1996. After his initial astronaut training, he worked in the Astronaut Office Spacecraft Systems/Operations Branch, where he worked on projects including the landing and rollout evaluator in the Shuttle Avionics Integration Laboratory, Advanced Projects, Multifunction Electronics Display Enhancements, Advanced Cockpit and Cockpit Upgrade, Rendezvous and Close Proximity Operations and Visiting Vehicles. He also recently served as capsule communicator, working in the Mission Control Center.

Tracy Caldwell

Tracy Caldwell, who holds a doctorate in physical chemistry, will serve as mission specialist 1 for her first spaceflight since her selection in 1998. She will join Kelly and Hobaugh on the flight deck for the ascent, since her mission responsibilities start promptly after liftoff. She will film the jettison of the external fuel tank approximately eight minutes into the flight. Caldwell also will operate the shuttle's robotic arm to inspect Endeavour's thermal tiles and serve as the intravehicular officer during the mission's spacewalks.

Caldwell has done many other jobs in the Astronaut Office, such as conducting testing and integration of Russian hardware and software and flight software verification in the Shuttle Avionics Integration Laboratory (SAIL). She served as a crew support astronaut for the Expedition 5 crew and as a spacecraft communicator in Mission Control. She also has supported launch and landing operations at NASA's Kennedy Space Center, Fla.

Caldwell is a private pilot and conversational in American Sign Language (ASL) and Russian.

Rick Mastracchio

This will be the second trip to space for Rick Mastracchio, who will serve as mission specialist 2. He served as a mission specialist on STS-106 Atlantis in 2000, a 12-day mission to prepare the International Space Station for the arrival of the first permanent crew.

Mastracchio will be seated on the flight deck for both the launch and landing. His primary task will be to serve as EV1, or spacewalker 1, for the three spacewalks planned for the mission. He'll join fellow spacewalker Dave Williams to install a new segment on the station's truss or backbone.

Mastracchio joined NASA in 1990 as an engineer in the Flight Crew Operations Directorate and later worked as an ascent/entry guidance and procedures officer in Mission Control, supporting 17 shuttle missions as a flight controller.

Dave Williams

Dave Williams, a physician, is a veteran astronaut from the Canadian Space Agency. He joined NASA in 1995 as part of an international class of astronaut candidates and went on to serve as a mission specialist on STS-90, a 16-day flight known as Neurolab.

He also participated in two missions aboard the Aquarius Underwater Laboratory off the Florida Coast. In 2001, Williams served in NASA Extreme Environment Mission Operations (NEEMO) 1. In 2006, he led NEEMO 9, dedicated to assess new ways to deliver medical care to a remote location, as would be necessary in a long spaceflight.

For four years, Williams served as director of the Space and Life Sciences Directorate and concurrently held a six-month position as the first deputy associated administrator for crew health and safety in the Office of Space Flight at NASA Headquarters.

For STS-118, Williams will fly in the middeck, and will conduct at least two spacewalks.

Barbara R. Morgan

This will be the first spaceflight for Barbara R. Morgan, mission specialist 4. Morgan will ride in the middeck for the launch of Endeavour and be seated in the flight deck for entry and landing. As the "loadmaster," Morgan is the crew member responsible for the 5,000 pounds of supplies and equipment that will be transferred between the shuttle and the space station. She also will operate the shuttle and station robotic arms during delicate spacewalk and installation tasks.

Morgan was selected as the backup candidate for the NASA Teacher in Space Project on July 19, 1985. From September 1985 to January 1986, Morgan trained with Christa McAuliffe and the Challenger crew at NASA's Johnson Space Center, Houston. Following the Challenger accident, Morgan assumed the duties of Teacher in Space designee, speaking to educational organizations throughout the country. In the fall of 1986, Morgan returned to Idaho to resume her teaching career, but returned to NASA as a mission specialist in January 1998. She has served numerous technical jobs in the Astronaut Office.

Alvin Drew

This will be the first flight to space for Alvin Drew, who was assigned in May to this mission. Drew, who will ride in the middeck for both ascent and landing, will serve as mission specialist 5. He will assist with cargo transfer and other mission support, including documenting operations with photographs and video.

He was selected as a mission specialist by NASA in 2000 and supported technical duties in the Astronaut Office Station Operations Branch. Drew is also a colonel in the U.S. Air Force and flew combat missions in operations Just Cause, Desert Shield/Desert Storm, and Provide Comfort. He has commanded two flight test units and served on Air Combat Command Staff. He is a command pilot with 3,000 hours in more than 30 types of aircraft.

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PAYLOAD OVERVIEW

The S5 short spacer is shown in the Space Station Processing Facility at Kennedy Space Center.

STARBOARD 5 (S5) SHORT SPACER

During STS-118, space shuttle Endeavour will deliver as its primary payload the Boeing-built square-shaped Starboard 5 segment to the right side of the International Space Station's backbone. The shuttle's cargo also includes more than 740 either Boeing-built and/or Boeing-designed flight hardware components to the station. S5 is part of the 11-segment integrated truss structure (ITS) and the third starboard truss element to be delivered. Without S5, one quarter of the space station’s power cannot be realized. The ITS forms the station's backbone with mountings for unpressurized logistics carriers, radiators, solar arrays and various other elements. S5 will be attached to the Starboard 4 (S4) truss element via the Modified Rocketdyne

Truss Attachment System (MRTAS) interface. S5 is used primarily to connect power, cooling lines and serve as a spacer between the S4 photovoltaic module (PVM) and Starboard 6 (S6) PVM, which will be joined during a later assembly mission. S5 is very similar in construction to the long spacer located on S6. Without the S5 short spacer, the S4 and S6 solar arrays would not be able to connect due to the way the photovoltaic arrays (PVA) are deployed on-orbit.

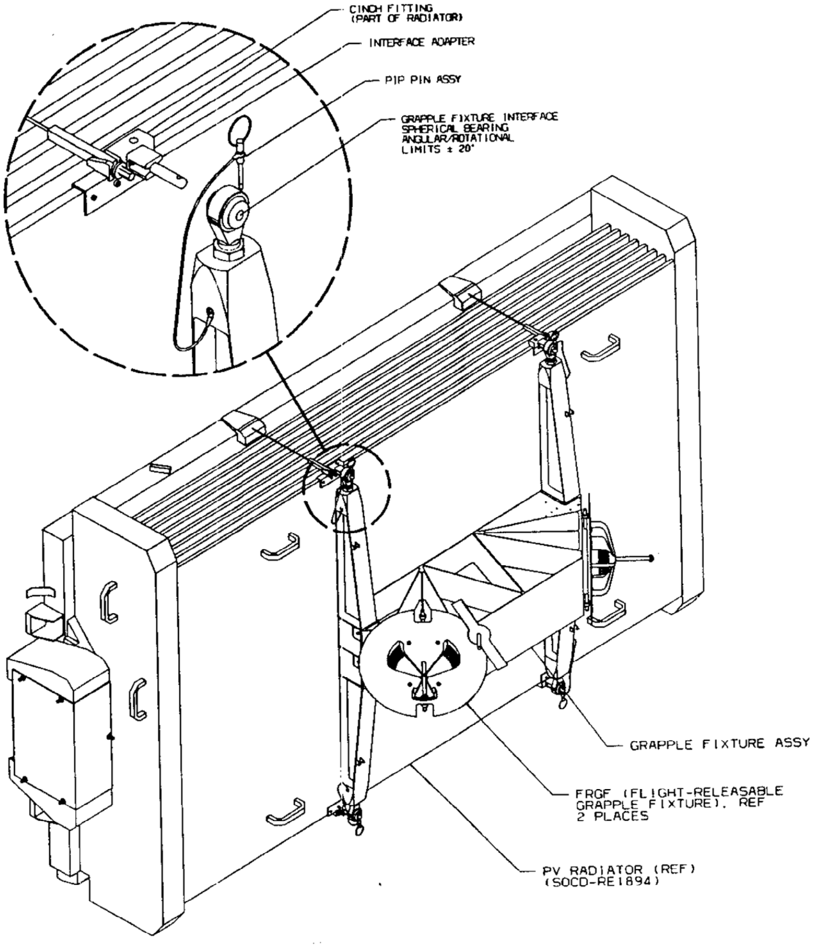
The girder-like structure is made of mostly aluminum and provides several extravehicular aids, robotic interfaces, ammonia servicing hardware (as part of the Station's External Active Thermal Control System that allows ammonia fluid to transfer from S4 to S6) and can also accommodate an external storage platform. The Enhanced Universal Trunnion Attachment System (EUTAS) allows platforms to be attached to S5 for the storage of additional science payloads or spare Orbital Replacement Units. S5 also has white thermal blankets on the structure, which help shade the S4 Solar Array Assembly ORUs.

S5 Specifications	
Dimensions:	**Length** is 132.813 inches or 11 feet and 0.813 inches (3.37 meters) **Width** is 179.014 inches or 14 feet, 11 inches (4.55 meters) **Height** is 167.031 inches or 13 feet and 11 inches (4.24 meters)
Weight:	4,010 lbs
Cost:	$10,971,693

S5 is transferred using the shuttle arm from the payload bay to the Space Station Robotic Manipulator System (SSRMS) where it will be placed into the install or soft-dock position. While being moved on the SSRMS, S5 will have about two inches of clearance as it passes the S4 Sequential Shunt Unit (SSU). The truss element is installed robotically with help from crew members. During the first spacewalk, astronauts will use the MRTAS to connect S5 to S4 by using their portable hand tools to drive in four 3/4 inch diameter primary bolts in each corner. If a primary bolt cannot be secured, two contingency bolts at each corner on S5 can be tightened into the nut assemblies on S4.

Another unique feature of S5 is the Photovoltaic Radiator Grapple Feature (PVRGF). For launch, the PVRGF is stowed on top (zenith) of S5 and is used by the shuttle and station robotic arms to grab S5 and pull it out and attach it. After S5 is attached to S4, the PVRGF will be relocated to the keel during the first spacewalk by using four fasteners. The PVRGF also is used to grapple the station's photovoltaic radiators (PVR) located on P3/P4, S3/S4, P6 and S6. The PVRGF can be used to replace a PVR, should they malfunction or become damaged from debris while on orbit.

Boeing's Rocketdyne Power and Propulsion (now Pratt and Whitney) designed S5. S5 was constructed in Tulsa, Okla., in 2000. S5 arrived at Kennedy Space Center July 19, 2001, for final manufacture, acceptance and checkout. Boeing will continue to provide sustaining engineering of S5 and for the entire 310-foot integrated truss assembly.



Drawing shows the Photovoltaic Radiator Grapple Feature (PVRGF) attached to a folded photovoltaic radiator (PVR)

EXTERNAL STOWAGE PLATFORM-3

For the first time ever, space shuttle astronauts will not have to conduct a spacewalk to install a vital piece of equipment onto the International Space Station (ISS). The effort to install a stowage platform equipped with crucial Boeing-built spare parts during the STS-118 mission will be done completely by robotics, using only the shuttle and station's robotic arms, an External Berthing Camera System (BCS) and a Photovoltaic Radiator Grapple Fixture (PVRGF). Astronauts will robotically install the platform onto the station's Port 3 truss element during the mission's seventh day.

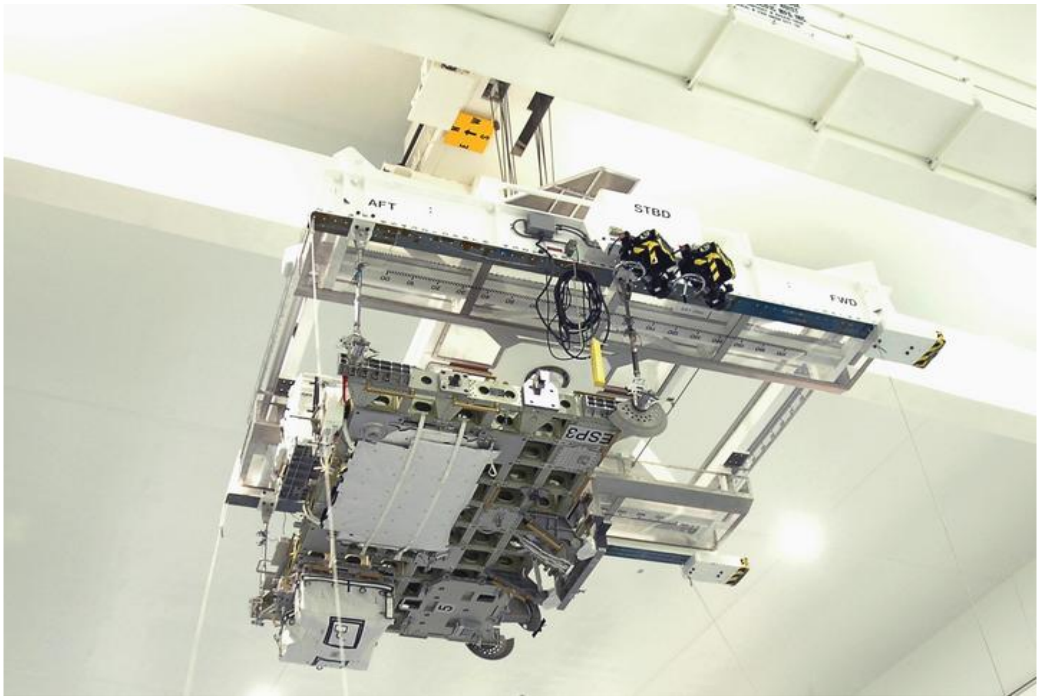
ESP-3 is an external pallet that can securely hold up to seven critical spare parts, or Orbital Replacement Units (ORUs), for the station. ESP-3 is the third in a series of external storage pallets transported to the station and will be attached to the Port 3 truss element. ESP-1 was installed to the station's U.S. Destiny Lab on STS-102/ 5A.1 in March 2001. ESP-2 was installed to the U.S. Airlock on STS-114//LF1 in August 2005.

The Boeing parts flown on the ESP-3 include a Control Moment Gyroscope (CMG) for station attitude control, a Nitrogen Tank Assembly (NTA) for pressurizing external thermal control system ammonia lines and Battery Charge/Discharge Unit (BCDU) for charging station batteries.

ESP-3 has six Flight Releasable Attachment Mechanisms (FRAM) to secure or release the ORUs and other equipment stored on it and an Ammonia Tank Assembly (ATA) Flight Support Equipment (FSE) directly mounted to a seventh site. Like ESP-2, the platform is derived from an Integrated Cargo Carrier (ICC), an equipment carrier designed for use in the shuttle's payload, and adapted for deployment on the station by developing a device to attach it to ISS structure.

Electrical power for the ESP-3 pallet and its contents is provided by the shuttle while in the payload bay and by the station after installation on P3. Most of the ORUs have heaters to keep their internal components from getting too cold while stored on the ESP-3, although only the CMG ORU is expected to draw heater power due to its +35 degrees Fahrenheit thermostat setting. The CMG ORU is removed from the ESP-3 by the EVA crew (with robotic assist) on flight day 6 and transferred to the ESP-2 on the Joint Airlock as part of the CMG-3 removal and replacement activity. The shuttle power cables are disconnected from the ESP-2 just prior to CMG removal.

With the berthing camera and grapple fixture as aides, the ESP-3 installation process involves Endeavour astronauts removing the platform from the shuttle payload bay on flight day 7 with its robotic arm and handing it off to the station’s robotic arm. The station’s robotic arm will then mount ESP-3 directly to the Port 3 truss element. Primary power for ESP-3 comes from the station through the Port 3 truss segment.



The External Stowage Platform-3 (ESP-3) is the first International Space Station element that will be will be installed completely by robotics.

ESP-3 launches with the following ORUs:

- Battery Charge/Discharge Unit (BCDU) – The BCDU charges batteries and provides conditioned battery power to power buses during eclipse periods.

- Control Moment Gyroscope (CMG) – The CMG maintains the station in the desired attitude, and the CMG system must cancel or absorb the momentum generated by the disturbance torques acting on the station.

- Nitrogen Tank Assembly (NTA) – The NTA is an ORU for one of two installed NTAs on the S1 and P1 Truss that provide a back pressure for ammonia in the external thermal control system lines.

- Pitch Roll Joint (P/R-J) – The P/R-J is an ORU provided by the Canadian Space Agency for the CanadaARM 2, or Space Station Remote Manipulator System (SSRMS).

ESP-3 Statistics:

Project Integrator: Lockheed Martin

Major Contractors:

ICC – SPACEHAB Inc.

Power Cables – Boeing

ORUs – Boeing, Honeywell, Lockheed Sunnyvale, and Loral

ORU FSE – Lockheed

Purpose: ESP-3 is an unpressurized external storage pallet with eight attachment sites capable of holding up to seven ISS spare parts and assemblies. The pallet also has handrails and attachment points for tethers and foot restraints that astronauts can use while working with the ORUs on the ESP-3.

Weight: Empty structure weighs about 6,937.44 pounds. (2901.7 kg). At launch with ORUs and other equipment, ESP-3 will weigh about 7,495.46 pounds (3399.7 kg).

Dimensions: 4 meters by 2.2 meters

Structure: An Integrated Cargo Carrier (ICC) is the basic structure of ESP-3 with six FRAM sites attached and one direct mount ATA FSE. The Passive Carrier Attachment System (PCAS) structure, developed by NASA's Goddard Space Flight Center, connects the ESP-3 to the P3 CAS. Each ORU has an active FRAM to attach the ORU/Flight Support Equipment to the passive FRAM site mounted on the ESP-3.

Construction: Integration of the ORUs with their Flight Support Equipment onto the ICC was performed by SPACEHAB, Inc. at Cape Canaveral, Fla. Once the ORUs were integrated onto the ESP-3 by SPACEHAB, the entire assembly was transferred to Kennedy Space Center's Space Station Processing Facility for final processing.

SPACEHAB'S LOGISTICS SINGLE MODULE

The Logistics Single Module (LSM) is a pressurized aluminum habitat that is carried in the space shuttle's cargo bay to enhance the onboard working and living environment for the crew. Connected to the shuttle's middeck by a pressurized access tunnel, the LSM is about 10 feet long, 14 feet wide and 11 feet high. This combination pressurized cargo carrier/research laboratory offers 1,100 cubic feet of habitable volume. The LSM can accommodate up to 118 middeck locker equivalent volumes on the module bulkheads, the double rack and the Maximum Envelope Stowage System (MESS) rack. The MESS rack also has the capability to accommodate oversized items. With a payload capacity of 6,000 pounds, the LSM will carry a multitude of pressurized cargo and research payloads on the STS-118 mission. Payloads that SPACEHAB will be integrating onto the LSM include cargo transfer bags, which carry essential crew provisions including food, personal items and clothing, hardware required for operating the spade station and research payloads.

Upon its return home, the LSM will bring back about 3,000 pounds of cargo including a high priority Department of Defense payload known as the "MISSE PEC." This suitcase-sized test bed was attached to the outside of the space station in July 2006 and contained about 875 specimens of various materials, representing 40 different investigators including government researchers, aerospace contractors and manufacturers. The containers exposed hundreds of potential space construction materials and solar cells to the harsh environment of space. When Endeavour returns to Earth, the equipment will undergo analysis, providing investigators with data to design more durable spacecraft.

SPACEHAB Bioscience Payload

During the STS-118 mission, SPACEHAB will be facilitating Pre-Processing Tests (PPTs) on two significant bioscience payloads stowed in a space shuttle middeck locker. The PPTs are expected to validate microgravity bioscience techniques, establishing the groundwork for the company's future role for the processing of pharmaceutical and advanced materials in microgravity.

In the Space Station Processing Facility, workers prepare the Spacehab module for its move to the payload canister. The module is part of the payload on mission STS-118 and will be loaded into Space Shuttle Endeavour's payload bay at the pad.

MOTION CONTROL SUBSYSTEM

The International Space Station (ISS) control system is composed of Russian and U.S. segments that maintain attitude control. When the Russian segment is in control, it uses thrusters, which burn propellant. When the U.S. segment is in control, Control Moment Gyroscopes (CMGs), manufactured by L3 Communications, are used. Four CMGs are mounted on the Z1 truss. The truss is an exterior framework that houses the gyroscopes and some communications equipment and temporarily serves as a mounting platform for large solar arrays, now retracted, that provided power to the station before permanent solar arrays were installed on the main US power truss. A shuttle crew installed the Z1 truss with the four gyroscopes in October 2000.

To maintain the station in the desired attitude, the CMG system must cancel or absorb the momentum generated by the disturbance torques acting on the station. The CMGs rely on electrical power readily available from the solar powered electrical subsystem.

Each CMG weighs approximately 600 pounds. A CMG consists of a large flat 220-pound stainless steel flywheel that rotates at a constant speed (6,600 rpm) and develops an angular momentum of 3,600 ft-lb-sec (4,880 Newton-meter-sec) about its spin axis. This rotating wheel is mounted in a two-degree-of-freedom gimbal system that can point the spin axis (momentum vector) of the wheel in any direction. Control motors on the CMG gimbals change the orientation of the spinning rotors to produce torque on the station to balance the effects of gravity and aerodynamics, maintaining the station at an equilibrium attitude without using propellant.

At least two CMGs are needed to provide attitude control and are the minimum necessary to steer and steady the station as it travels around the Earth every 90 minutes at a speed of more than five miles each second.

The International Space Station currently has three CMGs operating normally, and one that has been shut down due to high vibrations. This CMG is scheduled to be replaced on STS-118.

CMG Statistics:

Primary integrator: Boeing

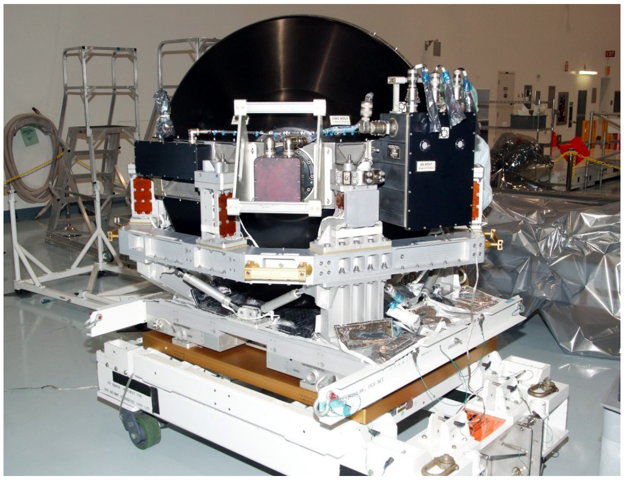
Manufacturer: L3 Communications, Space and Navigation Division, Budd Lake, N.J.

Weight: 600 pounds

Purpose: Control the attitude of the International Space Station without use of propellant

Structure: Each CMG contains a 220-pound stainless steel flywheel that spins at 6,600 rpm.

Removal and Installation: Only six bolts and four power connectors need to be detached to remove the Control Moment Gyroscope from the station's Z1 Truss.



Control Moment Gyroscope

STATION-TO-SHUTTLE POWER TRANSFER SYSTEM (SSPTS)

After an unprecedented series of three station spacewalks in February, the Station-to-Shuttle Power Transfer System (SSPTS) onboard the space station is complete and will allow the station to supplement the shuttles with electrical power. Shuttle modifications were completed in May 2007, and the new capability will enable the shuttle to stay on-orbit longer, provide additional crew time for science activities and Extra Vehicular Activities (EVA), and permit additional cargo to be unloaded by astronauts.

The space shuttle Discovery was the last of the three shuttles to be upgraded, and the new system will be utilized during shuttle Endeavour's STS-118 mission. Endeavour was the first of the shuttles to be upgraded.

The SSPTS project is unique because it’s the first major development project that the Boeing International Space Station and NASA's Space Shuttle programs have worked on together. The Boeing ISS Program is providing the funding under its existing contract.

The upgrade will allow the space shuttle’s electrical power system to connect into the station’s solar arrays to transfer power from the station to the shuttle, resulting in a lower consumption rate of liquid hydrogen and oxygen used for making electricity by the shuttle’s fuel cells. The SSPTS upgrade also will allow the shuttle to increase its time docked to the station from 6-8 to 9-12 days depending on the mission configuration.

The increased docking time will provide the station and visiting crew members with more time for logistics supply transfer, additional experiments and detailed shuttle inspections.

Before the modifications, the space shuttle fleet only had the capability to transfer power from its 28-volt dc system to the station's 120-volt dc system through a device called the Assembly Power Converter Unit (APCU). The fleet, however, could not transfer power from the station to the shuttle. The SSPTS upgrade will replace the APCU with a device called the Power Transfer Unit (PTU). The PTU includes the capabilities of the APCU with the additional capability to convert from the station's 120-volt system to the shuttle’s 28-volt system. With this upgrade, the station is now able to transfer up to eight kilowatts of power to the shuttle in a package that fits into the same footprint as the existing APCU.

In addition to the PTU, new power cables and displays were integrated into space shuttle Endeavour and Discovery. The additional station cables are routed along the outside of the Boeing-built U.S. Destiny lab. The power passes along the Pressurized Mating Adapter 2, where the shuttle docks to the station through the existing electrical ports used by the APCU.

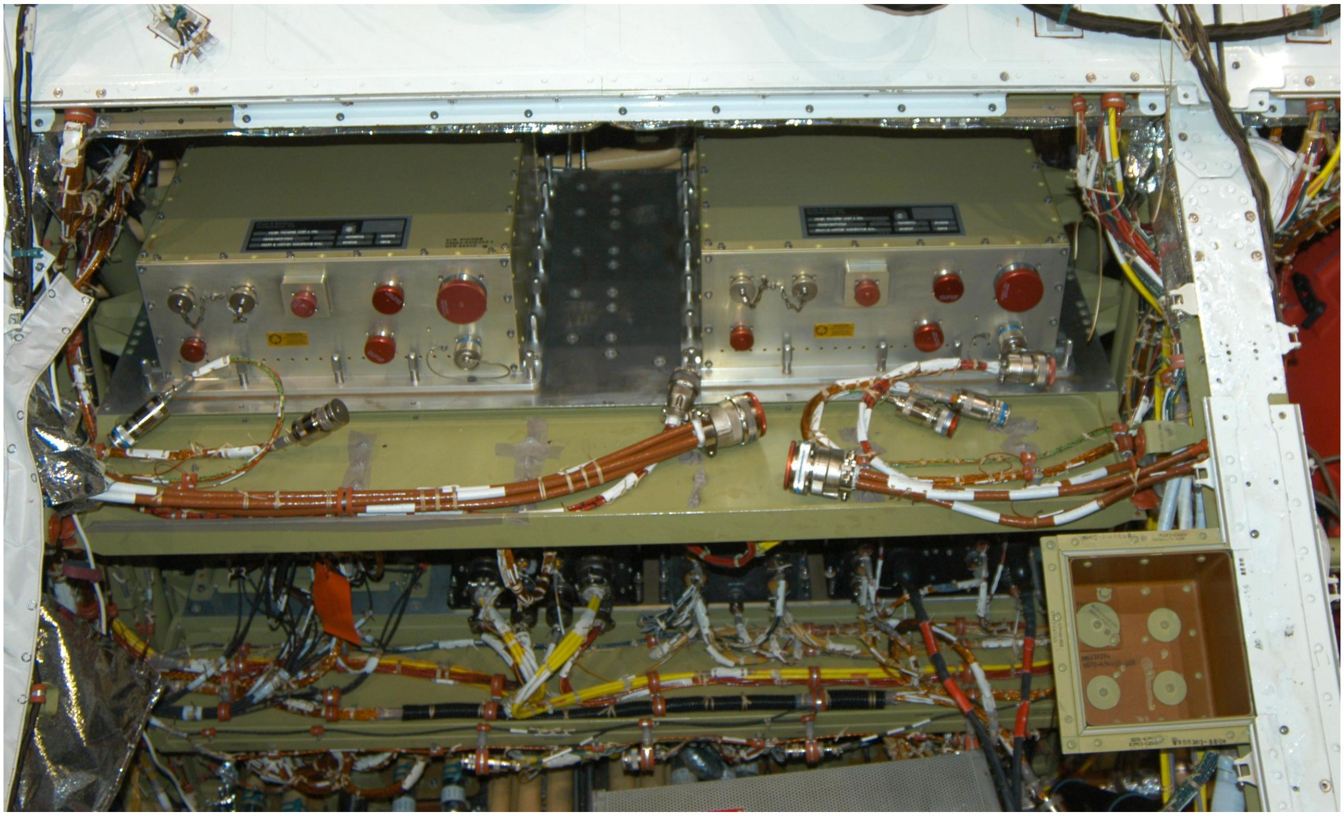
Timeline:

- Engineering Model (EM) testing of the PTUs and system level testing using the EM PTUs were completed during the summer and fall of 2006.
- Installation of the orbiter cables was completed in Endeavour (OV-105) at Kennedy Space Center in the summer 2006.
- The station cables were launched to the ISS on STS-116 in December 2006.
- Qualification of the flight PTU design was completed on Jan. 31, 2007.

- A portion of the station cables was installed during ISS stage EVA 6 on Jan. 31, 2007
- Delivery of the first flight PTU occurred on Feb. 5, 2007, in preparation for launch on ISS assembly flight 13A.1, scheduled for flight on STS-118 aboard Endeavour.
- The remaining station cables were installed Feb. 7, 2007, during EVA 8.
- The cables for Discovery (OV-103) were completed and installed in May 2007.

The space shuttle is still able to supply 120-volt power through the APCU converter in the PTU to power the Multi-Purpose Logistics Module when in the shuttle's cargo bay and provide heater power to pressurized modules being delivered to the station.

Boeing began work on the project in September 2003, but had a slight head start due to some internal development work that was done at the Huntington Beach and Canoga Park, Calif., facilities. Pratt and Whiney Rocketdyne Propulsion and Power (Canoga Park) manufactured the PTU, while the Boeing Houston Product Support Center manufactured the cables for the station. Boeing Huntington Beach has developed the shuttle upgrades, such as the new cables for each shuttle, cockpit control switches and crew displays.



Power Transfer Unit (PTU) Flight Unit #1

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RENDEZVOUS AND DOCKING

A view photographed from the International Space Station shows the Space Shuttle Atlantis backdropped over terrain as the two spacecraft were nearing their much-anticipated link-up in Earth orbit.

About 2.5 hours before docking, Endeavour's jets will be fired during what is called the Terminal Initiation burn to begin the final phase of the rendezvous. Endeavour will close the final miles to the station during the next orbit.

As Endeavour moves closer to the station, the shuttle's rendezvous radar system and trajectory control sensor will track the complex and provide range and closing rate data to the crew. During the final approach, Endeavour will execute several small mid-course correction burns that will place the shuttle about 1,000 feet directly below the station. STS-118 Commander Scott Kelly then will manually control the shuttle for the remainder of the approach and docking.

He will stop the approach 600 feet beneath the station to ensure proper lighting for imagery prior to initiating the standard Rendezvous Pitch Maneuver (RPM), or backflip.

Kelly will maneuver Endeavour through a 9-minute, 360-degree backflip that allows the station crew to take as many as 300 digital pictures of the shuttle's heat shield.

On verbal cue from Pilot Charles Hobaugh to the station crew, Kelly will command Endeavour to begin a nose-forward, three-quarter of a degree per second rotational backflip.

Both the 400 and the 800mm digital camera lenses will be used to photograph Endeavour by station crew members. The 400mm lens provides up to 3-inch resolution and the 800mm lens can provide up to 1-inch resolution. The imagery includes the upper surfaces of the shuttle as well as Endeavour's underside, capturing pictures of the nose landing gear door seals, the main landing gear door seals and the elevon cove.

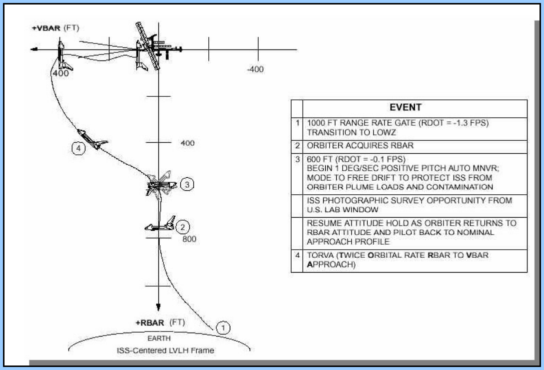
The photos will be taken out of windows in the Zvezda Service Module using Kodak DCS 760 digital cameras. The imagery is one of several inspection techniques to determine the health of the shuttle's thermal protection system, including the tiles and reinforced carbon-carbon wing leading edges and nose cap.

The photos will be downlinked through the station's Ku-band communications system for analysis by systems engineers and mission managers.

When Endeavour completes its rotation, its payload bay will be facing the station.

Kelly then will move Endeavour to a position about 400 feet directly in front of the station in preparation for the final approach to docking to the Destiny docking port.

Rendezvous Approach Profile



	EVENT
1	1000 FT RANGE RATE GATE (RDOT = -1.3 FPS) TRANSITION TO LOWZ
2	ORBITER ACQUIRES RBAR
3	600 FT (RDOT = -0.1 FPS) BEGIN 1 DEG/SEC POSITIVE PITCH AUTO MNVR; MODE TO FREE DRIFT TO PROTECT ISS FROM ORBITER PLUME LOADS AND CONTAMINATION
	ISS PHOTOGRAPHIC SURVEY OPPORTUNITY FROM U.S. LAB WINDOW
	RESUME ATTITUDE HOLD AS ORBITER RETURNS TO RBAR ATTITUDE AND PILOT BACK TO NOMINAL APPROACH PROFILE
4	TORVA (**T**WICE **O**RBITAL RATE **R**BAR TO **V**BAR **A**PPROACH)

Space Shuttle Rendezvous Maneuvers

OMS-1 (Orbit insertion) - Rarely used ascent 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.

The shuttle's crew members operate laptop computers processing the navigational data, the laser range systems and Endeavour's docking mechanism.

Using a view from a camera mounted in the center of the Orbiter Docking System, Kelly will precisely match up the docking ports of the two spacecraft. If necessary, he will temporarily pause 30 feet from the station to ensure proper alignment of the docking mechanisms.

For Endeavour's docking, Kelly will maintain the shuttle's speed relative to the station at about one-tenth of a foot per second (while both Endeavour and the station are traveling at about 17,500 mph), and keep the docking mechanisms aligned to within a tolerance of three inches. When Endeavour makes contact with the station, preliminary latches will automatically attach the two spacecraft. Immediately after Endeavour docks, the shuttle's steering jets will be deactivated to reduce the forces acting at the docking interface. Shock absorber springs in the docking mechanism will dampen any relative motion between the shuttle and the station.

Once the motion between the spacecraft has been stopped, the docking ring will be retracted to close a final set of latches between the two vehicles.

ISS015E11712

Backdropped by rugged Earth terrain, the Space Shuttle Atlantis approaches the International Space Station during STS-117 rendezvous and docking operations.

UNDOCKING, SEPARATION AND DEPARTURE

At undocking time, the hooks and latches will be opened, and springs will push the shuttle away from the station. Endeavour's steering jets will be shut off to avoid any inadvertent firings during the initial separation.

Once Endeavour is about two feet from the station and the docking devices are clear of one another, Hobaugh will turn the steering jets back on and will manually control Endeavour within a tight corridor as the shuttle separates from the station.

Endeavour will move to a distance of about 450 feet, where Hobaugh will begin to fly around the station in its new configuration. This maneuver will occur only if propellant margins and mission timeline activities permit.

Once Endeavour completes 1.5 revolutions of the complex, Hobaugh will fire Endeavour's jets to leave the area. The shuttle will move about 46 miles from the station and remain there while ground teams analyze data from the late inspection of the shuttle's heat shield. The distance is close enough to allow the shuttle to return to the station in the unlikely event that the heat shield is damaged, preventing the shuttle's re-entry.

S117E08011

Backdropped by the blackness of space and Earth's horizon, the International Space Station moves away from the Space Shuttle Atlantis. Earlier the STS-117 and Expedition 15 crews concluded about eight days of cooperative work onboard the shuttle and station.

This image depicts the configuration of the International Space Station after the shuttle undocks from the orbital outpost during the STS-118 mission.

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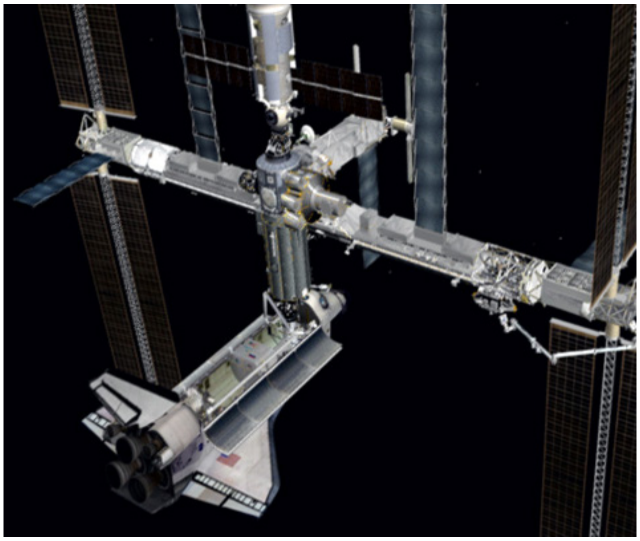
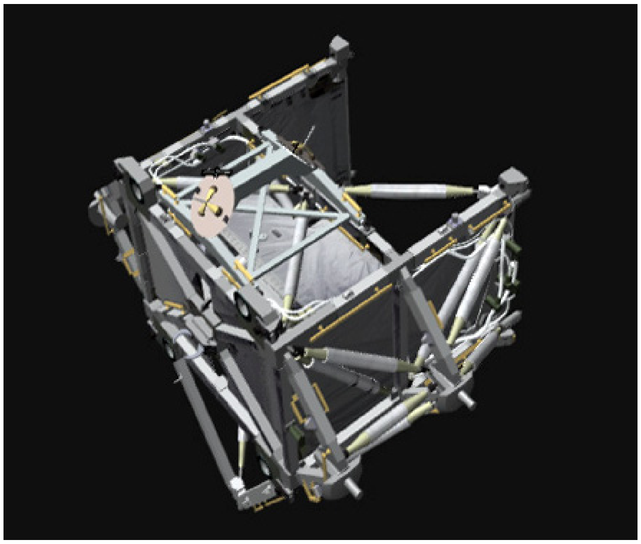
SPACEWALKS

The primary focus for STS-118's spacewalks, or extravehicular activities (EVAs), is to install the Starboard 5 (S5) short spacer truss segment to the right side of the integrated truss system and remove and replace control moment gyroscope-3, which failed last year.



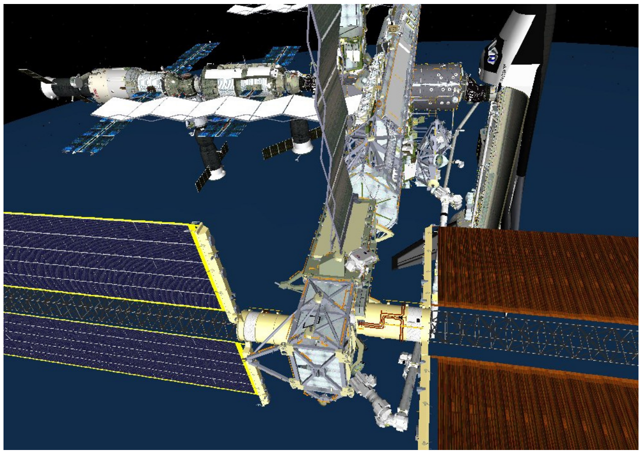
This computer graphic depicts how the S5 truss will be grappled by the station's robotic arm and installed to the integrated truss system.

The installation of S5 is similar to that of the STS-116 mission, where its sister Port 5 (P5) segment was installed. The square-shaped S5 truss is about the length of a small compact car and weighs 4,010 pounds. It will provide structural shaping, utility connections and sufficient span for adequate clearance between the Starboard 4 (S4) and Starboard 6 (S6) solar arrays as they track the sun.



The square-shaped S5 truss is about the length of a small compact car and weighs 4,010 pounds.

When the station's truss system is complete, there will be 11 integrated segments that stretch 356 feet. The truss will support four virtually identical solar array assemblies that generate electrical power and hold radiators to cool the station.



The S5 truss, shown installed, in the lower foreground.

The mission's three planned spacewalks also include some assembly and maintenance tasks in preparation for the relocation of the Port 6 (P6) truss planned for the STS-120 mission. Those tasks include relocating two crew and equipment translation aid (CETA) carts, moving the P6 S-band antennae, installing the Port 1 (P1) baseband signal processor and transponder and retrieving the P6 transponder.

The spacewalks, each estimated to last 6.5 hours, are planned on flight days 4, 6 and 8. However, mission managers could add three more days to the 11-day mission and add another spacewalk after the Station-to-Shuttle Power Transfer System (SSPTS) is activated and checked out.

First-time spacewalkers Rick Mastracchio and Dave Williams will do the first two EVAs. Mastracchio and Expedition 15 Flight Engineer Clayton Anderson will do the third. If the mission is extended, Williams and Anderson will perform the fourth spacewalk. Mission Specialist Tracy Caldwell will be the intravehicular lead for the spacewalks, assisting the spacewalkers from inside the spacecraft with their tasks. Pilot Charlie Hobaugh will operate the station robotic arm and Mission Specialist Barbara R. Morgan will operate the shuttle robotic arm.

Astronaut Richard A. (Rick) Mastracchio, STS-118 mission specialist, attired in a training version of his Extravehicular Mobility Unit (EMU) spacesuit, awaits a training session in the waters of the Neutral Buoyancy Laboratory (NBL) near Johnson Space Center.

Canadian Space Agency astronaut Dave Williams prepares for a training session in the Neutral Buoyancy Laboratory.

The spacewalkers will be identifiable by various markings on their spacesuits. Mastracchio will wear one with solid red stripes, while Williams' suit will be solid white. Anderson will wear a suit with red, broken stripes.

The spacewalks will start from the station's Quest airlock. As in recent missions, the astronauts will prepare for the EVA by using the "campout" prebreathe protocol, spending the night before the spacewalk in the airlock. The prebreathe exercise purges nitrogen from the astronauts' systems so they avoid the condition known as the bends.

Astronaut Clayton C. Anderson, Expedition 15 NASA space station science officer and flight engineer, gets help with the donning of a training version of his EMU spacesuit prior to being submerged in the NBL.

During the campout, the crew members isolate themselves in the airlock. The airlock's air pressure is lowered to 10.2 psi, while the station is kept at 14.7 psi, or near sea-level pressure. Upon rising, the astronauts don oxygen masks and the airlock's pressure is raised again to 14.7 psi for an hour. After breakfast, the pressure is lowered back to 10.2 psi for an additional hour as the spacewalk suits are donned. An additional 30 minutes in the suits completes the protocol. As a result, the crew can get outside earlier to perform the day's tasks.

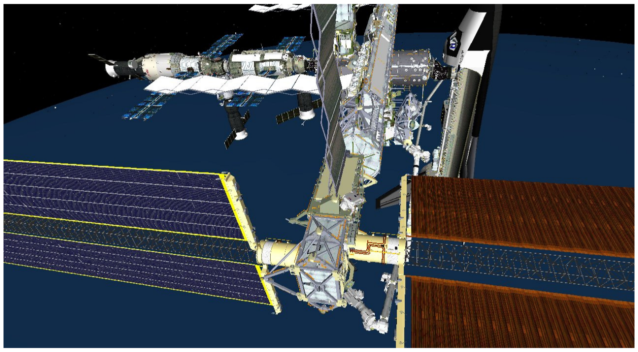
EVA 1

- **EV1:** Mastracchio
- **EV2:** Williams
- **Duration:** 6:30
- **EVA Operations:**
  - Egress/Set-up (00:50)
  - S5 Launch Lock Removal (00:35)
  - S5 Installation (01:30)
  - PVRGF Transfer to Keel (01:00)
  - Get-aheads (00:15)
  - S5 Cleanup (0:35)
  - P6 PVR Cinch (01:10)
  - Clean-up/Ingress (00:35)

The most important objective during EVA 1 is to install the S5 truss. One of the challenges that Hobaugh will face is sliding the S5 spacer into its position using the station's robotic arm, known as the Space Station Remote Manipulator System. In a move similar to parallel parking in a snug space, the spacer will come as close as 2.7 inches to the S4 truss. The two spacewalkers will monitor structural clearances for the maneuver.

Once the S5 is in position, Mastracchio and Williams will remove the locks that secured it and S4 during launch. The truss will be brought into "soft" capture position so that the crew can fasten the primary structural bolts.

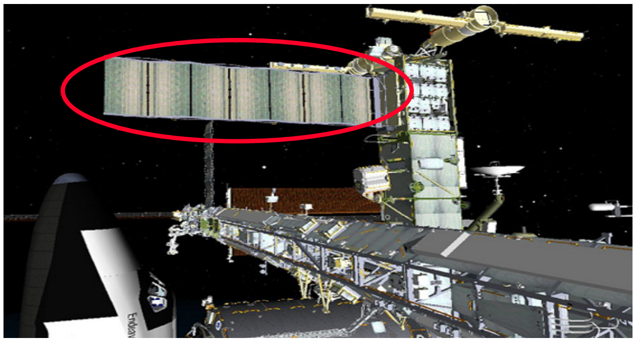
With the S5 secured, the two spacewalkers will move the Photovoltaic Radiator Grapple Fixture (PVRGF) from its launch location on top of S5 to the keel of the truss. The PVRGF is a handle that was used by the shuttle and station arms to move the truss. It is being relocated to provide enough clearance for the solar arrays to rotate and track the sun.



S5 installation on S4

If time permits, the crew will prepare the S5 for the future attachment of the S6 truss segment, connect six utility cables between S5 and S4, remove the S5 and S6 launch locks and open the S5 capture latch assembly.

Next, the two also will monitor the retraction and cinching of the P6 photovoltaic radiator, readying it for the next shuttle mission. The retraction will provide clearance for the robotic arm that will be used when the S-band antenna sub-assembly (SASA) is moved during the third spacewalk.



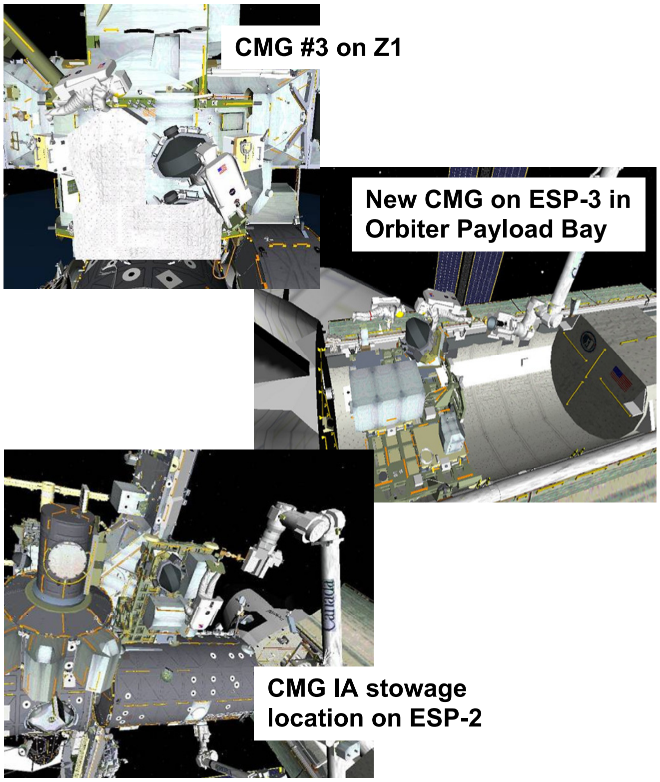
P6 Fwd PVR

EVA 2

- **EV1:** Mastracchio
- **EV2:** Williams
- **Duration:** 6:30
- **EVA Operations:**
  - Egress/Set-up (00:50)
  - Remove Failed CMG (00:30)
  - Transfer New CMG to ESP-2 (01:30)
  - Remove New CMG from FSE on ESP-2 (00:50)
  - Install New CMG on Z1 (00:55)
  - Install Failed CMG into FSE on ESP-2 (01:10)
  - Cleanup/Ingress (0:45)

During the second spacewalk, Mastracchio and Williams will remove and replace a failed control moment gyroscope. The station’s four CMGs provide primary attitude control for the station. CMG-3 suffered a mechanical failure in October 2006. The remaining gyroscopes have been providing attitude control since then, but all four CMGs will be needed as the station's integrated truss continues to expand.

During the spacewalk, Mastracchio and Williams will remove the failed CMG from the Zenith 1 (Z1) truss and temporarily stow it on the truss. Then, the crew will move to the shuttle’s payload bay and remove the new CMG from where it is stowed on external stowage platform-3 (ESP-3). The station’s robotic arm will be used to transfer the CMG to ESP-2, located on the starboard side of the Quest Airlock, to prepare it for installation on the Z1 truss.



Once the new CMG is installed, the failed CMG will be moved from the truss to ESP-2. The CMG will be returned to Earth on a later mission. External stowage platforms are designed to hold Orbital Replacement Units, or ORUs, such as the CMGs.

The two spacewalkers also will install the Z1 shroud, an embossed silver Teflon blanket that is used to protect the CMG from heat.

EVA 3

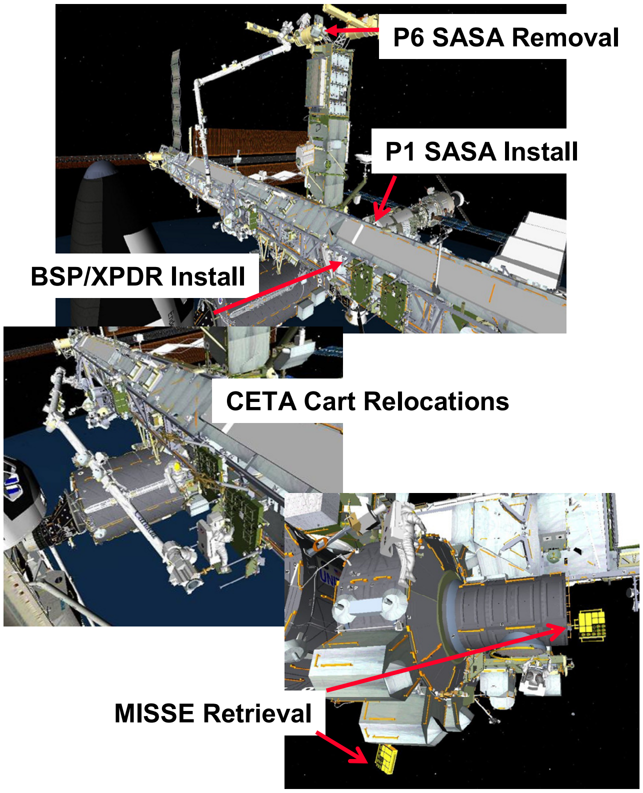
- **EV1:** Mastracchio
- **EV3:** Anderson
- **Duration:** 6:30
- **EVA Operations:**
  - Egress/Set-up (01:00)
  - EV1: SASA Relocation (01:55)
  - EV3: P1 BSP and XPDR Install (01:55)
  - CETA Cart Relocation (02:00)
  - EV1: Z1 SASA Gimbal Bolts (00:30) MISSE 3/4 Retrieval (00:30)
  - EV3: P6 Transponder Retrieval (01:00)
  - Clean-up/Ingress (00:35)

The primary purpose of the third spacewalk is to prepare for the relocation of the P6 truss, planned for the STS-120 mission, targeted for October.

One of the primary tasks is to relocate two crew and equipment translation aid (CETA) carts from the port side of the station’s Mobile Transporter to its starboard side. This will allow the Mobile Transporter to move to the proper worksite when the P6 truss is relocated.

During the spacewalk, Mastracchio and Anderson also will upgrade the port S-band communications system. Using the station's robotic arm, Hobaugh will move the S-band antenna sub-assembly, or SASA, from the P6 truss to the P1. The two astronauts will then install a new S-band transponder and baseband signal processor to P1 and activate it. Together with the relocated SASA antenna, the new transponder and processor provide upgraded voice communications for the station.

Mastracchio and Anderson also will retrieve the P6 transponder so that it can be returned to Earth where it will be upgraded and available for a future mission. They will engage the Z1 SASA gimbal locks to prepare them for the next mission and recover some material experiments, MISSE experiments 3 and 4, to return to Earth.



EVA 4 (IF ADDITIONAL DAYS ADDED TO MISSION)

- EV2: Williams
- EV3: Anderson
- Duration: 6:30
- EVA Operations:
  - Egress/Set-up (00:20)
  - OBSS Boom Stand Install (01:00)
  - EV2: GPS Antenna #4 Remove (00:40)
  - EV3: P6 Aux Bag Move (00:30)
  - EWIS Antenna Install (01:30)
  - Lab MMOD Shield Clean-up (00:30)
  - Node MMOD Shield Clean-up (00:30)
  - CP1 WETA Antenna Install (01:15)
    - Time permitting based on MMOD Shield Clean-up
  - Clean-up/Ingress (00:45)

If mission managers add three more days and another spacewalk, Williams and Anderson will install orbital support equipment for the Orbiter Boom Sensor System (OBSS) on the S1 truss. This installation will allow the addition of a 50-foot inspection boom assembly (IBA) during STS-123, targeted for February 2008. The boom assembly will be used for heat shield inspections during the STS-124 mission, targeted for April.

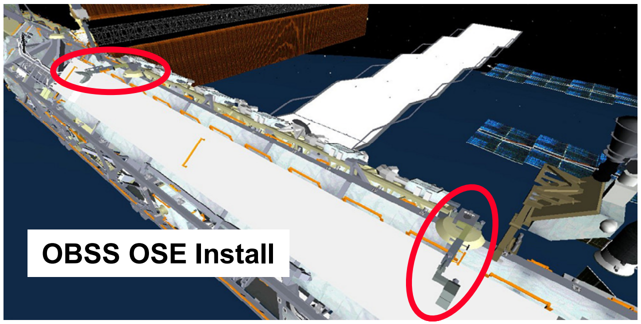
The OBSS provides the capability to inspect the shuttle for thermal protection system (TPS) damage and, if needed, to provide a platform to perform TPS repair during a spacewalk. The

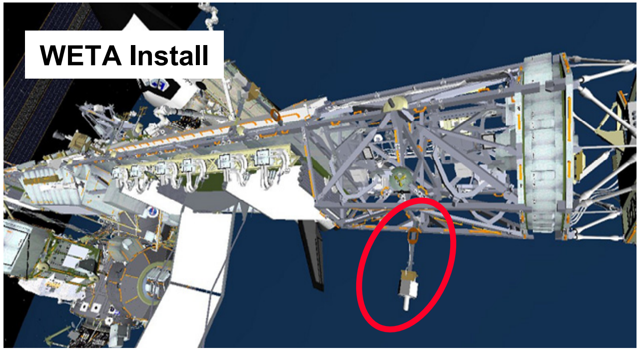
IBA will consist of two laser sensors, a special black and white TV camera (ITVC), an integrated sensor inspection system (ISIS) digital camera, a pan and tilt unit, two grapple fixtures, and EVA hand-holds.

The crew also will install the S3 Wireless Video System External Transceiver Assembly (WETA) on camera port 1 on the S3 truss to provide better wireless video coverage during future missions.

Additional tasks that may be added to the spacewalk include retrieving failed global positioning satellite antenna No. 4 and installing the External Wireless Instrumentation System Installation Antenna. The crew also will move the P6 Auxiliary Bag, which holds contingency spacewalk tools, from P6 to the Destiny lab. The move to a more centralized area is expected to save spacewalking time should the tools be needed.

If time permits, Williams and Anderson also will secure the debris shields on the station's lab and Node 1. During STS-117, spacewalkers were unable to fully fasten the shields and used tethers to hold them in place.





EDUCATOR ASTRONAUT PROJECT

NASA's Office of Education aims to strengthen NASA and the nation's future workforce by attracting and retaining students in science, technology, engineering and mathematics, or STEM, disciplines. The Educator Astronaut Project (EAP) is part of NASA's Elementary and Secondary Education Program. NASA believes that by increasing the number of students involved in NASA-related activities at the elementary and secondary education levels more students will be inspired and motivated to pursue higher levels of STEM courses.

The EAP facilitates education opportunities and activities that use the unique environment of spaceflight. It builds upon space exploration and the experiences of astronauts to launch the next generation of explorers.

NASA has selected educators with expertise in kindergarten through 12th-grade classrooms to train to become fully qualified astronauts. NASA will send educators to space so that they can use their skills and experiences as classroom teachers to connect space exploration to the classroom. By utilizing their talents as educators and the unique platform of spaceflight, these astronauts can offer a new avenue for imagination and ingenuity for teachers and their classrooms.

There are four educators in the astronaut corps, Barbara Morgan, Joe Acaba, Ricky Arnold and Dottie Metcalf-Lindenburger. Morgan is assigned as a mission specialist on STS-118. Acaba, Arnold and Metcalf-Lindenburger completed their initial astronaut training in February 2006. They now support various aspects of the International Space Station and space shuttle operations in the Astronaut Office at NASA's Johnson Space Center in Houston. Their assignments are no different than those given other astronauts.

The EAP collaborates with its Network of Educator Astronaut Teachers (NEAT) to develop additional ways to provide teachers unique professional development opportunities, which will strengthen the overall teaching of STEM disciplines. NEAT is currently comprised of approximately 190 teachers from around the country, excellent educators who applied in 2003, but were not selected for educator astronaut positions. NASA provides NEAT with professional development through national conferences and workshops at NASA's field centers. They receive NASA education resources, special training and are offered unique NASA experiences.

NASA Education and the EAP are planning a variety of education activities that will give students, educators and families the opportunity to engage in the STS-118 mission, before, during and after the flight. Educator resources are available online.

EDUCATION PAYLOAD OPERATIONS (EPO)

Overview

Education Payload Operations (EPO) is an education payload or activity designed to support NASA's mission to inspire the next generation of explorers. Generally, these payloads and activities focus on demonstrating science, mathematics, technology, engineering or geography principles on orbit. EPO goals and objectives are met by capturing video and still images of the crew operating EPO hardware. The images are used to support NASA education products and services. The overall goal for every mission is to facilitate education opportunities that use the unique environment of spaceflight.

In support of STS-118, NASA Education has put together a comprehensive education plan designed to engage students in the mission through an engineering design challenge in which students will design, build and assess their own plant growth chambers for future missions to the moon. The challenge ties directly to the two education payloads planned for STS-118 (EPO Kit C and EPO Educator).

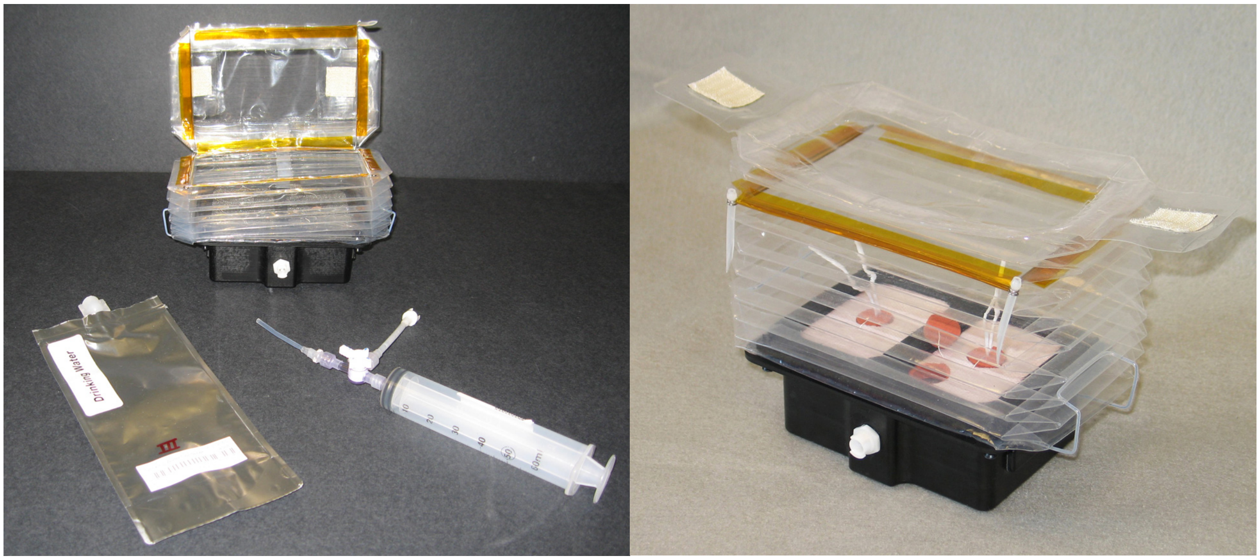
EPO Educator is manifested for launch and return on flight STS-118, while EPO Kit C is manifested for launch on STS-118 and return on STS-120, targeted for October. The investigations and related activities will have strong ties to NASA's Vision for Space Exploration, encouraging students to pursue studies and careers in STEM fields and applying these disciplines to future exploration goals.

EPO-Kit C

EPO-Kit C is an education payload consisting of two small collapsible plant growth chambers and the associated hardware to conduct a 20-day plant germination investigation (See Figure below). During the investigation, crew members will maintain the plants and will capture still images of plant growth. All images will be incorporated into a comprehensive set of education activities planned in association with STS-118 and Expedition 15.

EPO- Educator

EPO-Educator is an education payload consisting of approximately 10 million basil seeds. The seeds will launch and return with STS-118. After the mission, the seeds will be distributed to students and educators as part of a comprehensive education plan for STS-118. On-orbit operations include capturing still images of the seeds in a microgravity environment. The still images will be incorporated into a set of education activities.



EPO Kit C Hardware and Plant Growth Chamber

Both EPO-Kit C and EPO-Educator align with ground-based education activities being planned in conjunction with STS-118. As part of these activities, students in kindergarten through 12th grade will plan, design, build and validate the performance of their plant growth chamber design using flown and control seeds by conducting scientific investigations of their choosing.

In-flight Education Downlinks

Depending on mission activities, Morgan and selected crew members will participate in at least one and perhaps as many as three live, in-flight education downlinks. Downlinks afford education audiences the opportunity to learn first-hand from space explorers what it is like to live and work in space. Downlinks are approximately 20 minutes in length and allow students and educators to interact with the crews on the International Space Station and space shuttle through a question and answer session. These events are broadcast live on NASA TV.

The three locations chosen for in-flight educational downlinks, mission events permitting, are the Discovery Center of Idaho (DCI) in Boise, the Challenger Learning Center in Alexandria, Va., and the Robert L. Ford K-8 NASA Explorer School in Lynn, Mass.

DCI is a hands-on science museum directly serving 100,000 visitors (ages 1-100) a year in southwestern Idaho. DCI has educational programs that serve 30,000 students statewide. Challenger Center for Space Science Education (CCSSE) is a not-for-profit education organization founded by the families of the shuttle Challenger astronauts lost in 1986. From this event, the Challenger families and CCSSE developed a network of 49 Challenger Learning Centers (CLCs) across the nation, enabling 400,000 students and 25,000 teachers to experience a simulated space mission each year. The Robert L. Ford School NASA Explorer School is a full-service community school that offers a variety of services to help support families and students.

EDUCATION ACTIVITIES

NASA Education developed a Web presence for STS-118, http://www.nasa.gov/sts118. This site provides a central location for all information related to education opportunities. The site contains a variety of information on events and opportunities, education challenges, education materials, related stories and partnerships. The “Events and Opportunities” section involves current opportunities to engage in conferences and workshops.

The “Education Challenges” section involves opportunities to engage students in exciting learning experiences. The “Education Materials” section includes focused materials connected to the STS-118 mission objectives. The “Related Stories & Profiles” section portrays stories related to the STS-118 crew and their interaction with education audiences. Through a series of profiles, students and teachers will learn more about the STS-118 space shuttle mission through a behind-the-scenes look from a few members of the team that are preparing for the flight. At the same time, readers will learn more about some of the many diverse jobs performed by the NASA workforce. The “Partnerships” section includes the organizations that NASA has partnered with to involve students in the excitement of the STS-118 space shuttle mission.

Ground-Based Activities

From the STS-118 Education home page, formal and informal educators can engage their students in activities that connect to the STS-118 mission objectives. Learn more by preparing for and following the mission. Preparation for the education mission activities is separated into two categories: Engineering Design and Sustaining Life. The mission activities are organized according to a broad overview of a mission timeline, including “Endeavour lifts off,” “Endeavour docks to the ISS” and “Endeavour undocks from the ISS.”

Engineering Design Challenge

To mark Morgan’s first flight, NASA’s Exploration Systems Mission Directorate (ESMD) and Office of Education are co-sponsoring a standards-based Engineering Design Challenge for students in kindergarten through 12th grade. This will be the primary focus for ground-based education activities aligned with the STS-118 mission.

In this challenge, students will be charged with designing a plant growth system for the moon that can be either delivered to the moon as a complete unit, or assembled on the lunar surface. Given a basic set of requirements and constraints, students will design, analyze, build and assess the system. All elements of the design challenge will map to standards in technology (which includes engineering design), science and mathematics.

The challenge is being developed in cooperation with International Technology Education Association (ITEA) and will be offered, free of charge, through the NASA Web site. It will be presented in versions appropriate for elementary, middle, and high school teachers. In addition to a design/build/assess track, a design/assess track will be offered in order to make the challenge attractive to both teachers with experience in engineering and technology education and those that may not have as much comfort teaching design, and/or classroom time to build a chamber prototype.

The engineering design challenge will offer lesson guides, extensions, assessments, and relevant background materials. Teaching tips and strategies, advice from NASA plant researchers, and recommendations from NASA design engineers will be incorporated into the challenge website. A career corner will be established on the Web site to highlight the different areas of study that are related to plant growth research and engineering design.

Once a system is built or obtained (and the design evaluated), registered teachers are eligible to receive a set of basil seeds, flown on STS-118 with Educator Astronaut Barbara Morgan, with which to validate the performance of the system and run additional experiments. Park Seed Company has partnered with NASA to provide and package the seeds for education distribution. Approximately 100,000 sets of STS-118 seeds will be made available. Control (non-space flown) basil seeds will also be provided by Park Seed Company.

Educators may obtain from NASA a certificate of participation by completing a final evaluation of the engineering design challenge. Professional development for educators will be offered through the ITEA, NASA Centers, at educator conferences, NASA Educator Resource Centers, and through other NASA projects such as NASA Explorer Schools and Aerospace Education Services Project. Active engagement of educators will also be pursued through educational promotion to principals, state science supervisors, and curriculum developers. The National Science Teachers Association is also partnering with NASA to provide a guide on how to conduct a scientific experiment.

Pennant Design Challenge

Students created a design, conducted research, and wrote an essay about the design's connection to exploration. The pennant design was based on the STS-118 space shuttle mission or NASA's Vision for Space Exploration. In May, one overall winner was selected through online voting at KOL, AOL's service for kids. The winning design will be flown aboard space shuttle Endeavour during the STS-118 mission.

Physical Fitness Challenge

NASA's Fit Explorer project is a scientific and physical approach to human health and fitness on Earth and in space. While using a standards-based science activity set related to the STS-118 shuttle mission and human spaceflight in general, students will learn about NASA's exploration mission and the requirements of living in space. They also will perform physical activities, including: Base Station Walk-Back, Spacewalking, Jumping for the Moon, and a simulated crew strength training exercise. The Fit Explorer project will start with the launch of STS-118 and is targeted for students in elementary school.

Additional Information

Educators are encouraged to sign up for the Education Express email mailing list via the NASA Portal to receive updates on the engineering design challenge, information on how to register for the seeds, as well as other related activities and events that surround the STS-118 mission.

http://www.nasa.gov/audience/foreducators/topnav/mailinglist/

For additional information please check out:

http://www.nasa.gov/sts118

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EXPERIMENTS

DETAILED TEST OBJECTIVES

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

Such experiments assigned to STS-118 are listed below.

DTO 853 In-Flight Evaluation for Areas of CO2 Concentration

The purpose of the DTO is to evaluate carbon dioxide (CO2) levels at specific times during the mission and in shuttle areas that have the potential to contain elevated levels. The DTO will be carried out over four missions, including STS-118, STS-120, STS-122 and STS-123. During the missions, the data will be collected over a period of five days, during similar time periods and in similar locations.

The CO2 levels will be recorded using the Carbon Dioxide Monitor (CDM) — a portable handheld device designed to monitor and quantify CO2 concentrations.

The test was prompted by the STS-121 and STS-115 mission crews who reported experiencing stuffiness and headaches while sleeping in the middeck area. The symptoms are believed to most likely result from exposure to high levels of CO2.

For the reported times during STS-121 and 115, the CO2 levels within the crew module, as indicated by the vehicle instrumentation, were within the acceptable range. Additionally, for the course of the docked phase, the CO2 levels in the shuttle tracked well with the levels in the station. The station crew did not report any symptoms.

Data sampling locations for the test are dependent upon crew sleep locations and high activity locations because the post-sleep activity period and high activity periods are the times when CO2 symptoms was reported by the STS-121 and 115 crews.

During the four missions, the crew will place the CDM in the middeck before they go to sleep so that ground controllers can monitor CO2 levels continuously. The information will be used to identify CO2 “hot spots” within the shuttle.

As a result, engineering evaluations will be made to fine-tune air exchange analyses, to determine if any configuration changes are necessary to optimize airflow and to determine if operational improvements are needed or if crew exposure time in identified areas should be limited.

CDM technology was successfully used to determine the existence of CO2 pockets on the space station. The kit that will be used on the shuttle will include the CDM, filters and several battery packs. The CDM is capable of monitoring CO2 in a localized area for either long or short durations of time, depending on the operating mode.

SDTO 13005-U ISS Structural Life and Life Validation and Extension

The purpose of this Station Development Test Objective (SDTO) is to guarantee safety of the station structure and crew by validating the on-orbit math models that were created for the space station. The test will be used to validate critical interface load and to help improve fatigue life prediction on the station.

During this mission, if crew time is available, three tests will be performed: one during the shuttle-station mated reboost, one during undocking and one during S5 truss installation. The tests will provide dynamic loads information for engineers to use in creating precise models that can be used for analysis. On-orbit data may aid in detecting structural anomalies, and the station's response to actual loading events aids in post-flight reconstruction of loads that help determine structural life usage.

The test requires actual or educated estimates of input (forcing function) and actual output (on-orbit sensor measurements) of the station response. Measurement of the force input (i.e., thruster firing sequences, video of crew activity, etc.) and station response will aid reconstruction of station loads and structural life usage over the life of the station, thus allowing life extension of the structure.

All of the on-orbit dynamic tests were also performed on the ISS-Orbiter mated configuration models.

SHORT-DURATION RESEARCH TO BE COMPLETED DURING STS-118/13A.1

The space shuttle and International Space Station have an integrated research program that optimizes use of shuttle crew members and long-duration space station crew members in addressing research questions in a variety of disciplines.

Human Research Experiments

Incidence of Latent Virus Shielding during Spaceflight (Latent Virus) will determine the frequencies of reactivation of latent viruses — inactive viruses in the body that can be reactivated, such as cold sores — and clinical diseases after exposure to the physical, physiological, and psychological stressors associated with spaceflight. Understanding latent virus reactivation may be critical to crew health during extended space missions when crew members live and work in a closed environment.

Test of Midodrine as a Countermeasure Against Post-Flight Orthostatic Hypotension (Midodrine) is a test of the ability of the drug midodrine to reduce the incidence or severity of orthostatic hypotension. If successful, it will be employed as a countermeasure to the dizziness caused by the blood-pressure decrease that many astronauts experience upon returning to the Earth's gravity.

Perceptual Motor Deficits in Space (PMDIS) will investigate why astronauts experience difficulty with hand-eye coordination while in space. These measurements will be used to distinguish between three possible explanations: the brain not adapting to the near weightlessness of space; the difficulty of performing fine movements when floating in space; and stress due to factors such as space sickness and sleep deprivation. This experiment is a cooperative effort with the Canadian Space Agency.

Bioavailablity and Performance Effects of Promethazine during Spaceflight (PMZ) will examine the performance-impacting side-effects of promethazine and its bioavailability — the degree to which a drug can be absorbed and used by the parts of the body on which it is intended to have an effect. Promethazine is a medication taken by astronauts to prevent motion sickness.

Sleep-Wake Actigraphy and Light Exposure during Spaceflight - Short (Sleep-Short) will examine the effects of spaceflight on the sleep-wake cycles of the astronauts during shuttle missions. Advancing state-of-the-art technology for monitoring, diagnosing and assessing treatment of sleep patterns is vital to treating insomnia on Earth and in space.

Biological Science Investigations

Commercial Biomedical Test Module - 2 (CBTM-2) will use a validated mouse model to examine the effectiveness of an experimental therapeutic as a possible countermeasure for muscle atrophy. Combined with exercise, this experimental therapeutic developed by the biotechnology company, Amgen, could one day form the basis for a treatment that will help maintain a high level of physical fitness in future flight crews.

Cell Culture Module - Immune Response of Human Monocytes in Microgravity (CCM-Immune Response) is Department of Defense Space Test Program research that uses cell culture in microgravity as a model of reduced immune function. This investigation will examine the response of human immune cells in microgravity to new chitosan-based antibacterials.

Cell Culture Module - Effect of Microgravity on Wound Repair: In Vitro Model of New Blood Vessel Development (CCM-Wound Repair) is Department of Defense Space Test Program research that uses cell culture in microgravity as a model of wound healing. This investigation is directed at the use of adipose derived adult stem cells for use in injury repair. It will examine how microgravity alters new blood vessel development which is a key component of wound and tissue repair.

Streptococcus pneumoniae Gene Expression and Virulence Potential in the Space Environment (SPEGIS) will examine the behavior and growth of bacteria in microgravity. The data collected will give insight on what types of bacterial infections may occur during long-duration space missions and the risks to crew members.

Educational Activities

Education Payload Operations - Educator (EPO - Educator) will use video and still photography to capture data of experiment activities in space. Students also will be designing and completing ground-based investigations developed by the NASA Education Office, focusing on kindergarten through 12th grade students. The activities will support educator astronauts in their missions. An educator astronaut is a full-time astronaut who has experience teaching in elementary, middle school, or high school classrooms.

Spaceflight Technology Tests

Maui Analysis of Upper Atmospheric Injections (MAUI) will observe the space shuttle engine exhaust plumes from the Maui Space Surveillance Site in Hawaii. The observations will occur when the shuttle fires its engines at night or twilight. A telescope and all-sky imagers will take images and data while the shuttle flies over the Maui site. The images will be analyzed to better understand the interaction between the spacecraft plume and the upper atmosphere.

Ram Burn Observations (RAMBO) is an experiment in which the Department of Defense uses a satellite to observe space shuttle orbital maneuvering system engine burns. The study's purpose is to improve plume models, which predict the direction of the plume, or rising column of exhaust, as the shuttle maneuvers on orbit. Understanding this flow direction could be significant to the safe arrival and departure of spacecraft on current and future exploration missions.

ISS RESEARCH SAMPLES RETURNED ON STS-118/13A.1

Human Research Experiment Samples

Nutritional Status Assessment (Nutrition) is NASA's most comprehensive in-flight study to date of human physiologic changes during long-duration spaceflight; this includes measures of bone metabolism, oxidative damage, nutritional assessments and hormonal changes. This study will impact both the definition of nutritional requirements and development of food systems for future space exploration missions to the moon and Mars. This experiment also will help to understand the impact of countermeasures — exercise and pharmaceuticals — on nutritional status and nutrient requirements for astronauts.

A Comprehensive Characterization of Microorganisms and Allergens in Spacecraft (SWAB) will use advanced molecular techniques to comprehensively evaluate microbes on the space station, including pathogens (organisms that may cause disease). It also will track changes in the microbial community as spacecraft visit the station and new station modules are added. This study will allow an assessment of the risk of microbes to the crew and the spacecraft.

Technology Test Samples

Capillary Flow Experiment (CFE) is a suite of fluid physics experiments that investigate capillary flows and flows of fluids in containers with complex geometries. Results will improve current computer models that are used by designers of low gravity fluid systems and may improve fluid transfer systems on future spacecraft.

Elastic Memory Composite Hinge (EMCH) will study the performance of a new type of composite hinge to determine if it is suitable for use in space. The experiment will use elastic memory hinges to move an attached mass at one end. Materials tested in this experiment are stronger and lighter than current material used in space hinges and could be used in the design of future spacecraft.

Materials on the International Space Station Experiment - 3 and 4 (MISSE - 3 and 4) are the third and fourth in a series of five suitcase-sized test beds attached to the outside of the space station. The station crew deployed the beds during a spacewalk in August 2006. They are exposing hundreds of potential space construction materials and different types of solar cells to the harsh environment of space. Mounted to the space station for approximately a year, the equipment then will be returned to Earth for study. Investigators will use the resulting data to design stronger, more durable spacecraft. MISSE 1, 2 and 5 already have been returned to Earth for analysis.

Life Sciences Samples

Threshold Acceleration for Gravisensing (Gravi) will determine the minimum amount of artificial gravity needed to cause lentil seedling roots to start growing in a new direction. This work supports future efforts to grow sufficient edible crops on long-duration space missions.

Analysis of a Novel Sensory Mechanism in Root Phototropism (Tropi) sprouted Arabidopsis thaliana (thale cress) plants from seeds under different frequencies of light and levels of artificial gravity. The plants will be analyzed at the molecular level to determine what genes are responsible for successful plant growth in microgravity.

ADDITIONAL ISS RESEARCH FROM NOW UNTIL THE END OF EXPEDITION 15

Human Research Experiments

Cardiovascular and Cerebrovascular Control on Return from ISS (CCISS) will study the effects of long-duration spaceflight on crew members' heart functions and their blood vessels that supply the brain. Learning more about the cardiovascular and cerebrovascular systems could lead to specific countermeasures that might better protect future space travelers. This experiment is collaborative with the Canadian Space Agency.

Analysis of Astronaut Journals (Journals), using journals kept by the crew and surveys, is studying the effect of isolation. By quantifying the importance of different behavioral issues in long-duration crews, the study will help NASA design equipment and procedures to allow astronauts to cope effectively with isolation and long-duration spaceflight.

Sleep-Wake Actigraphy and Light Exposure during Spaceflight-Long (Sleep-Long) will examine the effects of spaceflight and ambient light exposure on the sleep-wake cycles of the crew members during long-duration stays on the space station.

Exploration Technology Testing

Analyzing Interferometer for Ambient Air (ANITA) will monitor 32 gaseous contaminants, including formaldehyde, ammonia and carbon monoxide, in the station atmosphere. The experiment will test the accuracy and reliability of this technology as a potential next-generation atmosphere trace-gas monitoring system for the station.

Smoke and Aerosol Measurement Experiment (SAME) will measure the smoke properties, or particle size distribution, from typical spacecraft fire smokes to identify ways to improve smoke detectors on future spacecraft.

Synchronized Position Hold, Engage, Reorient, Experimental Satellites (SPHERES) are bowling-ball sized spherical satellites. They will be used inside the space station to test a set of well-defined instructions for spacecraft performing autonomous rendezvous and docking maneuvers. Three free-flying spheres will fly within the cabin of the station, performing flight formations. Each satellite is self-contained with power, propulsion, computers and navigation equipment. The results are important for satellite servicing, vehicle assembly and formation flying spacecraft configurations.

Physical and Life Sciences

BCAT-3 (Binary Colloidal Alloy Test – 3): Crews photographed samples of colloidal particles (tiny nanoscale spheres suspended in liquid) to document liquid/gas phase changes, growth of binary crystals, and the formation of colloidal crystals confined to a surface. Data may lead to improvements in supercritical fluids used in rocket propellants and biotechnology applications, and advancements in fiberoptics technology.

Coarsening in Solid Liquid Mixtures-2 (CSLM-2) examines the kinetics of competitive particle growth within a liquid matrix. During this process, small particles shrink by losing atoms to larger particles, causing the larger particles to grow (coarsen) within a liquid lead/tin matrix. This study defined the mechanisms and rates of coarsening that govern turbine blades, dental amalgam fillings, iron copper, etc.

The Effect of An Experimental Therapeutic on Reducing the Muscle Atrophy that Occurs in Spaceflight. This investigation will use a validated mouse model to examine the effectiveness of an experimental therapeutic developed by Amgen as a possible countermeasure for muscle atrophy. Combined with exercise, this experimental therapeutic could one day form the basis for a treatment that will help maintain a high level of physical fitness in future flight crews. This experiment will remain aboard the shuttle during the STS-118 flight.

Microgravity Acceleration Measurement System (MAMS) and Space Acceleration Measurement System (SAMS-II) measure vibration and quasi-steady accelerations that result from vehicle control burns, docking and undocking activities. The two different equipment packages measure vibrations at different frequencies.

Molecular and Plant Physiological Analyses of the Microgravity Effects on Multigeneration Studies of Arabidopsis thaliana (Multigen) will grow Arabidopsis thaliana – a small flowering plant related to cabbage and mustard — in orbit for three generations. The results of this investigation will support future plans to grow plants on the long-duration transit to Mars. This is a cooperative investigation with the European Space Agency, ESA.

Earth Observations

Crew Earth Observations (CEO) takes advantage of the crew in space to observe and photograph natural and human-made changes on Earth. The photographs record the Earth’s surface changes over time, along with more fleeting events such as storms, floods, fires and volcanic eruptions. Together, they provide researchers on Earth with vital, continuous images to better understand the planet.

Crew Earth Observations - International Polar Year (CEO-IPY) is an international collaboration of scientists for the observation and exploration of Earth’s Polar Regions from 2007 to 2009. International Space Station crew members will photograph polar phenomena including auroras and mesospheric clouds to meet requests from scientists conducting ground research for the International Polar Year.

Educational Activities

Commercial Generic Bioprocessing Apparatus Science Insert - 02 (CSI-02) is an educational payload designed to interest middle school students in science, technology, engineering and math by participating in near real-time research conducted on board the station. Students will observe three experiments through data and imagery downlinked and distributed directly into the classroom via the Internet. The first is a seed germination experiment through which students will learn how gravity affects plant development. Small seeds will be developed on orbit in a garden habitat. The second experiment will examine crystal growth formation using specific types of proteins and enzymes, and the third experiment will examine crystal formation using silicates — compounds containing silicon, oxygen and one or more metals. For the two crystal growth experiments, students will grow crystals in their classrooms and analyze growth of those compared to the crystals grown in space.

Education Payload Operations - Kit C (EPO - Kit C) is an on-orbit plant growth investigation using basil seeds. The still and video imagery captured will be used as part of a national engineering design challenge for students in kindergarten through 12th grade. On the ground, students will grow basil seeds — control and flown seeds — in growth chambers to conduct their own science experiments on plant growth.

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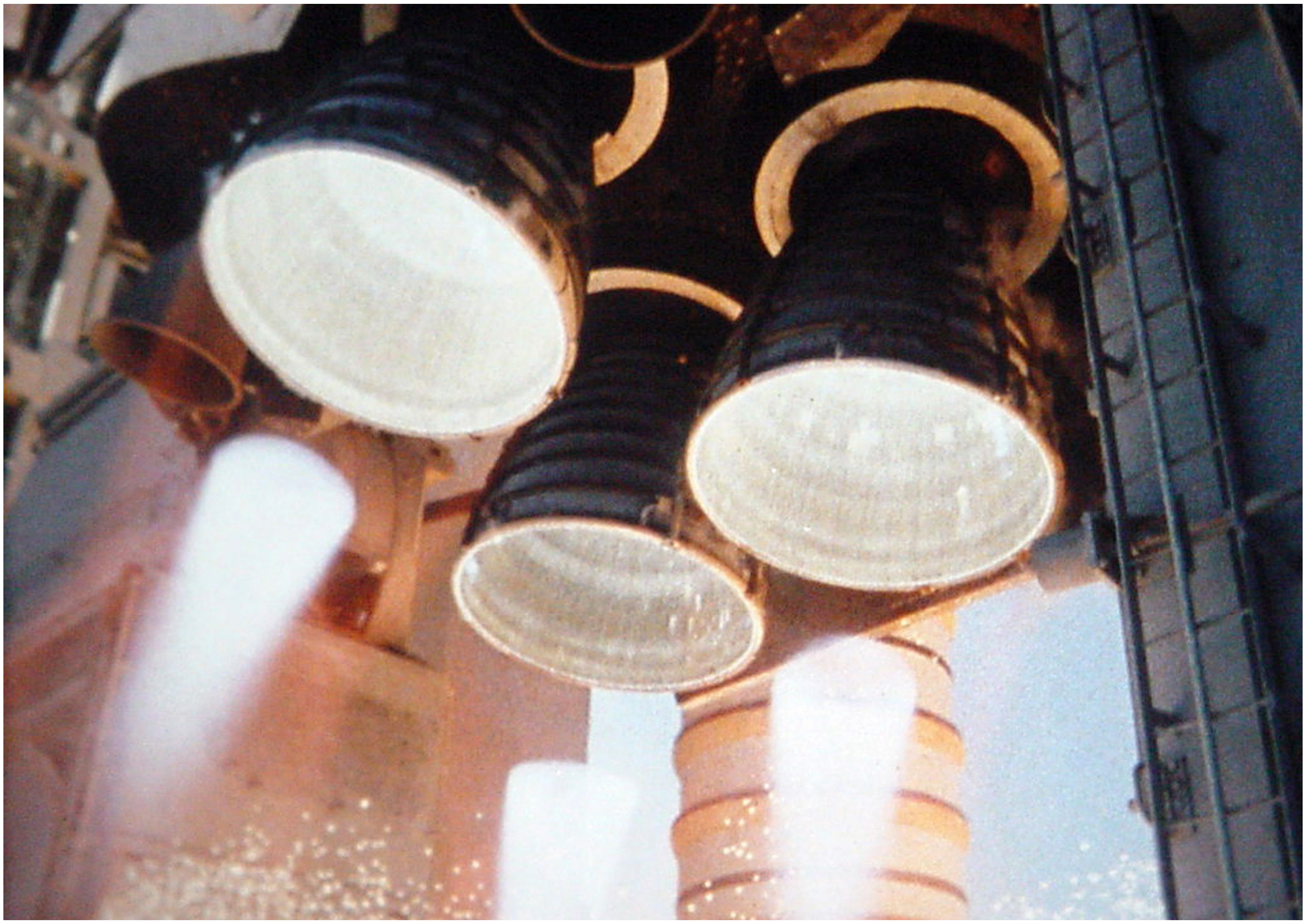
SPACE SHUTTLE MAIN ENGINE ADVANCED HEALTH MANAGEMENT SYSTEM

During the STS-118 mission, the Advanced Health Management System (AHMS) — an engine improvement system that shuts down an engine if anomalies are detected — will be actively operating on all three engines for the first time. The AHMS collects and processes turbopump accelerometer data, a measure of turbopump vibration, and continuously monitors turbopump health. If vibration anomalies are detected, the system shuts the engine down.

The AHMS operated in monitor-only mode on one engine during the STS-116 mission in December 2006 and in active-mode on one engine during the STS-117 mission in June 2007. Data from STS-117 indicated the AHMS operated as intended.



The space shuttle main engine is the world's most sophisticated reusable rocket engine. During a shuttle launch, the shuttle's three engines operate for about eight-and-one-half minutes during liftoff and ascent.

When a shuttle lifts off the launch pad, it does so with the help of three reusable, high performance rocket engines. Each main engine is 14 feet long and 7.5 feet in diameter at the nozzle exit. One engine weighs approximately 7,750 pounds and generates more than 12 million horsepower, equivalent to more than four times the output of the Hoover Dam. The engines operate for about 8.5 minutes during liftoff and ascent — long enough to burn more than 500,000 gallons of super-cold liquid hydrogen and liquid oxygen propellants stored in the external fuel tank, which is attached to the shuttle's underside. Liquid oxygen is stored at -298 degrees Fahrenheit, and liquid hydrogen is stored at -423 degrees Fahrenheit. The engines shut down just before the shuttle, traveling at about 17,000 mph, reaches orbit.

This engine upgrade significantly improves space shuttle flight safety and reliability. The upgrade, developed by NASA’s Marshall Space Flight Center in Huntsville, Ala., is a modification of the existing main engine controller, which is the on-engine computer that monitors and controls all main engine operations.

The modifications include the addition of advanced digital signal processors, radiation-hardened memory and new software. These changes to the main engine controller provide the capability for completely new monitoring and insight into the health of the two most complex components of the space shuttle’s main engine — the high-pressure fuel turbopump and the high-pressure oxidizer turbopump.

The fuel and oxidizer turbopumps rotate at approximately 34,000 and 23,000 revolutions per minute, respectively. To operate at such extreme speeds, the high-pressure turbopumps use highly specialized bearings and precisely balanced components. The AHMS upgrade utilizes data from three existing sensors (accelerometers) mounted on each of the high-pressure turbopumps to measure how much each pump is vibrating. The output data from the accelerometers is routed to the new AHMS digital signal processors installed in the main engine controller. These processors analyze the sensor readings 20 times per second, looking for vibration anomalies that are indicative of impending failure of rotating turbopump components such as blades, impellers, inducers and bearings. If the magnitude of any vibration anomaly exceeds safe limits, the upgraded main engine controller immediately shuts down the unhealthy engine.

SHUTTLE REFERENCE DATA

SHUTTLE ABORT MODES

RSLS Aborts

These occur when the on-board 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 engine. 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 liftoff.

The RTLS profile is designed to accommodate the loss of thrust from one space shuttle main engine between liftoff 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 external tank 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, 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, about 3 minutes, 34 seconds into the mission; whereas an RTLS chosen due to an engine out at liftoff is selected at the earliest time, about 2 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 toward 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 maneuver 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 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 about 45 minutes after launch. The landing site is selected near the normal ascent ground track of the orbiter 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. The three landing sites that have been identified for a launch are Zaragoza, Spain; Moron, Spain; and Istres, France.

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 normal 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, Calif.; or the Kennedy Space Center, Fla). Thus, an AOA results in the orbiter circling the Earth once and landing about 90 minutes after liftoff.

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 also may necessitate a contingency abort. Such an abort would maintain orbiter integrity for in-flight crew escape if a landing cannot be achieved at a suitable landing field.

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

Abort Decisions

There is a definite order of preference for the various abort modes. The type of failure and the time of the failure determine which type of abort is selected. In cases where performance loss is the only factor, the preferred modes are 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.

Mission Control 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 on-board 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 on-board methods, such as cue cards, dedicated displays and display information, to determine the 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 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 about 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 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 No. 3.The main engine was replaced and Discovery was finally launched on Aug. 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 No. 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 No. 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) Aug. 12, 1993

The countdown for Discovery's third launch attempt ended at the T-3 second mark when onboard computers detected the failure of one of four sensors in main engine No. 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 Sept. 12, 1993.

(STS-68) Aug. 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 No. 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 No. 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 Oct. 2 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 No. 1, resulting in a safe "abort to orbit" and successful completion of the mission.

SPACE SHUTTLE MAIN ENGINES

Developed in the 1970s by NASA's Marshall Space Flight Center in Huntsville, Ala., the space shuttle main engine is the most advanced liquid-fueled rocket engine ever built. Every space shuttle main engine is tested and proven flight-worthy at NASA's Stennis Space Center in south Mississippi, before installation on an orbiter. Its main features include variable thrust, high performance reusability, high redundancy and a fully integrated engine controller.

The shuttle's three main engines are mounted on the orbiter aft fuselage in a triangular pattern. Spaced so that they are movable during launch, the engines are used — in conjunction with the solid rocket boosters — to steer the shuttle vehicle.

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

The engines operate for about 8½ minutes during liftoff and ascent — burning more than 500,000 gallons (1.9 million liters) of super-cold liquid hydrogen and liquid oxygen propellants stored in the huge external tank attached to the underside of the shuttle. The engines shut down just before the shuttle, traveling at about 17,000 mph (28,000 kilometers per hour), reaches orbit.

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

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

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

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

At about 26 seconds into launch, the main engines are throttled down to 316,000 pounds of thrust to keep the dynamic pressure on the vehicle below a specified level — about 580 pounds per square foot or max q. Then, the engines are throttled back up to normal operating level at about 60 seconds. This reduces stress on the vehicle. The main engines are throttled down again at about seven minutes, 40 seconds into the mission to maintain three g's — three times the Earth's gravitational pull — again reducing stress on the crew and the vehicle. This acceleration level is about one-third the acceleration experienced on previous crewed space vehicles.

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

The engine performance has the highest thrust for its weight of any engine yet developed. In fact, one space shuttle main engine generates sufficient thrust to maintain the flight of 2½ 747 airplanes.

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

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

After the orbiter lands, the engines are removed and returned to a processing facility at Kennedy Space Center, Fla., where they are rechecked and readied for the next flight. Some components are returned to the main engine's prime contractor, Pratt & Whitney RocketDyne, West Palm Beach, Fla., for regular maintenance. The main engines are designed to operate for 7.5 accumulated hours.

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 about 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 liftoff and during first-stage ascent. Seventy-five seconds after SRB separation, SRB apogee occurs at an altitude of about 220,000 feet, or 35 nautical miles (40 statute miles). SRB impact occurs in the ocean about 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 about 1,300,000 pounds at launch. The propellant for each solid rocket motor weighs about 1,100,000 pounds. The inert weight of each SRB is about 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 liftoff.

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 done 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 about 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 about a third 50 seconds after liftoff 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, a transition piece between the nose cone and solid rocket motor, 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 ATK 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 (NSDs), 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 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 on-board computers at T minus 6.6 seconds (staggered start — engine three, engine two, engine one — all about 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 liftoff 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 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 on-board 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 on-board master timing unit, event timer and mission event timers are started; the three SSMEs are at 100 percent; and the ground launch sequence is terminated.

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

Electrical Power Distribution

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

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

Hydraulic Power Units

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

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

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

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

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

When the APU speed reaches 100 percent, the APU primary control valve closes, and the APU speed is controlled by the APU controller electronics. If the primary control valve logic fails to the open state, the secondary control valve assumes control of the APU at 112 percent speed. Each HPU on an SRB is connected to both servoactuators on that SRB. One HPU serves as the primary hydraulic source for the servoactuator, and the other HPU serves as the secondary hydraulics for the servoactuator. Each servoactuator 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 liftoff 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.

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 allows 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 percent stronger and 5 percent less dense.

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

LAUNCH AND LANDING

LAUNCH

As with all previous space shuttle launches, Endeavour has several options to abort its ascent if needed due to engine failures or other systems problems. Shuttle launch abort philosophy aims toward safe recovery of the flight crew and intact recovery of the orbiter and its payload.

Abort modes include:

ABORT-TO-ORBIT (ATO)

This mode is used if there’s a partial loss of main engine thrust late enough to permit reaching a minimal 105 by 85 nautical mile orbit with the orbital maneuvering system engines. The engines boost the shuttle to a safe orbital altitude when it is impossible to reach the planned orbital altitude.

TRANSATLANTIC ABORT LANDING (TAL)

The loss of one or more main engines midway through powered flight would force a landing at either Zaragoza, Spain; Moron, Spain; or Istres, France. For launch to proceed, weather conditions must be acceptable at one of these TAL sites.

RETURN-TO-LAUNCH-SITE (RTLS)

If one or more engines shuts down early and if there’s not enough energy to reach Zaragoza, the shuttle would pitch around toward KSC until within gliding distance of the Shuttle Landing Facility. For launch to proceed, weather conditions must be forecast to be acceptable for a possible RTLS landing at KSC about 20 minutes after liftoff.

ABORT ONCE AROUND (AOA)

An AOA is selected if the vehicle cannot achieve a viable orbit or will not have enough propellant to perform a deorbit burn, but has enough energy to circle the Earth once and land about 90 minutes after liftoff.

LANDING

The primary landing site for Endeavour on STS-118 is the Kennedy Space Center’s Shuttle Landing Facility. Alternate landing sites that could be used if needed due to weather conditions or systems failures are at Edwards Air Force Base, Calif., and White Sands Space Harbor, N.M.

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ACRONYMS AND ABBREVIATIONS

AA	Antenna Assembly
AAA	Avionics Air Assembly
ABC	Audio Bus Coupler
AC	Assembly Complete
ACBM	Active Common Berthing Mechanism
ACO	Assembly and Checkout Officer
ACS	Atmosphere Control and Supply
ACSM	Attitude Control System Moding
ACU	Arm Computer Unit
ADO	Adaptation Data Overlay
ADSEP	Advanced Separation
ADVASC	Advanced Astroculture
ADVASC-GC	Advanced Astroculture–Growth Chamber
AEA	Antenna Electronics Assembly
AFD	Aft Flight Deck
AJIS	Alpha Joint Interface Structure
AKA	Active Keel Assembly
APAS	Androgynous Peripheral Attachment System
APCU	Assembly Power Converter Unit
APDS	Androgynous Peripheral Docking System
APFR	Articulating Portable Foot Restraint
APM	Attached Pressurized Module
APPCM	Arm Pitch Plane Change Mode
APS	Automated Payload Switch
AR	Atmosphere Revitalization
ARCU	American-to-Russian Converter Unit
ARIS	Active Rack Isolation System
ARS	Air Revitalization System
ASCR	Assured Safe Crew Return
ATA	Ammonia Tank Assembly
ATCS	Active Thermal Control System
ATU	Audio Terminal Unit
AUAI	Assemble Contingency System/UHF Audio Interface
AVU	Artificial Vision Unit
AVV	Accumulator Vent Valve
BA	Bearing Assembly
BBC	Bus Bolt Controller
BC	Bus Controller

BCDU	Battery Charge/Discharge Unit
BCU	Backup Controller Unit
BDU	Backup Drive Unit
BG	Beta Gimbal
BGA	Beta Gimbal Assembly
BGDTS	Beta Gimbal Deployment Transition Structure
BGHS	Beta Gimbal Housing Subassembly
BIT	Built-In Test
BITE	Built-In Test Equipment
BMRRM	Bearing Motor and Roll Ring Module
BONEMAC	Bone Marrow Macrophages in Space
BPSMU	Battery Powered Speaker Microphone Unit
BRS	Bottom Right Side
BSP	Baseband Signal Processor
BTS	Bolt Tight Switch

C&C	Command and Control
C&DH	Command and Data Handling
C&M	Control and Monitor
C&T	Communication and Tracking
C&W	Caution and Warning
C/A-code	Coarse/Acquisition-code
C/L	Crew Lock
CA	Control Attitude
CAS	Common Attach System
CBM	Common Berthing Mechanism
CBOSS	Cellular Biotechnology Operating Science System
CCAA	Common Cabin Air Assembly
CCASE	Commercial Cassette Experiment
CCD	Cursor Control Device
CCMS	Concentric Cable Management System
CCS	Communication and Control System
CCTV	Closed-Circuit Television
CDDT	Common Display Development Team
CDRA	Carbon Dioxide Removal Assembly
CDS	Command and Data Software
CETA	Crew and Equipment Translation Aid
CEU	Control Electronics Unit
CFA	Circular Fan Assembly
CGBA	Commercial Generic Bioprocessing Apparatus
CHeCS	Crew Health Care System
CHX	Condensing Heat Exchanger

CID	Circuit Interrupt Device
CIOB	Cargo Integration and Operations Branch
CLA	Camera and Light Assembly
CLPA	Camera Light and Pan/Tilt Assembly
CMG	Control Moment Gyroscope
CMG-TA	Control Moment Gyroscope-Thruster Assist
CO_2	Carbon Dioxide
COAS	Crew Optical Alignment Sight
COR	Communication Outage Recorder
COTS	Commercial-Off-The-Shelf
CP	Cold Plate
CPCG-H	Commercial Protein Crystal Growth-High
CR	Change Request
CRES	Corrosion Resistant Steel
CRIM	Commercial Refrigerator Incubator Module
CRIM-M	Commercial Refrigerator Incubator Module-Modified
CRPCM	Canadian Remote Power Controller Module
CSA	Computer Systems Architecture
CSA-CP	Compound Specific Analyzer-Combustion Products
CSCI	Computer Software Configuration Item
CSM	Cargo Systems Manual
CSS	Crew Support Station
CTB	Cargo Transfer Bag
CVIU	Common Video Interface Unit
CVT	Current Value Table
CVV	Carbon Dioxide Vent Valve
CWC	Contingency Water Collection

DAA	Docked Air-to-Air
DAG1	Docked A/G 1
DAIU	Docked Audio Interface Unit
DAP	Digital Autopilot
DC	Docking Compartment
dc	direct current
DCP	Display and Control Panel
DCSU	Direct Current Switching Unit
DDCU	DC-to-DC Converter Unit
DDCU-CP	DC-to-DC Converter Unit-Cold Plate
DDCU-E	External DDCU
DDCU-HP	DC-to-DC Converter Unit-Heat Pipe
DDCU-I	Internal DDCU
DFL	Data Format Load

DLA	Drive Locking Assembly
DMCU	Docking Mechanism Control Unit
DMS-R	Data Management System-Russian
dp/dt	delta pressure/delta time
DPA	Digital Preassembly
DPS	Data Processing System
DTO	Development Test Objective
DTV	Digital Television
E/L	Equipment Lock
E-Stop	Emergency Stop
EACP	EMU Audio Control Panel
EAIU	EMU Audio Interface Unit
EAS	Early Ammonia Servicer
EATCS	External Active Thermal Control Subsystem
ECLSS	Environmental Control and Life Support System
ECU	Electronics Control Unit
ED	Engagement Drive
EDDA	External Maneuvering Unit Don/Doff Assembly
EE	End Effector
EEATCS	Early External Active Thermal Control System
EET	Experiment Elapsed Time
EETCS	Early External Thermal Control System
EFGF	Electrical Flight-releasable Grapple Fixture
EGIL	Electrical Generation and Integrated Lighting Systems Engineer
EIA	Electrical Interface Assembly
EMPEV	Emergency Manual Pressure Equalization Value
EMU	Extravehicular Mobility Unit
EOA	EVA Ohmmeter Assembly
EPCE	Electrical Power Consuming Equipment
EPG	Electrical Power Generator
EPS	Electrical Power System
ER	Edge Router
ESA	External Sampling Adapter
ESP	External Stowage Platform
ESSMDM	Enhanced Space Station Multiplexer/Demultiplexer
ESU	End Stop Unit
ETCS	External Thermal Control System
ETI	Elapsed Time Indicator
ETRS	EVA Temporary Rail Stop
ETSD	EVA Tool Storage Device
ETVCG	External Television Cameras Group

EUE	Experiment Unique Equipment
EV	Extravehicular
EV-CPDS	Extravehicular-Charged Particle Directional Spectrometer
EVA	Extravehicular Activity
EVR	Extravehicular Robotics
EVSU	External Video Switching Unit
EXPRESS	EXpedite the PRocessing of Experiments to the Space Station
EXT	Experimental Terminal
EWIS	External Wireless Instrumentation System
FAWG	Flight Assignment Working Group
FC	Firmware Controller
FCC	Flat Controller Circuit
FCT	Flight Control Team
FCV	Flow Control Valve
FD	Flight Day
FDA	Fault Detection Annunciation
FDIR	Failure, Detection, Isolation and Recovery
FDS	Fire Detection and Suppression
FET	Field Effect Transistor
FGB	Functional Cargo Block
FHRC	Flex Hose Rotary Coupler
FI	Fault Isolator
FPU	Fluid Pumping Unit
FQDC	Fluid Quick Disconnect Coupling
FRD	Flight Requirements Document
FRGF	Flight Releasable Grapple Fixture
FSE	Flight Support Equipment
FSS	Fluid System Servicer
FWCI	Firmware Configuration Item
GAS	Get Away Special
GC	Growth Cell
GCA	Growth Cell Assembly
GFE	Government-Furnished Equipment
GFI	Ground Fault Interrupter
GJOP	Generic Joint Operations Panel
GLONASS	GLObal Navigational Satellite System
GN&C	Guidance, Navigation and Control
GNC	Guidance Navigation Computer
GPC	General Purpose Computer
GPRV	Gas Pressure regulating Valve

GPS	Global Positioning System
GUI	Graphical User Interface
H_2	Hydrogen
HAB	Habitat Module
HC	Hand Controller
HCA	Hollow Cathode Assembly
HCOR	High-Rate Communication Outage Recorder
HDR	High Data Rate
HDRL	High Date Rate Link
HEPA	High Efficiency Particulate Air
HGA	High Gain Antenna
HHL	Handheld Lidar
HP	Heat Pipe
HPGT	High Pressure Gas Tank
HRF	Human Research Facility
HRF-PUF-DK	Human Research Facility Puff Data Kit
HRF-Res	Human Research Facility Resupply
HRFM	High Rate Frame Multiplexer
HRM	High Rate Modem
HRS	Hand Reaction Switch
I/F	Interface
I/O	Input/Output
IAC	Internal Audio Controller
IAS	Internal Audio Subsystem
IATCS	Internal Active Thermal Control System
ICC	Integrated Cargo Carrier
ICOM	Intercom
IDA	Integrated Diode Assembly
IDRD	Increment Definition Requirements Document
IEA	Integrated Equipment Assembly
IFHX	Interface Heat Exchanger
IFI	Item for Investigation
IFM	In-flight Maintenance
IMCA	Integrated Motor Control Assembly
IMCS	Integrated Mission Control System
IMU	Impedance Matching Unit
IMV	Intermodule Ventilation
INCO	Instrumentation and Communication Officer
INSTM	Instrumentation
INT	Internal
INTSYS	Internal Systems

IOC	Input/Output Controller
IOCU	Input/Output Controller Unit
IP	International Partner
IRU	In-Flight Refill Unit
ISA	Internal Sampling Adapter
ISIS	International Space Station Interface Standard
ISL	Integrated Station LAN
ISO	Inventory and Stowage Officer
ISPR	International Standard Payload Rack
ISS	International Space Station
ISSPO	International Space Station Program Office
ISSSH	International Space Station Systems Handbook
IT	Integrated Truss
ITCS	Internal Thermal Control System
ITS	Integrated Truss Segment
IUA	Interface Umbilical Assembly
IV	Intravehicular
IVA	Intravehicular Activity
IVSU	Internal Video Switch Unit
IWIS	Internal Wireless Instrumentation System
JAXA	Japan Aerospace Exploration Agency
JEM	Japanese Experiment Module
JEU	Joint Electronic Unit
KSC	Kennedy Space Center
kW	Kilowatt
LA	Launch Aft
Lab	Laboratory
LAN	Local Area Network
LB	Local Bus
LB-RWS	RWS Local Bus
LCA	Lab Cradle Assembly
LCC	Launch Commit Criteria
LCD	Liquid Crystal Display
LDI	Local Data Interface
LDR	Low Data Rate
LDU	Linear Drive Unit
LED	Light-Emitting Diode
LEE	Latching End Effector
LEU	LEE Electronic Unit
LFDP	Load Fault Detection Protection

LGA	Low Gain Antenna
LLA	Low Level Analog
LMC	Lightweight Multipurpose Carrier
LON	Launch On Need
LT	Low Temperature
LTA	Launch to Activation
LTL	Low Temperature Loop
LTU	Load Transfer Unit
LVLH	Local Vertical Local Horizontal

MA	Mechanical Assembly
MAM	Manual Augmented Role
MBA	Motorized Bolt Assembly
MBE	Metal Bellows Expander
MBM	Manual Berthing Mechanism
MBS	Mobile Remote Service Base System
MBSU	Main Bus Switching Unit
MC	Midcourse Correction
MCA	Major Constituent Analyzer
MCAS	MBS Common Attach System
MCC	Mission Control Center
MCC-H	Mission Control Center-Houston
MCC-M	Mission Control Center-Moscow
MCDS	Multifunction CRT Display System
MCS	Motion Control System
MCU	MBS Computer Unit
MDA	Motor Drive Assembly
MDL	Middeck Locker
MDM	Multiplexer/Demultiplexer
MED OPS	Medical Operations
MEPS	Microencapsulation Electrostatic Processing System
MEPSI	Micro-Electromechanical System-based Pico Satellite Inspector
MER	Mission Evaluation Room
MET	Mission Elapsed Time
METOX	Metal Oxide
MFCV	Manual Flow Control Valve
MHS	MCU Host Software
MIL-STD	Military Standard
MILA	Mode Indicating Light Assembly
MIP	Mission Integration Plan
MISSE	Materials International Space Station Experiment
MLI	Multi-Layer Insulation

MM/OD	Micrometeoroid/Orbital Debris
MMT	Mission Management Team
MOD	Mission Operations Directorate
MPEV	Manual Pressure Equalization Valve
MPLM	Multipurpose Logistics Module
MPM	Manipulator Positioning Mechanism
MRL	Manipulator Retention Latch
MRS	Mobile Remote Servicer
MRSBS	Mobile Remote Servicer Base System
MSD	Mass Storage Device
MSFC	Marshall Space Flight Center
MSG	Microgravity Science Glovebox
MSS	Mobile Servicing System
MT	Mobile Transporter
MTCL	Mobile Transporter Capture Latch
MTL	Moderate Temperature Loop
MTS	Module-to-Truss Segment
MTSAS	Module-to-Truss Segment Attachment System
MTWsN	Move to Worksite Number

N_2	Nitrogen
N. mi.	Nautical mile
NASA	National Aeronautics and Space Administration
NCC	Nominal Corrective Combination burn
NCG	Non Condensable Gas
NCS	Node Control Software
NCU	Network Control Unit
NET	No Earlier Than
NIA	Nitrogen Interface Assembly
NiH_2	Nickel Hydrogen
NIV	Nitrogen Introduction Valve
NSI	NASA Standard Initiator
NSTS	National Space Transportation System
NTA	Nitrogen Tank Assembly

O_2	Oxygen
OCA	Orbital Communications Adapter
OCAD	Operational Control Agreement Document
OCJM	Operator-Commanded Joint Position Mode
OCPM	Operator-Commanded POR Mode
OCS	Operations and Control Software
ODIN	Orbital Design Integration System
ODS	Orbiter Docking System

OI	Operational Increment
OIU	Orbiter Interface Unit
OIV	Oxygen Isolation Valve
OMI	On-Orbit Maintainable Item
OMS	Orbital Maneuvering System
OPCGA	Observable Protein Crystal Growth Apparatus
OPP	OSVS Patch Panel
Ops	Operations
OPS LAN	Operations Local Area Network
ORBT	Optimized RBar Targeting Technique
ORCA	Oxygen Recharge Compressor Assembly
ORU	Orbital Replacement Unit
OSE	Orbiter Support Equipment
OSO	Operations Support Officer
OSVS	Orbiter Space Vision System
OTD	ORU Transfer Device
OV	Orbiter Vehicle
P&S	Pointing and Support
P-Code	Precision Code
P/L	Payload
P/TV	Photo/Television
P3/P4	Port 3/Port 4
PAS	Payload Attach System
PBA	Portable Breathing Apparatus
PC	Personal Computer
PCA	Pressure Control Assembly
PCAM	Protein Crystallization Apparatus for Microgravity
PCBM	Passive Common Berthing Mechanism
PCC	Power Converter Controller
PCG-STES	Protein Crystal Growth-Single Thermal Enclosure System
PCMCIA	Personal Computer Memory Card International Adapter
PCP	Pressure Control Panel
PCR	Portable Computer Receptacle
PCS	Portable Computer System
PCT	Post-Contact Thrusting
PCU	Plasma Connector Unit
PCVP	Pump and Control Valve Package
PDGF	Power and Data Grapple Fixture
PDI	Payload Data Interface
PDIP	Payload Data Interface Panel
PDRS	Payload Deployment and Retrieval System

PDTA	Power Data Transfer Assembly
PDU	Power Drive Unit
PEHG	Payload Ethernet Hub Gateway
PF	Payload Forward
PFCS	Pump Flow Control Subassembly
PFE	Portable Fire Extinguisher
PFMC	Pump/Fan Motor Controller
PFR	Portable Foot Restraint
PGBA-S	Plant Generic Bioprocessing Apparatus-Stowage
PGSC	Portable General Support Computer
PGT	Pistol Grip Tool
PHALCON	Power, Heating, Articulation, Lighting, and Control Officer
PJPAM	Pre-stored Joint Position Autosequence Mode
PLB	Payload Bay
PM	Pump Module
PMA	Pressurized Mating Adapter
PMCU	Power Management Control Unit
PMDIS	Perceptual Motor Deficits In Space
PMP	Payload Mounting Panel
POA	Payload/ORU Accommodation
POC	Portable Onboard Computer
POR	Point of Reference
POST	Power ON Self-Test
PP	Planning Period
PPA	Pump Package Assembly
PPAM	Pre-stored POR Autosequence Mode
ppO_2	partial pressure of oxygen
PPRV	Positive Pressure Relief Valve
PPT	Precipitate
PRD	Payload Retention Device
PRLA	Payload Retention Latch Assembly
Prox-Ops	Proximity Operations
PSN	Power Source Node
PSP	Payload Signal Processor
PTB	Payload Training Buffer
PTCS	Passive Thermal Control System
PTR	Port Thermal Radiator
PTU	Pan/Tilt Unit
PV	Photovoltaic
PVCA	Photovoltaic Controller Application
PVCE	Photovoltaic Controller Element
PVCU	Photovoltaic Controller Unit

PVM	Photovoltaic Module
PVR	Photovoltaic Radiator
PVRGF	Photovoltaic Radiator Grapple Fixture
PVTCS	Photovoltaic Thermal Control System
PWP	Portable Work Platform
PWR	Portable Water Reservoir
PYR	Pitch Yaw Roll
QD	Quick Disconnect
R/F	Refrigerator/Freezer
R&R	Removal and Replacement
RACU	Russian-to-American Converter Unit
RAIU	Russian Audio Interface Unit
RAM	Random Access Memory
RAMV	Rheostat Air Mix Valve
RB	Radiator Beam
RBB	Right Blanket Box
RBI	Remote Bus Isolator
RBVM	Radiator Beam Valve
RCC	Reinforced Carbon-Carbon
RCS	Reaction Control System
RDA	Retainer Door Assembly
RF	Radio Frequency
RFCA	Rack Flow Control Assembly
RFG	Radio Frequency Group
RGA	Rate Gyro Assemblies
RHC	Rotational Hand Controller
RHX	Regenerative Heat Exchanger
RIC	Rack Interface Controller
RJMC	Rotary Joint Motor Controller
RMS	Remote Manipulator System
ROBO	Robotics Operations Support Officer
ROS	Russian Orbital Segment
RP	Receiver/Processor
RPC	Remote Power Controller
RPCM	Remote Power Controller Module
RPDA	Remote Power Distribution Assembly
RPM	Rbar Pitch Maneuver
RPOP	Rendezvous and Proximity Operations Program
RS	Russian Segment
RSC	RMS Sideview Camera
RSP	Resupply Stowage Platform

RSR	Resupply Stowage Rack
RSTS	Rack Standalone Temperature Sensor
RSU	Roller Suspension Unit Remote Sensing Unit
RT	Remote Terminal
RT-Box	Reaction Time Box
RTAS	Rocketdyne Truss Attachment System
RTD	Resistive Thermal Device
RTL	Ready to Latch
RWS	Robotic Workstation
S	Starboard
S&M	Structures and Mechanisms
S3/S4	Starboard 3/Starboard 4
SA	Solar Array
SABB	Solar Array Blanket Box
SAGE	Space Arabidoposis Genomics Experiment
SARJ	Solar Alpha Rotary Joint
SARJ_C	SARJ Controller
SARJ_M	SARJ Manager
SASA	S-band Antenna Support Assembly
SAW	Solar Array Wing
SCA	Switchgear Controller Assembly
SCI	Signal Conditioning Interface
SCU	Service and Cooling Umbilical
SD	Smoke Detector
SDO	Solenoid Driver Output
SDS	Sample Delivery System
SEM	Shunt Electronics Module
SEPS	Secondary Electrical Power Subsystem
SFCA	System Flow Control Assembly
SFU	Squib Firing Unit
SGANT	Space-to-Ground Antenna
SHOSS	Spacehab Oceaneering Space System
SHOT	Space Hardware Optimization Technology
SIGI	Space Integrated Global Positioning System/Inertial Navigation System
SJRM	Single Joint Rate Mode
SLDP	Spacelab Data Processing
SLP	Spacelab Logistics Pallet
SM	Service Module
SMCC	Shuttle Mission Control Center
SMDP	Service Module Debris Panel
SOC	State of Charge

SOV	Shutoff Valve
SPCE	Servicing Performance and Checkout Equipment
SPD	Spool Positioning Device
SPDA	Secondary Power Distribution Assembly
SPDM	Special Purpose Dexterous Manipulator
SPG	Single-Point Ground
SRMS	Shuttle Remote Manipulator System
SSAS	Segment-to-Segment Attach System
SSBA	Space Station Buffer Amplifier
SSC	Station Support Computer
SSMDM	Space Station Multiplexer/Demultiplexer
SSOR	Space-to-Space Orbiter Ratio
SSP	Standard Switch Panel
SSPTS	Station-to-Shuttle Power Transfer System
SSRMS	Space Station Remote Manipulator System
SSSH	Space Shuttle Systems Handbook
SSSR	Space-to-Space Station Radio
SSU	Sequential Shunt Unit
STCR	Starboard Thermal Control Radiator
STES	Single Thermal Enclosure System
STR	Starboard Thermal Radiator
SVS	Space Vision System
TA	Thruster Assist
TAA	Triaxial Accelerometer Assembly
TAH	Tray Actuation Handle
TBA	Trundle Bearing Assembly
TC	Terminal Computer
TCCS	Trace Contaminant Control Subassembly
TCCV	Temperature Control and Check Valve
TCS	Trajectory Control Sensor
TD	Translation Drive
TDRS	Tracking and Data Relay Satellite
TDRSS	Tracking and Data Relay Satellite System
TEA	Torque Equilibrium Attitude
TFR	Translation Foot Restraint
THC	Temperature and Humidity Control
THOR	Thermal Operations and Resources Officer
TI	Terminal Phase Initiation
TORF	Twice Orbital Rate Flyaround
TORU	Teleoperator Control Mode
TORVA	Twice Orbital Rate +Rbar to +Vbar Approach

TPL	Transfer Priority List
TRAC	Test of Reaction and Adaption Capabilities
TRC	Transmitter Receiver Controller
TRRJ	Thermal Radiator Rotary Joint
TSP	Twisted Shielded Pair
TTCR	Trailing Thermal Control Radiator
TUS	Trailing Umbilical System
TVIS	Treadmill Vibration Isolation System
TWMV	Three-Way Mixing Valve

UB	User Bus
UCCAS	Unpressurized Cargo Carrier Attach System
UDG	User Data Generation
UF	Utilization Flight
UHF	Ultrahigh Frequency
UIA	Umbilical Interface Assembly
ULCAS	Unpressurized Logistics Carrier Attach System
UIP	Utility Interface Panel
ULF	Utilization Logistics Flight
UMA	Umbilical Mechanism Assembly
UOP	Utility Outlet Panel
USA	United Space Alliance
USL	U.S. Laboratory
USOS	United States On-Orbit Segment
UTA	Utility Transfer Assembly

VAJ	Vacuum Access Jumper
VBSP	Video Baseband Signal Processor
VCP	Video Camera Port
VCSA	Video Camera Support Assembly
VDS	Video Distribution System
VDU	Video Distribution Unit
VES	Vacuum Exhaust System
VGS	Video Graphics Software
VRCV	Vent/Relief Control Valve
VRIV	Vent/Relief Isolation Valve
VRS	VES Resource System
VRV	Vent/Relief Valve
VSC	Video Signal Converter
VSSA	Video Stanchion Support Assembly

W/S	Worksite
WETA	WVS External Transceiver Assembly

WHS	Workstation Host Software
WIF	Worksite Interface
WRM	Water Recovery Management
WS	Water Separator
WVA	Water Vent Assembly
XPOP	X-axis Pointing Out of Plane
ZCG-SS	Zeolite Crystal Growth—Sample Stowage
ZSR	Zero-g Stowage Rack

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MEDIA ASSISTANCE

NASA TELEVISION TRANSMISSION

NASA Television is carried on an MPEG-2 digital signal accessed via satellite AMC-6, at 72 degrees west longitude, transponder 17C, 4040 MHz, vertical polarization. For those in Alaska or Hawaii, NASA Television will be seen on AMC-7, at 137 degrees west longitude, transponder 18C, at 4060 MHz, horizontal polarization. In both instances, a Digital Video Broadcast (DVB)-compliant Integrated Receiver Decoder (IRD) (with modulation of QPSK/DBV, data rate of 36.86 and FEC ¾) will be needed for reception. The NASA Television schedule and links to streaming video are available at:

http://www.nasa.gov/ntv

NASA TV's digital conversion will require members of the broadcast media to upgrade with an 'addressable' Integrated Receiver Decoder, or IRD, to participate in live news events and interviews, press briefings and receive NASA's Video File news feeds on a dedicated Media Services channel. NASA mission coverage will air on a digital NASA Public Services ("Free to Air") channel, for which only a basic IRD will be needed. The schedule for television transmissions from the orbiter and for mission briefings will be available during the mission at Kennedy Space Center, Fla.; Marshall Space Flight Center, Huntsville, Ala.; Dryden Flight Research Center, Edwards, Calif.; Johnson Space Center, Houston; and NASA Headquarters, Washington. 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 posted at:

http://www.nasa.gov/shuttle

This site also contains information on the crew and will be updated regularly with photos and video clips throughout the flight.

Briefings

A mission press briefing schedule will be issued before launch. The updated NASA television schedule will indicate when mission briefings are planned.

Internet Information

Information on safety enhancements made since the Columbia Accident is available at:

www.nasa.gov/returntoflight/system/index.html

Information on other current NASA activities is available at:

http://www.nasa.gov/home

Resources for educators can be found at the following address:

http://education.nasa.gov

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PUBLIC AFFAIRS CONTACTS

HEADQUARTERS
WASHINGTON, DC

Allard Beutel
Public Affairs Officer
Space Operations
202-358-4769

Katherine Trinidad
Public Affairs Officer
Space Operations
202-358-3749

John Yembrick
Public Affairs Officer
Space Operations
202-358-0602

Michael Braukus
Public Affairs Officer
International Partners
202-358-1979

JOHNSON SPACE CENTER
HOUSTON, TEXAS

James Hartsfield
News Chief
281-483-5111

Kyle Herring
Public Affairs Specialist
Space Shuttle Program Office
281-483-5111

Kylie Clem
Public Affairs Specialist
Mission Operations and Flight Crew Operations
281-483-5111

Rob Navias
Program and Mission Operations Lead
281-483-5111

Lynnette Madison
Public Affairs Specialist
International Space Station and Engineering
281-483-5111

KENNEDY SPACE CENTER
FLORIDA

George Diller
Public Affairs Specialist
Space Shuttle
321-867-2468

Tracy Young
Public Affairs Specialist
International Space Station
321-867-2468

MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA

Dom Amatore
Public Affairs Manager
256-544-0034

June Malone
Public Affairs Specialist
News Chief/Media Manager
256-544-0034

Steve Roy
Public Affairs Specialist
Space Shuttle Propulsion
256-544-0034

STENNIS SPACE CENTER MISSISSIPPI

Linda Theobald
Public Affairs Specialist
228-688-3249

Paul Foerman
News Chief
228-688-1880

Rebecca Strecker
Public Affairs Specialist
228-688-3346

AMES RESEARCH CENTER MOFFETT FIELD, CALIFORNIA

Mike Mewhinney
News Chief
650-604-3937

Jonas Dino
Public Affairs Specialist
650-604-5612

DRYDEN FLIGHT RESEARCH CENTER CALIFORNIA

Alan Brown
News Chief
661-276-2665

Leslie Williams
Public Affairs Specialist
661-276-3893

GLENN RESEARCH CENTER CLEVELAND, OHIO

Lori Rachul
News Chief
216-433-8806

Katherine Martin
Public Affairs Specialist
216-433-2406

LANGLEY RESEARCH CENTER HAMPTON, VIRGINIA

H. Keith Henry
Deputy, Office of Public Affairs
757-864-6120

UNITED SPACE ALLIANCE

Mike Curie
Space Program Operations Contract
Houston Operations
281-483-9251
321-861-3805

Tracy Yates
Florida Operations
321-861-3956

BOEING

Ed Memi
Media Relations
Boeing NASA Systems
281-226-4029