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Mission Highlights STS-88

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Endeavour begins construction

The Shuttle *Endeavour* with five Americans and one Russian, began construction of the International Space Station. During the 12-day mission the international crew joined the U.S. Unity module and the Russian module, Zarya. Unity was attached to Zarya during a flawless shuttle flight that included three space walks to complete connections between the two elements.

Mission Events

The Shuttle *Endeavour* launched from Kennedy Space Center at 2:36 a.m. CST on December 4, 1998, to begin the largest cooperative space construction project in history.

Commander Robert Cabana steered the *Endeavour* to a picture perfect rendezvous with Zarya. Using the shuttle's Canadian built robotic arm, Mission Specialist Nancy Currie was then able to capture Zarya and managed an impressive docking with the Unity connecting module. The Unity was connected to the Zarya module, completing the first construction phase of the International Space Station.

Mission Specialists Jerry Ross and James Newman conducted three Extravehicular Activities (EVA). During the first EVA on flight day five, Ross and Newman made all umbilical connections necessary to activate the Zarya module. With the

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Astronaut James Newman, holds one of the hand rails on the Unity Connecting Module during the early stages of a 7-hour, 21-minute space walk.

Space Shuttle *Endeavour*

December 4–15, 1998

Commander:	Robert Cabana
Pilot:	Frederick Sturkow
Mission Specialists:	Jerry Ross
	Nancy Currie
	James Newman
	Sergei Krikalev

STS088-E-5124

From left, astronauts Robert Cabana, Jerry Ross and James Newman are pictured during work to ready the Unity connecting module for its International Space Station role.

electrical and data connections complete, Cabana and Krikalev issued the commands from *Endeavor*'s aft flight deck to activate the station's computers for the first time.

Tasks completed during the second EVA on flight day seven included installation of EVA handrails and foot restraint sockets, installation of the early communications (ECOMM) system antennas, and routing of the COMM cable from Zarya to the starboard antenna.

The crew performed the initial activation and first entry into the International Space Station preparing it for future assembly missions and full time occupation. The crew entered the Space Station and installed the ECOMM system equipment and transferred stowage items. The historic event took place between the second and third EVAs on flight day eight. The crew worked replacing a faulty battery controller and removing bolts, nuts and washers from panels that no longer were required.

The third EVA was performed on flight day nine to support objectives of downstream assembly missions. Tasks included installation of a large tool bag for storing EVA tools outside the station and repositioning of foot restraints. Additionally, the two crewmembers disconnected the umbilical on Pressurized Mating Adapter 2 (PMA-2) so that it can be relocated in the future.

Following the completion of the three EVAs, Zarya and Unity ingress activities, the orbiter undocked from the International Space Station.

In addition to the International Space Station tasks the crew also performed IMAX Cargo Bay Camera operations, deployed two antennas on Zarya and deployed two satellites, MightySat 1 and SAC-A. SAC-A was the first successful launch of an Argentine satellite.

Endeavour ended its mission with a landing at the Kennedy Space Center on December 15, 1998, at 9:54 p.m. CST. The mission was accomplished in 185 orbits of the Earth in 283 hours and 18 minutes. *Endeavour*'s landing at KSC marked the 10th night landing in the history of the Shuttle program. It was also the 17th straight landing at Kennedy Space Center and the 24th in the last 25 Shuttle missions to land at the Florida spaceport.

PAYLOADS

Unity Connecting Module (Node 1), is a passageway to the living and working areas of the International Space Station. It is the first major U.S.-built component of the station, joining Zarya. Unity was delivered by the space shuttle with Pressurized Mating Adapter 1 (PMA-1) prefitted to its aft port. The shuttle crew conducted three space walks to attach PMA-1 to Zarya and also prepared PMA-2 for its role in future missions.

In addition to its connection to Zarya, the node serves as a passageway to the U.S. laboratory module, U.S. habitation module and an airlock. It has six hatches that serve as docking ports for the other modules. The node is 15 feet long, 22 feet in diameter. It includes 4 equipment racks fabricated of aluminum. The node also contains more than 50,000 mechanical items, 216 lines to carry fluids and gases, and 121 internal and external electrical cables using six miles of wire.

IMAX Cargo Bay Camera (ICBC): The ICBC is a space-qualified, 65 mm color motion picture camera system consisting of a camera, lens assembly, and a film supply magazine containing approximately 3,500 feet of film and an empty take-up magazine.

The primary objectives of ICBC on STS-88 were to film the Node 1 installation onto the orbiter docking system, the functional cargo block rendezvous, docking, extravehicular activity tasks, separation burn, and fly around.

Satelite de Aplicaciones/ Cientifico-A (SAC-A): The SAC-A is a small non-recoverable satellite built by the Argentinean National Commission of Space Activities. The satellite tests and characterizes the performance of new equipment and technologies that may be used in future operational or

scientific missions. SAC-A is comprised of five separate experiments:

The Differential Global Positioning System Receiver experiment provided real time autonomous attitude measurements for the satellite, ultimately simplifying the amount of ground processing required to control an orbiting satellite.

The Charge Coupled Device Camera tested the camera for digital space photography performance. This camera focused on Earth imaging photography.

The Magnetometer experiment investigated the Earth's magnetic field and evaluated the Differential Global Positioning System Receiver performance.

The Solar Cells experiment evaluated the performance of a new solar cell design. This experiment was an in-flight assessment of the solar cells and panels developed by the Argentine National Commission of Atomic Energy.

The Whale Tracker experiment validated techniques that will be used to track the endangered whale population using hardware developed in Argentina.

MightySat 1: The MightySat 1 payload consisted of a non-recoverable all-composite spacecraft structure and experiments integrated with a Hitchhiker (HH) Ejection System, then mounted inside a lidless carrier. The HH equipment consists of one HH lightweight avionics plate, the HH avionics, one 5-cubic-foot HH canister, and one HH adapter beam assembly.

MightySat 1 is a United States Air Force Phillips Laboratory multi-mission small satellite program dedicated to providing frequent, inexpensive, on-orbit demonstrations of space system technologies. The MightySat 1 payload was launched from the shuttle via the Hitchhiker Ejection System, which is managed out of the Goddard Space Flight Center in Greenbelt, MD. The payload was deployed on flight day twelve.

The MightySat 1 payload had five advanced technology demonstration experiments:

The Advanced Composite Structure, which served as the structure for the vehicle, had no command interfaces with the spacecraft. All relevant data on the structure was captured in ground testing.

The Advanced Solar Cell experiment tested the performance of dual-junction solar cells comprised of Gallium Indium Phosphide layers atop a Gallium Arsenide (GaAs) layer. These dual junction cells provide more power than conventional GaAs cells.

The Microsystem and Packaging for Low Power Electronics experiment was a demonstration of advanced microelectronics and electronics packaging techniques. The objective was to provide an on-orbit demonstration of the electronics in the space environment.

The Shape-Memory Actuated Release Device payload demonstrated a new class of low shock release devices. Release devices are used to separate satellites from launch vehicle adapters, or to deploy antennae, solar arrays, and sensor covers. Such devices offer reduced shock levels because the separation time is longer. They are low-cost and can be completely reset.

The objective of the Micro-Particle Impact Detector experiment was to place as many detectors into space to provide indications of natural and man-made orbital debris. The principal investigator for MightySat 1 was the Air Force Research Laboratory.

STS088-355-015

Astronaut Jerry Ross, STS-88 mission specialist, is pictured during one of three space walks which were conducted on the twelve-day mission. The solar array panel for the Russian-built Zarya module can be seen along right edge.

STS088-E-5170

Inflight crew portrait for the STS-88 members on Endeavour's mid deck. From left are Frederick Sturckow, Jerry Ross, James Newman, Nancy Currie, Robert Cabana and Sergei Krikalev. A banner representing the participating countries of the International Space Station is in the background.

Space Experiment Module (SEM-07): Eleven experiments were flown on STS-88 as part of NASA's Space Experiment Module managed by Goddard Space Flight Center in Greenbelt, MD. The SEM program is an educational initiative to increase student access to space. Kindergarten through University students participated.

Teachers and their schools, participating in the NASA Educational Workshop for Mathematics, Science and Technology Program provided eight of the eleven experiments.

Getaway Special (G-093R): The objective of this experiment was to investigate the propagation of a vortex ring through a liquid-gas interface in microgravity. The G-093R payload was designed and built by the University of Michigan (Ann Arbor) students for the Exploration and Development of Space. Also known as the Vortex Ring Transit Experiment, G-093R attempted to answer basic questions about fluid atomization-the process whereby a liquid is converted into small droplets.

The main components of the G-093R experiment were a fluid test-cell system, a laser-based illumination system, a charge-coupled device digital imaging system, and a computer-based data acquisition and control system.

The University of Michigan sponsored the GAS payload.

CREW BIOGRAPHIES

Commander: Robert D. Cabana (Col., USMC). Cabana, 49, was born in Minneapolis, MN. He received a bachelor of science degree in mathematics from the United States Naval Academy.

Cabana became an astronaut in 1986, and has now logged more than 1,010 hours of space flight. He served as pilot on STS-41 and STS-53, and was mission commander on STS-65 and STS-88.

The STS-41 crew successfully deployed the Ulysses spacecraft, starting the interplanetary probe on its four-year journey, via Jupiter, to investigate the Polar Regions of the Sun.

The focus of STS-53 was the deployment of the classified Department of Defense payload DOD-1 and the performance of several Military-Man-in-Space and NASA experiments.

STS-65 was the second International Microgravity Laboratory mission utilizing the long Spacelab module in the payload bay. During the record setting 15-day flight, the crew conducted experiments focused on materials and life sciences research in a microgravity environment paving the way for future operations and cooperation aboard the International Space Station.

STS-88 was the first International Space Station assembly mission. During the 12-day mission the Unity module was mated with the Zarya module. Two crew members performed three space walks to connect umbilicals and attach tools/hardware for use in future EVAs. The crew also performed IMAX Cargo Bay Camera operations, and deployed two satellites, SAC-A and MightySat 1.

Pilot: Frederick W. "Rick" Sturckow (Maj., USMC). Sturckow, 37, was born in La Mesa, CA. He received a bachelor of science degree in mechanical engineering from California Polytechnic State University.

Sturckow became an astronaut in 1996. After completing a year of training, Sturckow was assigned to work technical issues for the Vehicle Systems and Operations Branch of the Astronaut Office at Johnson Space Center.

STS-88 was his first mission and he has now logged more than 283 hours of space flight.

Mission Specialist: Jerry L. Ross (Col., USAF). Ross, 50, was born in Crown Point, IN. He received a bachelor of science and master of science degrees in Mechanical Engineering from Purdue University.

Ross became an astronaut in 1981, and was a mission specialist on STS 61-B, STS-27, STS-37, STS-55, STS-74 and STS-88. He has logged more than 1,133 hours of space flight.

STS 61-B saw the deploy of the MORELOS-B, AUSSAT II, and SATCOM Ku-2 communications satellites, and two 6-hour space walks to demonstrate Space Station construction techniques with the EASE/ACCESS experiments.

STS-27 *Atlantis* was a Department of Defense mission.

The STS-37 crew deployed the 35,000-pound Gamma Ray Observatory. Ross performed two space walks totaling 10 hours and 49 minutes to manually deploy the stuck Gamma Ray Observatory antenna and to test prototype Space Station hardware.

Ross served as Payload Commander/Mission Specialist on STS-55 aboard the Orbiter *Columbia*. Nearly 90 experiments were conducted during the German-sponsored Spacelab D-2 mission to investigate life sciences, material sciences, physics, robotics, astronomy, and the Earth and its atmosphere.

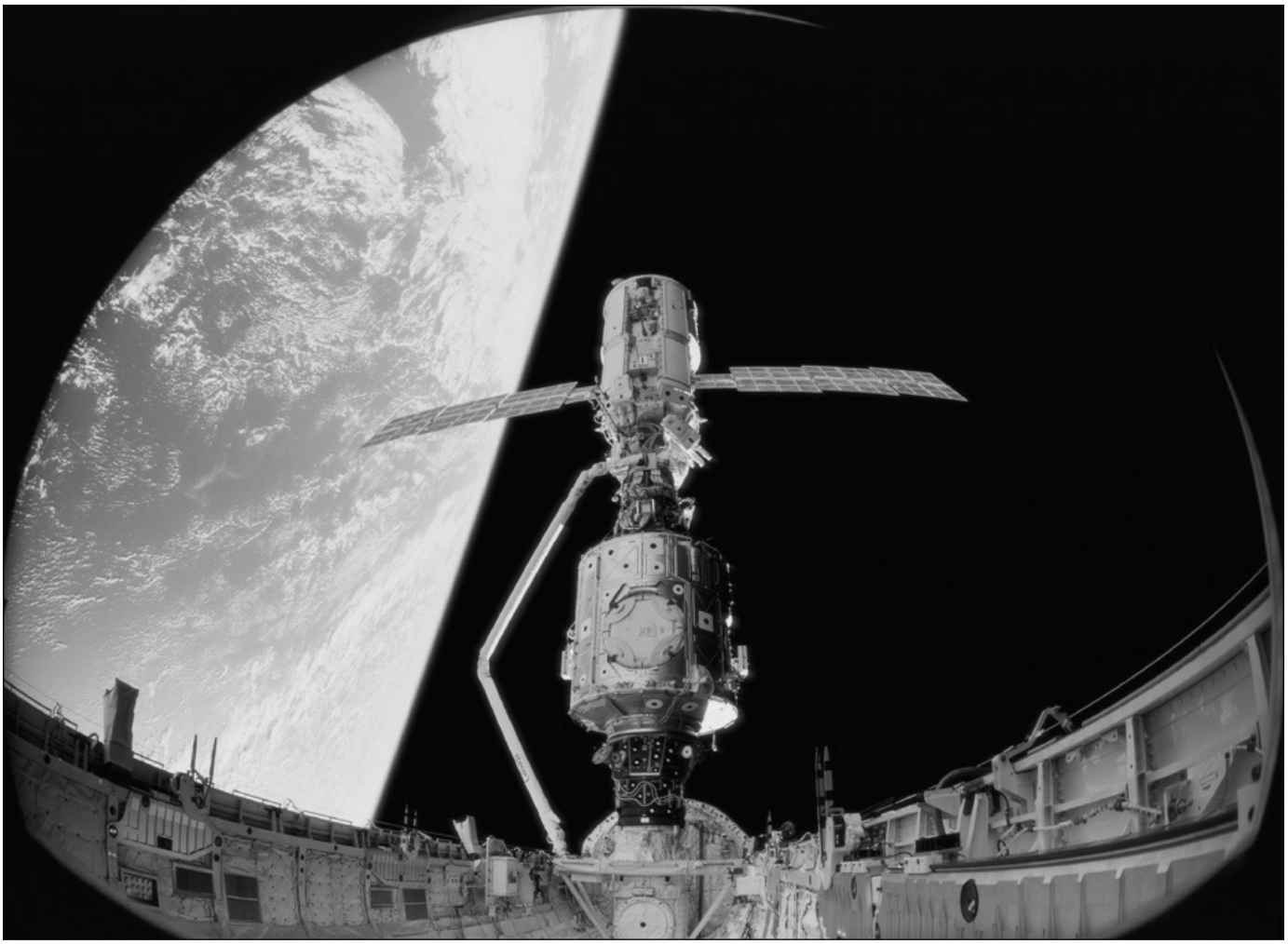
STS-74 *Atlantis* was NASA's second space shuttle mission to rendezvous and dock with the Russian Space Station Mir.

During the flight the crew attached a permanent docking module to Mir, conducted a number of secondary experiments, and transferred 1½ tons of supplies and experiment equipment between *Atlantis* and the Mir Space Station.

Mission Specialist: Nancy J. Currie (Lt. Col., USA). Currie, 40, was born in Wilmington, DE. She received a bachelor of arts degree in biological science from Ohio State University, a master of science degree in safety engineering from the University of Southern California, and a doctorate in industrial engineering from the University of Houston.

Currie became an astronaut in July 1991, and has logged more than 737 hours of space flight. She was a mission specialist on STS-57, STS-70 and STS-88.

The primary objective of STS-57 was the retrieval of the European



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The International Space Station as first seen by the STS-88 crew and captured by the large-format IMAX camera.

STS-88
Quick Look

Launch Date:	December 4, 1998	
Time:	2:36 a.m. CST	
Site:	KSC Pad 39A	
Orbiter:	*Endeavour* OV-105 –13th flight	
Orbit/In.:	173 naut. miles 51.6 degrees	
Mission Duration:	11 days, 19 hrs, 18 mns.	
Landing Date:	December 15, 1998	
Time:	9:54 p.m. CST	
Site:	Kennedy Space Center	
Crew:	Robert Cabana	(CDR)
	Frederick Sturckow	(PLT)
	Jerry Ross	(MS1)
	Nancy Currie	(MS2)
	James Newman	(MS3)
	Sergei Krikalev	(MS4)
Payloads:	Unity Connecting Module (Node 1), PMA-1, PMA-2, ICBC, SAC-A. MightySat 1, Space Experiment Module (SEM-07, Get Away Special	
Mission Events:	Delivered Unity, the first ISS connecting module. Completed first construction phase of the ISS by connecting Unity with the Zarya module. Performed the initial activation and first entry into the ISS. Two crew members performed three EVAs.	

Retrievable Carrier satellite using the RMS. Additionally, this mission featured the first flight of Spacehab, a commercially-provided mid deck augmentation module for the conduct of microgravity experiments, as well as a space walk by two crew members, which also involved the use of the shuttle's robotic arm.

STS-70 saw the deployment of the final NASA Tracking and Data Relay Satellite to complete the constellation of NASA's orbiting communication satellite system. The crew also conducted a myriad of biomedical and remote sensing experiments.

Mission Specialist: James H. Newman (Ph.D.). Newman, 42, was born in the Trust Territory of the Pacific Islands and received a bachelor of arts degree in physics from Dartmouth College, a master of arts degree and a doctorate in physics from Rice University.

Newman became an astronaut in July 1991, and has logged more than 779 hours of space flight. He was a mission specialist on STS-51, STS-69 and STS-88.

On the crew of STS-51, Newman conducted a seven-hour space walk to test tools and techniques for use on future missions.

The STS-69 crew successfully deployed and retrieved a SPARTAN satellite and the Wake Shield Facility. Also onboard was the International Extreme Ultraviolet Hitchhiker payload, numerous secondary payloads, and medical experiments.

Mission Specialist: Sergei K. Krikalev (Russian Cosmonaut). Krikalev, 40, was born in Leningrad, Russia, which has been renamed St. Petersburg. Krikalev became a cosmonaut in 1986. In 1988, he began training for his first long-duration flight aboard the MIR space station. Soyuz TM-7 was launched on November 26, 1988, with Krikalev as flight engineer.

Krikalev flew on STS-60, the first joint U.S./Russian space shuttle mission. This was the second flight of the Space Habitation Module-2, and the first flight of the Wake Shield Facility. The crew of *Discovery* conducted a wide variety of materials science, earth observation, and life science experiments. Krikalev conducted significant portions of the Remote Manipulator System operations during the flight.

Combined with his Russian space experience, Krikalev has logged more than 1 year, 3 months and 19 days in space, including seven EVAs.

The STS-88 patch commemorates the first assembly flight to carry U.S.-built hardware for constructing the International Space Station. This flight's primary task is to assemble the cornerstone of the Space Station: the Node with the Functional Cargo Block. The rising sun symbolizes the dawning of a new era of international cooperation in space and the beginning of a new program: the International Space Station. The Earth scene outlines the countries of the Station Partners: the United States, Russia, those of the European Space Agency, Japan, and Canada. Along with the Pressurized Mating Adapters and the Functional Cargo Block, the Node is shown in the final mated configuration while berthed to the Space Shuttle during the STS-88/2A mission. The Big Dipper Constellation points the way to the North Star, a guiding light for pioneers and explorers for generations. These stars symbolize the efforts of everyone, including all the countries involved in the design and construction of the International Space station, guiding us into the future.