The CBS News

Space Reporter's Handbook
Mission Supplement

Shuttle Mission STS-107:
Spacehab Microgravity Research

Written and Edited By

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Revision History

Editor's Note

Mission-specific sections of the Space Reporter's Handbook are posted as flight data becomes available. Readers should check the CBS News "Space Place" web site in the weeks before a launch to download the latest edition:

http://www.cbsnews.com/network/news/space/current.html

DATE POSTED	RELEASE NOTES
01/10/03	Initial release
01/15/03	Updating with actual launch time; flight plan, etc.

Introduction

This document is an outgrowth of my original UPI Space Reporter's Handbook, prepared prior to STS-26 for United Press International and updated for several flights thereafter due to popular demand. The current version is prepared for CBS News.

As with the original, the goal here is to provide useful information on U.S. and Russian space flights so reporters and producers will not be forced to rely on government or industry public affairs officers at times when it might be difficult to get timely responses. All of this data is available elsewhere, of course, but not necessarily in one place.

The SRH features a mission-specific "press kit" supplement, a Quick-Look Facts & Figures supplement and several appendixes covering shuttle program background, space demographics, abort data and information about the Challenger accident. The STS-107 version of the CBS News Space Reporter's Handbook was compiled from NASA news releases, JSC flight plans, the Shuttle Flight Data and In-Flight Anomaly List, NASA Public Affairs and the Flight Dynamics office (abort boundaries) at the Johnson Space Center in Houston.

Appendix 3 - Shuttle Abort Background - is written primarily in present tense so portions can be read aloud on the air if necessary. Each abort section is a stand-alone document in that general abort background is repeated in each section. The Quick-Look supplement is provided to serve as a stand-alone quick reference for on-air reporters and anchors during launch and landing. As such, much of the data therein is repeated elsewhere in the SRH.

Sections of NASA's STS-107 press kit, crew bios and the mission TV schedule were downloaded via the Internet, formatted and included in this document. Word-for-word passages (other than lists) are clearly indicated.

The SRH is prepared on a Macintosh computer using Word 5.1 and Adobe Acrobat 5.0. It is a work in progress and while every effort is made to insure accuracy, errors are inevitable in a document of this nature and readers should double check critical data before publication.

As always, questions, comments and suggestions for improvements are always welcome. And if you spot a mistake or a typo, please let me know!

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NASA Media Information

NASA Television Transmission

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

The schedule for television transmissions from the orbiter and for mission briefings will be available during the mission at Kennedy Space Center, FL; Marshall Space Flight Center, Huntsville, AL; Dryden Flight Research Center, Edwards, CA; Johnson Space Center, Houston, TX; and NASA Headquarters, Washington, DC. The television schedule will be updated to reflect changes dictated by mission operations.

Status Reports

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

Briefings

A mission press briefing schedule will be issued before launch. During the mission, status briefings by a flight director or mission operations representative and when appropriate, representatives from the payload team, will occur at least once each day. The updated NASA television schedule will indicate when mission briefings are planned.

Internet Information

Information is available through several sources on the Internet. The primary source for mission information is the NASA Shuttle Web, part of the World Wide Web. This site contains information on the crew and its mission and will be updated regularly with status reports, photos and video clips throughout the flight. The NASA Shuttle Web's address is:

http://shuttle.nasa.gov or http://www.hq.nasa.gov/osf/

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

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

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

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

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

http://www.nasa.gov/ntv

Status reports, TV schedules and other information also are available from the NASA headquarters FTP (File Transfer Protocol) server, ftp.hq.nasa.gov. Log in as anonymous and go to the directory /pub/pao. Users should log on with the user name "anonymous" (no quotes), then enter their E-mail address as the password.

NASA Public Affairs Contacts

Kennedy Space Center	407-867-2468 (voice) 407-867-2692 (fax) 407-867-2525 (code-a-phone)
Johnson Space Center	281-483-5811 (voice) 281-483-2000 (fax) 281-483-8600 (code-a-phone)
Marshall Space Flight Center	256-544-0034 (voice) 256-544-5852 (fax) 256-544-6397 (code-a-phone).

Acronyms Used in This Document

Abbreviation	Meaning
Alt	Maximum altitude, or apogee, for shuttle missions
Apo	High point, or apogee, of an orbit
CDR	Mission commander; sits in left seat
Cryo	Shuttle fuel cell tank sets
D	Miles traveled
Day/Night	Day or night launch or landing
EOM	End of mission
ET	External tank
FE	Flight engineer
GPC	Shuttle computer software edition
Incl	Inclination
Lnd	Landing time
LV	Launch vehicle designation
ME	Space shuttle main engine serial number
MET	Mission elapsed time
MS	Mission specialist, i.e., a full-time astronaut
OMS	Orbital Maneuvering System
Pad	Launch pad
Per	Low point, or perigee, of an orbit
PLS	Primary landing site
PLT	Shuttle pilot; sits in right seat
PS	Payload specialist, i.e., not a full-time astronaut
Revs	Orbits
RMS	Shuttle robot arm (remote manipulator system)
RO,LO	Right OMS, Left OMS pod serial numbers
RW	Runway
SET	Shuttle program elapsed time
SOM	Start of mission
SRB/SRM	Shuttle booster serial number
SSME	Space shuttle main engine
TD	Touchdown time
T-0	Launch time
VET	Individual vehicle elapsed time

STS-107: Internet Pages of Interest

CBS Shuttle Statistics	http://www.cbsnews.com/network/news/space/spacestats.html
CBS Current Mission Page	http://www.cbsnews.com/network/news/space/current.html
CBS Challenger Background	http://www.cbsnews.com/network/news/space/51Lintro.html
NASA Shuttle Home Page	http://spaceflight.nasa.gov/shuttle/
NASA Station Home Page	http://spaceflight.nasa.gov/station/
NASA News Releases	http://spaceflight.nasa.gov/spacenews/index.html
KSC Status Reports	http://www-pao.ksc.nasa.gov/kscpao/status/stsstat/current.htm
JSC Status Reports	http://spaceflight.nasa.gov/spacenews/reports/index.html
STS-107 NASA Press Kit	http://www.shuttlepresskit.com/
STS-107 Imagery	http://spaceflight.nasa.gov/station/crew/exp6/index.html
STS-107 Crew Home Page	http://spaceflight.nasa.gov/shuttle/crew/index.html
ISS-5 Crew Home Page	http://spaceflight.nasa.gov/station/crew/exp5
ISS-6 Crew Home Page	http://spaceflight.nasa.gov/station/crew/exp6/index.html
Spaceflight Meteorology Group	http://www.srh.noaa.gov/smg/smgwx.htm
Hurricane Center	http://www.nhc.noaa.gov/index.shtml
Melbourne, Fla., Weather	http://www.srh.noaa.gov/mlb/-
Entry Groundtracks	http://spaceflight.nasa.gov/realdata/index.html
NASA TV Links	http://www.nasa.gov/ntv/ntvweb.html
NASA TV Sked	http://www.nasa.gov/ntv/ntvweb.html
Comprehensive TV/Audio Links	http://www.idb.com.au/dcottle/pages/nasatv.html

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STS-107: Quick-Look Mission Data

Flight Data	Crew/Notes	Payload	Hardware
STS-107 (113th flight)	CD: AF Col. Rick Husband, 45 (1)	Primary:	ME 1: 2056-2
OV: Columbia (28)	PL: Navy Cmdr. William McCool, 42 (0)	Spacehab	ME 2: 2053-2
SOM: 01/16/03	M1/EV1: Navy Capt. David Brown, 46 (0)	Microgravity	ME 3: 2049-2
T-0: 10:39 a.m. EST	M2/FE: Kalpana Chawla, 41 (1)	Research	SRB: Bi116
Pad/MLP: 39A/MLP-1	M3/EV2: AF Lt. Col. Mike Anderson, 42 (1)		SRM: RSRM-88
TAL: Moron/Zaragoza	M4: Navy Cmdr. Laurel Clark, M.D., 41 (0)		LO: LPO5/17/F2
OMS-2: 176/168 sm	P1: Ilan Ramon (Israel), 48 (0)		RO: RPO5/16/F2
Deorb: TBD			FRCS: FRC2/28/F2
Inclination: 39	FD: Kelly Beck		ET: 93
EOM: 02/02/03			RMS: None
TD: 08:49 a.m.			Software: OI-29
Site: KSC			Cryo/GN2: 9/5
RW: 33/15	**NOTES**:		Thrust: 104
Day (85)/Day (93)	Spacehab double module microgravity		Xrange: TBD
Revs: 255	research mission; more than 80		LNC WGT: 263,701
MET: 15/22:10	experiments; dual-shift 24/7 operations;		PLD WGT: TBD
VET: 284/19:19:01	cryo pallet; Ramon becomes the first		DEP WGT: N/A
SET: 1015/14:14:51	Israeli to fly in space		LND WGT: 232,788

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Countdown and Mission Highlights

Date	Time	Event	Date	Time	Event
01/12	08:00 p.m.	Crew arrives at KSC	N/A		ISS Docking
	11:00 p.m.	Countdown begins	N/A		Spacewalk 1
01/14	04:00 p.m.	Pre-launch briefing	N/A		Spacewalk 2
01/15	07:00 a.m.	ISS spacewalk begins	N/A		Crew news conference
	01:20 p.m.	ISS spacewalk ends	N/A		Spacewalk 3
01/16	02:19 a.m.	Shuttle fueling begins			
	07:30 a.m.	NASA coverage begins	N/A		ISS undocking
	09:59 a.m.	T-20 hold (10 minutes)			
	10:09 a.m.	Resume countdown	02/01	03:49 a.m.	Deorbit timeline begins
	10:20 a.m.	T-9 hold		05:20 a.m.	Close cargo bay doors
	10:30 a.m.	Resume countdown		08:00 a.m.	Deorbit ignition
	10:39 a.m.	Launch		08:56 a.m.	Landing

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The Sun, Moon and Planets at Launch

01/16/03	Rise	Transit	Set	Az/Alt	Visibility
Sun	07:17 a.m.	12:32 p.m.	05:47 p.m.	148+33	Yes
Moon	03:20 p.m.	10:31 p.m.	05:45 a.m.	N/A	No

Space Shuttle and Space Station Crew Data

Rank	Rank/Shift	Age	History/Time in Space*	MS	DOB
	RED SHIFT				
CDR	Air Force Col. Rick Husband Red Shift	45	STS-96 9.8 days	M/2	07/12/57
MS-2/FE	Kalpana Chawla, Ph.D. Red Shift	41	STS-87 15.7	S/0	07/01/61
MS-4	Navy Cmdr. Laurel Clark Red Shift	41	Rookie 0.0	M/1	03/10/61
PS-1	Israeli Air Force Col. Ilan Ramon Red Shift	48	Rookie 0.0	M/4	06/20/54
	BLUE SHIFT				
Pilot	Navy Cmdr. William McCool Blue Shift	42	Rookie 0.0 days	M/0	09/23/61
MS-1/EV-1	Navy Capt. David Brown Blue Shift	46	Rookie 0.0 days	S/?	04/16/56
MS-3/EV-2	Air Force Lt. Col. Mike Anderson Blue Shift	42	STS-89 8.8	M/0	12/25/59
	ISS Expedition 6 Crew				
ISS-6 CDR	Navy Capt. Kenneth Bowersox	46	STS-50,61,73,82,113/ISS6 95.5	M/?	11/14/56
ISS-6 FE	Cosmonaut Nikolai Budarin	49	Mir-19,25,STS-113/ISS6 330.5	M/2	04/29/53
ISS-6 SO	Donald Pettit, Ph.D.	47	STS-113/ISS6 45.5	M/2	04/20/55

* Time in space as of 01/08/03

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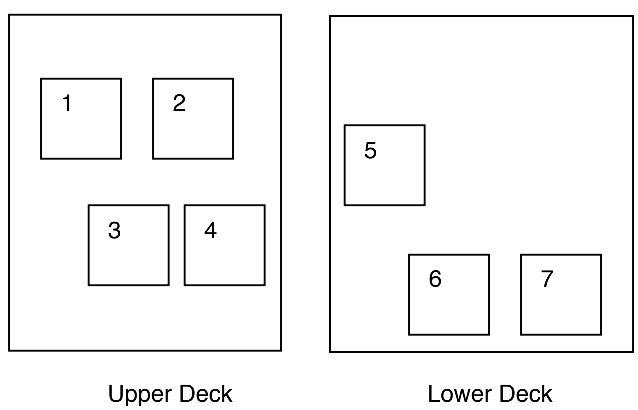
Crew Seating for Launch and Entry

Launch	Entry
1. Husband	1. Husband
2. McCool	2. McCool
3. Chawla	3. Chawla
4. Brown	4. Clark
5. Clark	5. Brown
6. Anderson	6. Anderson
7. Ramon	7. Ramon
8. N/A	8. N/A



STS-107 NASA Crew Biographies

1. Commander: Air Force Col. Rick Husband, 45

PERSONAL DATA
Born July 12, 1957, in Amarillo, Texas. Married. Two children. He enjoys singing, water and snow skiing, cycling, and spending time with his family.

EDUCATION
Graduated from Amarillo High School, Amarillo, Texas, in 1975. Received a bachelor of science degree in mechanical engineering from Texas Tech University in 1980, and a master of science degree in mechanical engineering from California State University, Fresno, in 1990.

ORGANIZATIONS
Member of the Society of Experimental Test Pilots, Tau Beta Pi, Air Force Association, and the Texas Tech Ex-Students Association.

SPECIAL HONORS
Distinguished Graduate of AFROTC, Undergraduate Pilot Training, Squadron Officers School, F-4 Instructor School, and USAF Test Pilot School; Outstanding Engineering Student Award, Texas Tech University, 1980; F-4 Tactical Air Command Instructor Pilot of the Year (1987); named a 1997 Distinguished Engineer of the College of Engineering, Texas Tech University. Military decorations include the Meritorious Service Medal with two Oak Leaf Clusters, the Aerial Achievement Medal, the Air Force Commendation Medal, the National Defense Service Medal, two NASA Group Achievement Awards for work on the X-38 Development Team and the Orbiter Upgrade Definition Team.

EXPERIENCE
After graduation from Texas Tech University in May 1980, Husband was commissioned a second lieutenant in the USAF and attended pilot training at Vance Air Force Base (AFB), Oklahoma. He graduated in October 1981, and was assigned to F-4 training at Homestead AFB, Florida. After completion of F-4 training in September 1982, Husband was assigned to Moody AFB, Georgia flying the F-4E. From September to November 1985, he attended F-4 Instructor School at Homestead AFB and was assigned as an F-4E instructor pilot and academic instructor at George AFB, California in December 1985. In December 1987, Husband was assigned to Edwards AFB, California, where he attended the USAF Test Pilot School.

Upon completion of Test Pilot School, Husband served as a test pilot flying the F-4 and all five models of the F-15. In the F-15 Combined Test Force, Husband was the program manager for the Pratt & Whitney F100-PW-229 increased performance engine, and also served as the F-15 Aerial Demonstration Pilot. In June 1992, Husband was assigned to the Aircraft and Armament Evaluation Establishment at Boscombe Down, England, as an exchange test pilot with the Royal Air Force. At Boscombe Down, Husband was the Tornado GR1 and GR4 Project Pilot and served as a test pilot in the Hawk, Hunter, Buccaneer, Jet Provost, Tucano, and Harvard. He has logged over 3800 hours of flight time in more than 40 different types of aircraft.

NASA EXPERIENCE
Husband was selected as an astronaut candidate by NASA in December 1994. He reported to the Johnson Space Center in March 1995 to begin a year of training and evaluation. Upon completion of training, Husband was named the Astronaut Office representative for Advanced Projects at Johnson Space Center, working on Space Shuttle Upgrades, the Crew Return Vehicle (CRV) and studies to return to the Moon and travel to Mars. Most recently, he served as Chief of Safety for the Astronaut Office. He flew as pilot on STS-96 in 1999, and has logged 235 hours and 13 minutes in space. Husband is assigned to command the crew of STS-107 scheduled for launch in 2002.

SPACE FLIGHT EXPERIENCE
STS-96 Discovery (May 27 to June 6, 1999) was a 10-day mission during which the crew performed the first docking with the International Space Station and delivered 4 tons of logistics and supplies in preparation for the arrival of the first crew to live on the station early next year. The mission was accomplished in 153 Earth orbits, traveling 4 million miles in 9 days, 19 hours and 13 minutes.

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2. Pilot: Navy Cmdr. William "Willie" McCool, 42

PERSONAL DATA
Born September 23, 1961 in San Diego, California. Married. He enjoys running, mountain biking, back country hiking/camping, swimming, playing guitar, chess.

EDUCATION
Graduated from Coronado High School, Lubbock, Texas, in 1979; received a bachelor of science degree in applied science from the US Naval Academy in 1983, a master of science degree in computer science from the University of Maryland in 1985, and a master of science degree in aeronautical engineering from the US Naval Postgraduate School in 1992.

ORGANIZATIONS
U.S. Naval Academy Alumni Association.

SPECIAL HONORS
Eagle Scout; graduated second of 1,083 in the Class of 1983 at the US Naval Academy; presented "Outstanding Student" and "Best DT-II Thesis" awards as graduate of U.S. Naval Test Pilot School, Class 101; awarded Navy Commendation Medals (2), Navy Achievement Medals (2), and various other service awards.

EXPERIENCE
McCool completed flight training in August 1986 and was assigned to Tactical Electronic Warfare Squadron 129 at Whidbey Island, Washington, for initial EA-6B Prowler training. His first operational tour was with Tactical Electronic Warfare Squadron 133, where he made two deployments aboard USS CORAL SEA (CV-43) to the Mediterranean Sea, and received designation as a wing qualified landing signal officer (LSO). In November 1989, he was selected for the Naval Postgraduate School/Test Pilot School (TPS) Cooperative Education Program.

After graduating from TPS in June 1992, he worked as TA-4J and EA-6B test pilot in Flight Systems Department of Strike Aircraft Test Directorate at Patuxent River, Maryland. He was responsible for the management and conduct of a wide variety of projects, ranging from airframe fatigue life studies to numerous avionics upgrades. His primary efforts, however, were dedicated to flight test of the Advanced Capability (ADVCAP) EA-6B.

Following his Patuxent River tour, McCool returned to Whidbey Island, and was assigned to Tactical Electronic Warfare Squadron 132 aboard USS ENTERPRISE (CVN-65). He served as Administrative and Operations Officer with the squadron through their work-up cycle, receiving notice of NASA selection while embarked on ENTERPRISE for her final pre-deployment at-sea period.

McCool has over 2,800 hours flight experience in 24 aircraft and over 400 carrier arrestments.

NASA EXPERIENCE
Selected by NASA in April 1996, McCool reported to the Johnson Space Center in August 1996. He completed two years of training and evaluation, and is qualified for flight assignment as a pilot. Initially assigned to the Computer Support Branch, McCool also served as Technical Assistant to the Director of Flight Crew Operations, and worked Shuttle cockpit upgrade issues for the Astronaut Office. He is assigned as pilot on STS-107 scheduled for launch in 2002.

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3. MS1/EV1: Navy Capt. David Brown, 46

PERSONAL DATA
Born April 16, 1956 in Arlington, Virginia. Single. Enjoys flying and bicycle touring. Was a four year collegiate varsity gymnast. While in college he performed in the Circus Kingdom as an acrobat, 7 foot unicyclist and stilt walker. His parents, Paul and Dorothy Brown, reside in Washington, Virginia.

EDUCATION
Graduated from Yorktown High School, Arlington, Virginia, in 1974; received bachelor of science degree in biology from the College of William and Mary in 1978 and a doctorate in medicine from Eastern Virginia Medical School in 1982.

ORGANIZATIONS
Past President, International Association of Military Flight Surgeon Pilots. Associate Fellow, Aerospace Medical Association. Society of U.S. Naval Flight Surgeons.

SPECIAL HONORS
Navy Operational Flight Surgeon of the Year in 1986, Meritorious Service Medal, Navy Achievement Medal.

EXPERIENCE
Brown joined the Navy after his internship at the Medical University of South Carolina. Upon completion of flight surgeon training in 1984, he reported to the Navy Branch Hospital in Adak, Alaska, as Director of Medical Services. He was then assigned to Carrier Airwing Fifteen which deployed aboard the USS Carl Vinson in the western Pacific. In 1988, he was the only flight surgeon in a ten year period to be chosen for pilot training. He was ultimately designated a naval aviator in 1990 in Beeville, Texas, ranking number one in his class. Brown was then sent for training and carrier qualification in the A-6E Intruder.

In 1991 he reported to the Naval Strike Warfare Center in Fallon, Nevada, where he served as a Strike Leader Attack Training Syllabus Instructor and a Contingency Cell Planning Officer. Additionally, he was qualified in the F-18 Hornet and deployed from Japan in 1992 aboard the USS Independence flying the A-6E with VA-115. In 1995, he reported to the U.S. Naval Test Pilot School as their flight surgeon where he also flew the T-38 Talon.

Brown has logged over 2,700 flight hours with 1,700 in high performance military aircraft. He is qualified as first pilot in NASA T-38 aircraft.

NASA EXPERIENCE
Selected by NASA in April 1996, Brown reported to the Johnson Space Center in August 1996. Having completed two years of training and evaluation, he is eligible for flight assignment as a mission specialist. He was initially assigned to support payload development for the International Space Station, followed by the astronaut support team responsible for orbiter cockpit setup, crew strap-in, and landing recovery. He is currently assigned to the crew of STS-107 scheduled to launch in 2002.

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4. MS2/FE: Kalpana Chawla, Ph.D., 41

PERSONAL DATA
Born in Karnal, India. Kalpana Chawla enjoys flying, hiking, back-packing, and reading. She holds Certificated Flight Instructor's license with airplane and glider ratings, Commercial Pilot's licenses for single- and multi-engine land and seaplanes, and Gliders, and instrument rating for airplanes. She enjoys flying aerobatics and tail-wheel airplanes.

EDUCATION
Graduated from Tagore School, Karnal, India, in 1976. Bachelor of science degree in aeronautical engineering from Punjab Engineering College, India, 1982. Master of science degree in aerospace engineering from University of Texas, 1984. Doctorate of philosophy in aerospace engineering from University of Colorado, 1988.

EXPERIENCE
In 1988, Kalpana Chawla started work at NASA Ames Research Center in the area of powered-lift computational fluid dynamics. Her research concentrated on simulation of complex air flows encountered around aircraft such as the Harrier in "ground-effect." Following completion of this project she supported research in mapping of flow solvers to parallel computers, and testing of these solvers by carrying out powered lift computations. In 1993 Kalpana Chawla joined Overset Methods Inc., Los Altos, California, as Vice President and Research Scientist to form a team with other researchers specializing in simulation of moving multiple body problems. She was responsible for development and implementation of efficient techniques to perform aerodynamic optimization. Results of various projects that Kalpana Chawla participated in are documented in technical conference papers and journals.

NASA EXPERIENCE
Selected by NASA in December 1994, Kalpana Chawla reported to the Johnson Space Center in March 1995 as an astronaut candidate in the 15th Group of Astronauts. After completing a year of training and evaluation, she was assigned as crew representative to work technical issues for the Astronaut Office EVA/Robotics and Computer Branches. Her assignments included work on development of Robotic Situational Awareness Displays and testing space shuttle control software in the Shuttle Avionics Integration Laboratory.

In November, 1996, Kalpana Chawla was assigned as mission specialist and prime robotic arm operator on STS-87 (November 19 to December 5, 1997). STS-87 was the fourth U.S Microgravity Payload flight and focused on experiments designed to study how the weightless environment of space affects various physical processes, and on observations of the Sun's outer atmospheric layers. Two members of the crew performed an EVA (spacewalk) which featured the manual capture of a Spartan satellite, in addition to testing EVA tools and procedures for future Space Station assembly. In completing her first mission, Kalpana Chawla traveled 6.5 million miles in 252 orbits of the Earth and logged 376 hours and 34 minutes in space.

In January, 1998, Kalpana Chawla was assigned as crew representative for shuttle and station flight crew equipment. Subsequently, she was assigned as the lead for Astronaut Office's Crew Systems and Habitability section. She is currently assigned to the crew of STS-107 scheduled for launch in 2002.

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5. MS3/EV2: Air Force Lt. Col. Michael Anderson, 42

PERSONAL DATA
Born December 25, 1959, in Plattsburgh, New York. Considers Spokane, Washington, to be his hometown. Married. Enjoys photography, chess, computers, and tennis.

EDUCATION
Graduated from Cheney High School in Cheney, Washington, in 1977. Bachelor of science degree in physics/astronomy from University of Washington, 1981. Master of science degree in physics from Creighton University, 1990.

SPECIAL HONORS
Distinguished graduate USAF Communication Electronics Officers course. Recipient of the Armed Forces Communication Electronics Associations Academic Excellence Award 1983. Received the USAF Undergraduate Pilot Training Academic Achievement Award for Class 87-08 Vance AFB. Awarded the Defense Superior Service Medal, the USAF Meritorious Service Medal, and the USAF Achievement Medal with one oak leaf cluster.

EXPERIENCE
Anderson graduated form the University of Washington in 1981 and was commissioned a second lieutenant. After completing a year of technical training at Keesler AFB Mississippi he was assigned to Randolph AFB Texas. At Randolph he served as Chief of Communication Maintenance for the 2015 Communication Squadron and later as Director of Information System Maintenance for the 1920 Information System Group. In 1986 he was selected to attend Undergraduate Pilot Training at Vance AFB, Oklahoma. Upon graduation he was assigned to the 2nd Airborne Command and Control Squadron, Offutt AFB Nebraska as an EC 135 pilot, flying the Strategic Air Commands airborne command post code-named "Looking Glass".

From January 1991 to September 1992 he served as an aircraft commander and instructor pilot in the 920th Air Refueling Squadron, Wurtsmith AFB Michigan. From September 1992 to February 1995 he was assigned as an instructor pilot and tactics officer in the 380 Air Refueling Wing, Plattsburgh AFB New York. Anderson has logged over 3000 hours in various models of the KC-135 and the T-38A aircraft.

NASA EXPERIENCE
Selected by NASA in December 1994, Anderson reported to the Johnson Space Center in March 1995. He completed a year of training and evaluation, and is qualified for flight crew assignment as a mission specialist. Anderson was initially assigned technical duties in the Flight Support Branch of the Astronaut Office. Most recently, he flew on the crew of STS-89. In completing his first space flight Anderson has logged over 211 hours in space. Anderson is assigned to the crew of STS-107 scheduled to launch in 2002.

SPACE FLIGHT EXPERIENCE
STS-89 (January 22-31, 1998), was the eighth Shuttle-Mir docking mission during which the crew transferred more than 9,000 pounds of scientific equipment, logistical hardware and water from Space Shuttle Endeavour to Mir. In the fifth and last exchange of a U.S. astronaut, STS-89 delivered Andy Thomas to Mir and returned with David Wolf. Mission duration was 8 days, 19 hours and 47 seconds, traveling 3.6 million miles in 138 orbits of the Earth.

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6. MS4: Navy Cmdr. Laurel Clark, M.D., 41

PERSONAL DATA
Born March 10, 1961 in Ames, Iowa, but considers Racine, Wisconsin, to be her hometown. Married to Jonathan B. Clark (Captain, USN). They have one child. She enjoys scuba diving, hiking, camping, biking, parachuting, flying, traveling. Her mother and step-father, Dr. and Mrs. R.J.C. Brown, reside in Racine, Wisconsin. Her father and step-mother, Mr. and Mrs. Robert Salton, reside in Albuquerque, New Mexico. His parents, Colonel (ret) & Mrs. E.B. Clark III, reside in Alexandria, Virginia.

EDUCATION
Graduated from William Horlick High School, Racine Wisconsin in 1979; received bachelor of science degree in zoology from the University of Wisconsin-Madison in 1983 and doctorate in medicine from the same school in 1987.

ORGANIZATIONS
Aerospace Medical Association, Society of U.S. Naval Flight Surgeons.

AWARDS
Navy Commendation Medals (3); National Defense Medal, and Overseas Service Ribbon.

EXPERIENCE
During medical school she did active duty training with the Diving Medicine Department at the Naval Experimental Diving Unit in March 1987. After completing medical school, Dr. Clark underwent postgraduate Medical education in Pediatrics from 1987-1988 at Naval Hospital Bethesda, Maryland. The following year she completed Navy undersea medical officer training at the Naval Undersea Medical Institute in Groton Connecticut and diving medical officer training at the Naval Diving and Salvage Training Center in Panama City, Florida, and was designated a Radiation Health Officer and Undersea Medical Officer. She was then assigned as the Submarine Squadron Fourteen Medical Department Head in Holy Loch Scotland. During that assignment she dove with US Navy divers and Naval Special Warfare Unit Two Seals and performed numerous medical evacuations from US submarines.

After two years of operational experience she was designated as a Naval Submarine Medical Officer and Diving Medical Officer. She underwent 6 months of aeromedical training at the Naval Aerospace Medical Institute in Pensacola, Florida and was designated as a Naval Flight Surgeon. She was stationed at MCAS Yuma, Arizona and assigned as Flight Surgeon for a Marine Corps AV-8B Night Attack Harrier Squadron (VMA 211). She made numerous deployments, including one overseas to the Western Pacific, and practiced medicine in austere environments, and flew on multiple aircraft. Her squadron won the Marine Attack Squadron of the year for its successful deployment. She was then assigned as the Group Flight Surgeon for the Marine Aircraft Group (MAG 13).

Prior to her selection as an astronaut candidate she served as a Flight Surgeon for the Naval Flight Officer advanced training squadron (VT-86) in Pensacola, Florida. LCDR Clark is Board Certified by the National Board of Medical Examiners and holds a Wisconsin Medical License. Her military qualifications include Radiation Health Officer, Undersea Medical Officer, Diving Medical Officer, Submarine Medical Officer, and Naval Flight Surgeon. She is a Basic Life Support Instructor, Advanced Cardiac Life Support Provider, Advanced Trauma Life Support Provider, and Hyperbaric Chamber Advisor.

NASA EXPERIENCE
Selected by NASA in April 1996, Dr. Clark reported to the Johnson Space Center in August 1996. After completing two years of training and evaluation, she was qualified for flight assignment as a mission specialist. From July 1997 to August 2000 Dr. Clark worked in the Astronaut Office Payloads/Habitability Branch. She is currently assigned to the crew of STS-107 scheduled for launch in 2002.

MARCH 2002

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7. PS1: Israeli Air Force Col. Ilan, Ramon, 48

PERSONAL DATA
Born June 20,1954 in Tel Aviv, Israel. Married to Rona. They have four children. He enjoys snow skiing, squash. His parents reside in Beer Sheva, Israel.

EDUCATION
Graduated from High School in 1972; bachelor of science degree in electronics and computer engineering from the University of Tel Aviv, Israel, in 1987.

SPECIAL HONORS/AWARDS
Yom Kippur War (1973); Operation Peace for Galilee (1982); F-16 1,000 Flight Hours (1992).

EXPERIENCE
In 1974, Ramon graduated as a fighter pilot from the Israel Air Force (IAF) Flight School. From 1974-1976 he participated in A-4 Basic Training and Operations. 1976-1980 was spent in Mirage III-C training and operations. In 1980, as one of the IAF's establishment team of the first F-16 Squadron in Israel, he attended the F-16 Training Course at Hill Air Force Base, Utah. From 1981-1983, he served as the Deputy Squadron Commander B, F-16 Squadron. From 1983-1987, he attended the University of Tel Aviv. From 1988-1990, he served as Deputy Squadron Commander A, F-4 Phantom Squadron. During 1990, he attended the Squadron Commanders Course. From 1990-1992, he served as Squadron Commander, F-16 Squadron. From 1992-1994, he was Head of the Aircraft Branch in the Operations Requirement Department. In 1994, he was promoted to the rank of Colonel and assigned as Head of the Department of Operational Requirement for Weapon Development and Acquisition. He stayed at this post until 1998.

Colonel Ramon has accumulated over 3,000 flight hours on the A-4, Mirage III-C, and F-4, and over 1,000 flight hours on the F-16.

NASA EXPERIENCE
In 1997, Colonel Ramon was selected as a Payload Specialist. He is designated to train as prime for a Space Shuttle mission with a payload that includes a multispectral camera for recording desert aerosol. In July 1998, he reported for training at the Johnson Space Center, Houston. He is currently assigned to STS-107 scheduled to launch in 2002

MARCH 2002

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Space Station Expedition 6 Commander: Navy Capt. Kenneth Bowersox, 45

PERSONAL DATA
Born November 14, 1956, in Portsmouth, Virginia, but considers Bedford, Indiana, to be his hometown.

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

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

NASA EXPERIENCE
Selected as an astronaut candidate by NASA in June 1987, Bowersox completed a one-year training and evaluation program in August 1988. He has held a variety of assignments since then including flight software testing in the Shuttle Avionics Integration Laboratory (SAIL); Technical Assistant to the Director of Flight Crew Operations; Astronaut Office representative for Orbiter landing and rollout issues; Chief of the Astronaut Office Safety Branch; Chairman of the Spaceflight Safety Panel; during several Shuttle missions he served as a spacecraft communicator (CAPCOM) in the Houston Mission Control Center. He also served as back-up to the first International Space Station crew. A four flight veteran, Bowersox has logged over 50 days in space. He flew as pilot on STS-50 in 1992 and STS-61 in 1993, and was the spacecraft commander on STS-73 in 1995 and STS-82 in 1997. Bowersox is assigned to command the Expedition-6 crew.

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

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

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

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

STS-113/ISS-6, 11/23-07/02; Bowersox, flight engineer Nikolai Budarin and science officer Donald Pettit became the sixth full-time crew to live aboard the lab complex; scheduled to return to Earth in mid March aboard the STS-114 mission.

DECEMBER 2002

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Space Station Expedition 6 Science Officer: Donald Pettit, Ph.D., 47

PERSONAL DATA
Born April 20, 1955 in Silverton, Oregon. Married. Two children.

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

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

NASA EXPERIENCE
Selected by NASA in April 1996, Dr. Pettit reported to the Johnson Space Center in August 1996. Having completed two years of training and evaluation, he is qualified for flight selection as a mission specialist. Initially, he was assigned technical duties in the Astronaut Office Computer Support Branch. Initially assigned as a backup crewmember, Dr. Pettit has now been assigned to the crew of Expedition-6, scheduled for launch in 2002, for a 4-month stay aboard the International Space Station.

SPACEFLIGHT EXPERIENCE
STS-113/ISS-6, 11/23-07/02; Pettit, commander Kenneth Bowersox and flight engineer Nikolai Budarin became the sixth full-time crew to live aboard the lab complex on Nov. 25; scheduled to return to Earth in mid March aboard the STS-114 mission.

DECEMBER 2002

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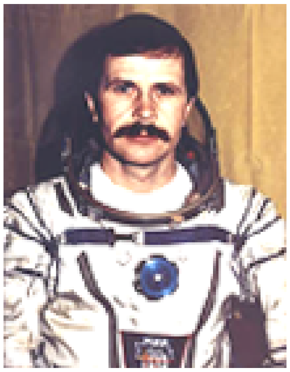
Space Station Expedition 6 Cosmonaut Nikolai Budarin, 49



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

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

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

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

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

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

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

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

STS-113/ISS-6, 11/23-07/02; Commander Kenneth Bowersox, flight engineer Budarin and science officer Donald Pettit became the sixth full-time crew to live aboard the lab complex; scheduled to return to Earth in mid March aboard the STS-114 mission.

DECEMBER 2002

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STS-107 Crew Photograph

Commander Rick Husband

Pilot William McCool

MS1/EV1 David Brown

MS2 Kalpana Chawla, Ph.D.

MS3/EV2 Michael Anderson

MS4 Laurel Clark, M.D.

PS1 Ilan Ramon

ISS-6 Crew Photographs

ISS-6 Commander Ken Bowersox
Launch on STS-113
Land on STS-114

ISS-6 FE Nikolai Budarin
Launch on STS-113
Land on STS-114

ISS-6 SO Donald Pettit
Launch on STS-113
Land on STS-114

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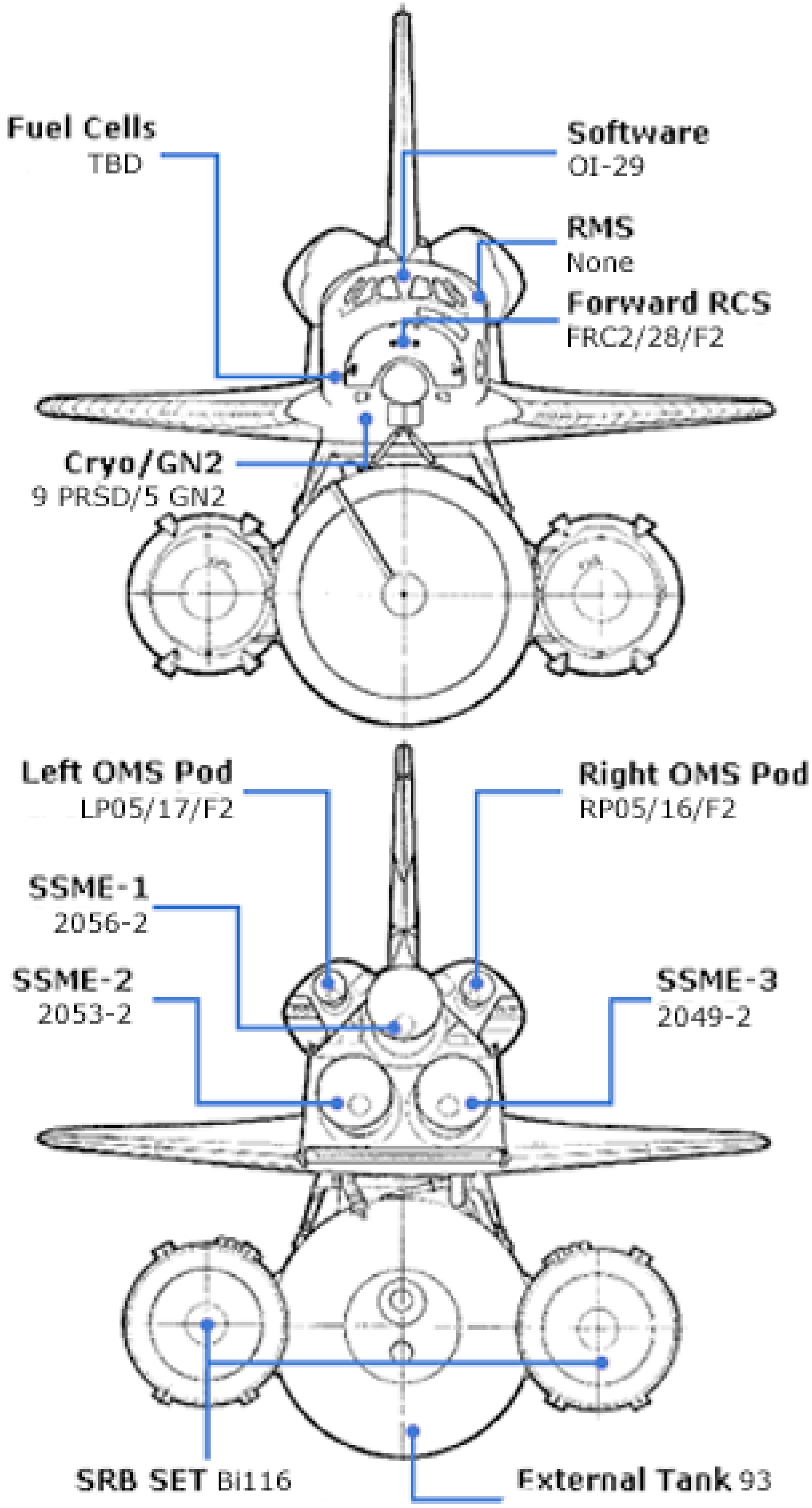
STS-107 Flight Hardware



STS-107 Ascent Events Summary

Time	Event	Inertial Velocity (mph)	Abort Option
0:10	START ROLL MANEUVER	920	RTLS
0:17	END ROLL MANEUVER	1002	ONLY
0:33	START THROTTLE DOWN (72%)	1234	2:38
0:45	START THROTTLE UP (104.5%)	1418	
0:59	MAX Q (741 psf)	1643	
2:04	SRB STAGING	3737	
2:14	START OMS ASSIST (1:42 duration)	3887	
2:39	2 ENGINE TAL MORON (104.5%, 2s)	4228	TAL
2:47	2 ENGINE TAL ZARAGOZA (104.5%, 2s)	4364	ONLY
3:50	NEGATIVE RETURN (104.5%, 3s)	5591	2:22
5:02	PRESS TO ATO (104.5%, 2s, 240 u/s)	7569	PRESS
5:15	SINGLE ENGINE OPS-3 MORON (109%,Os,2EO SIMO)	8046	TO
5:15	DROOP MORON (109%,Os)	8046	ORBIT
5:15	DROOP ZARAGOZA (109%,Os)	8046	3:18
5:39	PRESS TO MECO (104.5%, 2s, 240 u/s)	8864	
5:47	ROLL TO HEADSUP	9137	
5:53	SINGLE ENGINE TAL MORON (104.5%,2s,2EO SIMO)	9410	
5:56	SINGLE ENGINE TAL ZARAGOZA (104.5%,2s,2EO SIMO)	9546	
6:54	SINGLE ENGINE PRESS-TO-MECO (104.5%, 2s, 451 u/s)	12206	
7:21	3G LIMITING	13774	
7:30	LAST 2 ENG PRE-MECO TAL MORON (67%)	14319	
7:30	NEGATIVE ZARAGOZA (2@67%)	14319	
7:32	LAST SINGLE ENG PRE-MECO TAL MORON (104.5%)	14456	
7:32	NEGATIVE ZARAGOZA (1@104.5%)	14456	
7:42	LAST 3 ENG PRE-MECO TAL MORON (67%)	15138	
7:42	NEGATIVE ZARAGOZA (3@67%)	15138	
7:50	23K	15683	
8:15	LAST TAL DIEGO GARCIA	17252	
8:20	MECO COMMANDED	17592	
8:26	ZERO THRUST	17634	
	Throttle Settings	104.5%, 72%, 104.5%	
	Orbit Inclination	39.00 deg	
	MECO Apogee/Perigee	169/48 statute miles	
	OMS-2 Apogee/Perigee	176/168 statute miles	

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Shuttle and Payload Weights

Vehicle/Payload	Pounds
Shuttle Liftoff Weight:	4,528,420
Orbiter/Payload Liftoff Weight:	263,701
Orbiter/Payload Landing Weight:	232,788

STS-107 Mission Statistics

113th	Shuttle mission since STS-1	**8th**	39-degree incl. flight
1st	Of 6 flights planned for 2002	**62nd**	Planned KSC landing
88th	Post-Challenger mission	**93rd**	Day landing
28th	Flight of Columbia (OV-102)	**48th**	Day landing at KSC
64th	Launch off pad 39A	**3rd**	KSC landing in a row
85th	Day launch	**16.98**	Years since STS-51L
48th	Day launch off pad 39A	**6,196.96**	Days since 51L

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Columbia (OV-102)

OV	#	STS	Launch	D/	H:	M:	S	Notes
-	-	FRF	02/28/81	00	00	00	23	FRF: 2007, 2006, 2005; 100%
1	1	1	04/12/81	02	06	20	53	First shuttle flight
2	2	2	11/12/81	02	06	13	11	Fuel cell failure shortens flight
3	3	3	03/22/82	08	00	04	46	RMS tests; landing at White Sands, N.M.
4	4	4	06/27/82	07	01	09	31	Final test flight; first DOD payload
5	5	5	11/11/82	05	02	14	26	First shuttle satellite launchings (2)
6	9	9	11/28/83	10	07	47	24	First Spacelab flight
7	24	61C	01/12/86	06	02	03	51	Last pre-Challenger flight
8	30	28	08/08/89	05	01	00	08	DOD
9	33	32	01/09/90	10	21	00	36	LDEF recovery
10	38	35	12/02/90	08	23	05	08	ASTRO Spacelab mission
11	41	40	06/05/91	09	02	14	20	Life Science Spacelab mission
12	48	50	06/25/92	13	19	30	04	USML-1 (materials science mission)
13	51	52	10/22/92	09	20	56	13	LAGEOS-2, USMP-1
-	-	RSLS	03/22/93	00	00	00	00	ME-3 LOX preburner check valve at T-3
14	55	55	04/26/93	09	23	39	59	Spacelab D2
15	57	58	10/22/93	14	00	12	32	SLS-2
16	61	62	03/04/94	13	23	16	41	USMP-2, OAST-2
17	63	65	07/08/94	14	17	55	00	International Microgravity Laboratory-2
18	72	73	10/20/95	15	21	52	21	USML-2
19	75	75	02/22/96	15	17	40	21	TSS-1R, USMP-3
20	78	78	06/20/96	16	21	47	36	LMS-1
21	80	80	11/19/96	17	15	53	18	ORFEUS-SPAS, Wake Shield-3
22	83	83	04/04/97	03	23	12	39	MSL-1
23	94	85	07/01/97	15	16	44	34	MSL-1 reflight
24	87	88	11/19/97	15	16	34	04	CHRISTA-SPAS failure; USMP-4
25	90	90	04/17/98	15	21	49	59	Neurolab
26	95	93	07/23/99	04	22	49	35	Chandra X-ray Observatory
27	108	109	03/01/02	10	22	09	51	HST Servicing Mission 3B
			TOTAL:	**284**	**19**	**19**	**01**	

STS-107 Launch and Flight Control Personnel

Space Shuttle Mission Control

Shift	Flight Director	CAPCOM	PAO
Ascent	Leroy Cain	Charles Hobaugh	Rob Navias
Launch Weather		Duane Carey	
STS Orbit 1	Steve Stich	Linda Godwin	John Ira Petty
STS Orbit 2 (lead)	Kelly Beck	Stephanie Wilson	Cathy Watson
STS Orbit 3	Bryan Austin	Charles Hobaugh	Kylie Moritz
STS Orbit 4	Jeff Hanley	Ken Ham	Various
STS Entry	Leroy Cain	Charles Hobaugh	James Hartsfield
Landing Weather		Duane Carey	
STS Moscow	N/A	N/A	N/A

Space Station Mission Control

Shift	Flight Director	CAPCOM
ISS Orbit 1	N/A	
ISS Orbit 2 (lead)	N/A	
ISS Oribt 3	N/A	

STS-107 Quick-Look Personnel List

Position	Name
Launch director	Michael Leinbach
NASA Test Director	Jeff Spaulding
Voice of launch control	Bruce Buckingham
Voice of mission control	Rob Navias
Launch weather pilot	Kent Rominger
Landing weather pilot (KSC)	Kent Rominger
Landing weather pilot (EAFB)	Michael Bloomfield
TAL pilot-Banjul	N/A
TAL pilot-Zaragoza	Dominic Antonelli
TAL pilot-Ben Guerir	Not staffed
TAL pilot-Moron	Gregory Johnson
JSC PAO rep at KSC	TBD
JSC PAO rep at Moscow	N/A
Astronaut support personnel	TBD

STS-107 Pre-Launch Timeline

Editor's Note

Due to post Sept. 11 security precautions, NASA for the moment is not releasing mission-specific shuttle countdowns in advance. Only the terminal phase of the countdown can be posted here, after the launch time is announced.

ACRONYMS: STA: Shuttle Training Aircraft; MEC: master events controller; PRSD: power reactant storage and distribution system; TSM: tail service mast; SSME: space shuttle main engine; BFC: backup flight computer; NEP: non-essential personnel; SSV: space shuttle vehicle; PIC: pyro initiator; FCE: flight crew equipment; GPS: general purpose computer; NTD: NASA test director; LOX: liquid oxygen; LH2: liquid hydrogen; APU: auxilliary power unit

TIME	EVENT
01/15/03	
04:00 p.m.	RSS gantry retraction
05:30 p.m.	Blue team wakeup for launch
08:19 p.m.	Countdown resumes at the T-minus minus 11-hour mark
09:00 p.m.	Red team sleep begins
01/16/03	
01:19 a.m.	Countdown enters a 1-hour hold at the T-minus 6-hour mark
01:19 a.m.	Mission Management Team gives a "go" for fueling
02:19 a.m.	Countdown resumes
02:19 a.m.	Fueling begins
05:00 a.m.	Red team wake up; medical exams for both teams
05:19 a.m.	Countdown enters a 2-hour hold at the T-minus 3-hour mark
05:19 a.m.	Fueling complete
06:00 a.m.	Astronaut photo op (taped for later replay on NASA TV)
06:44 a.m.	Final weather briefing
06:54 a.m.	Astronauts suit up for launch
07:19 a.m.	Countdown resumes at the T-minus 3-hour mark
07:24 a.m.	Astronauts leave crew quarters
07:30 a.m.	NASA TV launch coverage begins
07:54 a.m.	Astronauts arrive at pad 39A; boarding begins
09:09 a.m.	Shuttle hatch closed for launch
09:59 a.m.	A 10-minute hold at the T-minus 20-minute mark begins
10:09 a.m.	Countdown resumes
10:20 a.m.	A final 10-minute hold begoms at the T-minus 9 minute mark
10:30 a.m.	Countdown resumes
10:34 a.m.	Hydraulic power system start
10:39 a.m.	Launch

CBS News STS-107 Mission Overview

Columbia crew faces grueling 24/7 microgravity research mission

By WILLIAM HARWOOD
CBS News

Not available in time for this edition. See the CBS News website at:

http://www.cbsnews.com/htdocs/space_place/framesource_current.html

for the mission preview. We apologize for the inconvenience.

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STS-107 NASA Background Package

Editor's Note:
The STS-107 mission overview below is from the NASA/United Space Alliance STS-107 press kit: http://www.shuttlepresskit.com

Station-Class Science Aboard a Space Shuttle

General Mission Overview

STS-107, the 28th flight of the space shuttle Columbia and the 111th shuttle mission to date, will give more than 70 international scientists access to both the microgravity environment of space and a set of seven human researchers for 16 uninterrupted days.

Columbia's 16-day mission is dedicated to a mixed complement of competitively selected and commercially sponsored research in the space, life and physical sciences. An international crew of seven, including the first Israeli astronaut, will work 24 hours a day in two alternating shifts to carry out experiments in the areas of astronaut health and safety; advanced technology development; and Earth and space sciences.

When Columbia is launched from Kennedy Space Center's Launch Pad 39B it will carry a SPACEHAB Research Double Module (RDM) in its payload bay. The RDM is a pressurized environment that is accessible to the crew while in orbit via a tunnel from the shuttle's middeck. Together, the RDM and the middeck will accommodate the majority of the mission's payloads/experiments. STS-107 marks the first flight of the RDM, though SPACEHAB Modules and Cargo Carriers have flown on 17 previous space shuttle missions.

Astronaut Rick Husband (Colonel, USAF) will command STS-107 and will be joined on Columbia's flight deck by pilot William "Willie" McCool (Commander, USN). Columbia will be crewed by Mission Specialist 2 (Flight Engineer) Kalpana Chawla (Ph.D.), Mission Specialist 3 (Payload Commander) Michael Anderson (Lieutenant Colonel, USAF), Mission Specialist 1 David Brown (Captain, USN), Mission Specialist 4 Laurel Clark (Commander, USN) and Payload Specialist 1 Ilan Ramon (Colonel, Israeli Air Force), the first Israeli astronaut.

STS-107 marks Husband's second flight into space – he served as pilot during STS- 96, a 10-day mission that saw the first shuttle docking with the International Space Station. Husband served as Chief of Safety for the Astronaut Office until his selection to command the STS-107 crew. Anderson and Chawla will also be making their second spaceflights. Anderson first flew on STS-89 in January 1998 (the eighth Shuttle-Mir docking mission) while Chawla flew on STS-87 in November 1997 (the fourth U.S. Microgravity Payload flight). McCool, Brown, Clark and Ramon will be making their first flights into space.

The seven crewmembers will work in two shifts throughout their 16 days in space. The Red Shift will include Husband, Chawla, Clark and Ramon, while the Blue Shift will include McCool, Brown and Anderson. The seven astronauts will work roundthe- clock to complete a multidisciplinary research program involving 32 payloads with 59 separate investigations. Under an agreement with NASA, SPACEHAB, Inc. has marketed 18 percent of the module's capacity of 9,000 pounds to international and industry commercial users from around the world – NASA research will utilize the remaining 82 percent of the payload capacity.

Experiments in the SPACEHAB RDM include nine commercial payloads involving 21 separate investigations, four payloads for the European Space Agency with 14 investigations, one payload/investigation for ISS Risk Mitigation and 18 payloads supporting 23 investigations for NASA's Office of Biological and Physical Research (OBPR).

In the physical sciences, three studies inside a large, rugged chamber will examine the physics of combustion, soot production and fire quenching processes in microgravity. These experiments will provide new insights into combustion and firesuppression that cannot be gained on Earth. An experiment that compresses granular materials, in the absence of gravity, will further our understanding of construction techniques. This information can help engineers provide stronger foundations for structures in areas where earthquakes, floods and landslides are common. Another experiment will evaluate the formation of zeolite crystals, which can speed the chemical reactions that are the basis for chemical processes used in refining, biomedical and other areas. Yet another experiment will use pressurized liquid xenon to mimic the behaviors of more complex fluids such as blood flowing through capillaries.

The STS-107 crew. From left to right: David Brown, commander Rick Husband
Laurel Clark, Kalpana Chawla, Michael Anderson, pilot William "Willie" McCool,
Ilan Ramon (Israel)

In the area of biological applications, two separate OBPR experiments will allow different types of cell cultures to grow together in weightlessness to enhance their development of enhanced genetic characteristics – one will be used to combat prostate cancer, the other to improve crop yield. Another experiment will evaluate the commercial usefulness of plant products grown in space. A facility for forming protein crystals more purely and with fewer flaws than is possible on Earth may lead to a drug designed for specific diseases with fewer side effects. A commercially sponsored facility will house two experiments to grow protein crystals to study possible therapies against the factors that cause cancers to spread and bone cancer to cause intense pain to its sufferers. A third experiment will look at developing a new technique of encapsulating anti-cancer drugs to improve their efficiency.

Other studies will focus on changes, due to spaceflight, in the cardiovascular and musculoskeletal systems; in the systems which sense and respond to gravity; and in the capability of organisms to respond to stress and maintain normal function. NASA is also testing a new technology to recycle water prior to installing a device to recycle water permanently aboard the International Space Station.

The European Space Agency (ESA), through a contract with SPACEHAB, is flying an important payload focused on astronaut health, biological function and basic physical phenomena in space. These experiments will address different aspects of many of the same phenomena that NASA is interested in, providing a more thorough description of the effects of spaceflight, often in the same subjects or specimens. ESA will perform seven in-flight experiments, and one ground-based, on the cardiopulmonary changes that occur in astronauts. Additional ESA biological investigations will examine bone formation and maintenance; immune system functioning; connective tissue growth and repair; and bacterial and yeast cell responses to the stresses of spaceflight. A special facility will grow large, wellordered protein and virus crystals that are expected to lead to improved drug designs. Another will study the physical characteristics of bubbles and droplets in the absence of the effects of Earth’s gravity.

SPACEHAB is also making it possible for universities, companies and other government agencies to do important research in space without having to provide their own spacecraft. The Canadian Space Agency is sponsoring three bone-growth experiments, and is collaborating with ESA on two others. The German Space Agency will measure the development of the gravity-sensing organs of fish in the absence of gravity. A university is growing ultra-pure protein crystals for drug research. Another university is testing a navigation system for future satellites. The U.S. Air Force is conducting a communications experiment. Students from six schools in Australia, China, Israel, Japan, Liechtenstein and the United States are probing the effects of spaceflight on spiders, silkworms, inorganic crystals, fish, bees and ants, respectively.

There are also experiments in Columbia’s payload bay, including three attached to the top of the RDM: the Combined Two-Phase Loop Experiment (COM2PLEX), Miniature Satellite Threat Reporting System (MSTRS) and Star Navigation (STARNAV). There are six payloads/experiments on the Hitchhiker pallet – the Fast Reaction Experiments Enabling Science, Technology, Applications and Research (FREESTAR), which is mounted on a bridge-like structure spanning the width of the payload bay. These six investigations look outward to the Sun, downward at Earth’s atmosphere and inward into the physics of fluid phenomena, as well as testing technology for space communications.

FREESTAR will hold the Critical Viscosity of Xenon-2 (CVX-2), Low Power Transceiver (LPT), Mediterranean Israeli Dust Experiment (MEIDEX), Space Experiment Module (SEM-14), Solar Constant Experiment-3 (SOLCON-3) and Shuttle Ozone Limb Sounding Experiment (SOLSE-2). The SEM is made up of 11 separate student experiments from schools across the U.S. and is the 14th flight of a SEM on the space shuttle. Additional secondary payloads are the Shuttle Ionospheric Modification with Pulsed Local Exhaust Experiment (SIMPLEX) and Ram Burn Observation (RAMBO).

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Common Experiment Acronyms

ARMS	Advanced Respiratory Monitoring System AST Astroculture
BACTER	Bacterial Physiology & Virulence on Earth and in Microgravity (BIOPACK)
BDS	Biotechnology Demonstration System
BIOPACK	ESA facility to conduct biological experiments (eight total)
LSP	Laminar Soot Process (in Combustion Module)
MEIDE	XMediterranean Israeli Dust Experiment (payload bay instrument) MGM Mechanics of Granular Materials
MIST	Water Mist Fire Suppression (in Combustion Module)
MPFE	Microbial Physiology Flight Experiments
PCBA	Portable Clinical Blood Analyzer
PhAB4	Physiology and Biochemistry Team (four experiments)
SOFBALL	Structures of Flame Balls at Low Lewis-number (in Combustion Module)
SOLSE	Shuttle Ozone Limb Sounding Experiment (payload bay instrument) STARS Space Technology and Research Students (six international student experiments on Columbia’s middeck)
VCD	Vapor Compression Distillation
YSTRS	Yeast Cells Under Stress (BIOPACK)
ZCG	Zeolite Crystal Growth

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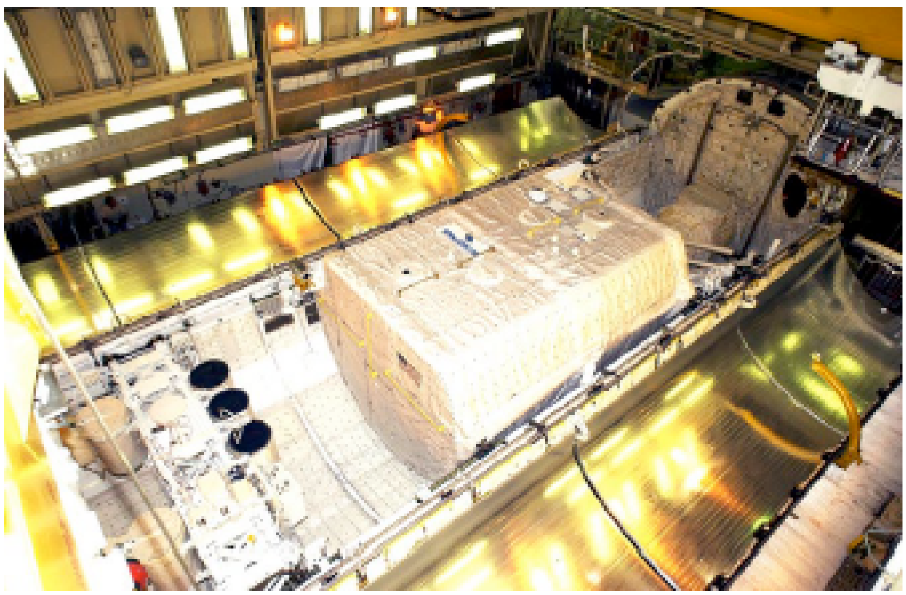
Major Payloads

SPACEHAB Research Double Module (RDM)

SPACEHAB Inc.'s Research Double Module (RDM) is making its first flight on STS- 107. The RDM is a pressurized aluminum habitat that is carried in the space shuttle's cargo bay to expand working space aboard the shuttle. The RDM is connected to the shuttle middeck by a pressurized access tunnel. Boeing-Huntsville performed the RDM's systems integration for SPACEHAB and serves as the company's mission integration contractor. SPACEHAB Single Modules outfitted for research or logistics and Double Modules outfitted for logistics have flown on 15 space shuttle missions to date.

The RDM is approximately 20 feet long, 14 feet wide, and 11 feet high. Outfitted as a state-of-the-art laboratory, it has a pressurized volume of 2,200 cubic feet and can hold up to 61 space shuttle middeck lockers (up to 60 pounds and 2 cubic feet each) plus six Double Racks (1,400 pounds and 45 cubic feet each). The RDM also can accommodate International Space Station Payload Racks (ISPRs). The Module has two viewports and can carry powered rooftop payloads (three on STS-107) using feed-through plates in the module ceiling. The RDM, which has a payload capacity of 9,000 pounds, will carry about 7,500 pounds of research payloads on STS-107. An additional 800 pounds of SPACEHAB-integrated payloads are flying on the shuttle middeck, making a total of 8,300 pounds of research payloads on STS-107.



Spacehab Double module in shuttle Columbia's cargo bay

The RDM provides investigators with the latest in telemetry and command control capabilities that are compatible with the International Space Station. The Module provides payload data downlink services via the shuttle's Ku-band communication system, increasing available downlink bandwidth up to 25 Mbps. It is equipped with an enhanced environmental control system designed for a four-person load capability, a key requirement to support round-the-clock crew operations on STS- 107.

The Module provides AC and DC power plus air and water cooling for experiments. STS-107 payloads using time-critical components, such as biological samples, require access to the RDM for loading as late as L-31 hours before launch. SPACEHAB will be loading approximately 40 percent of the payloads for STS-107 on the RDM after the Module is installed in the shuttle cargo bay and the shuttle is on the launch pad.

SPACEHAB's flight services contract with NASA provides the company with 12 percent of the RDM's payload capacity to sell to commercial customers on STS-107.

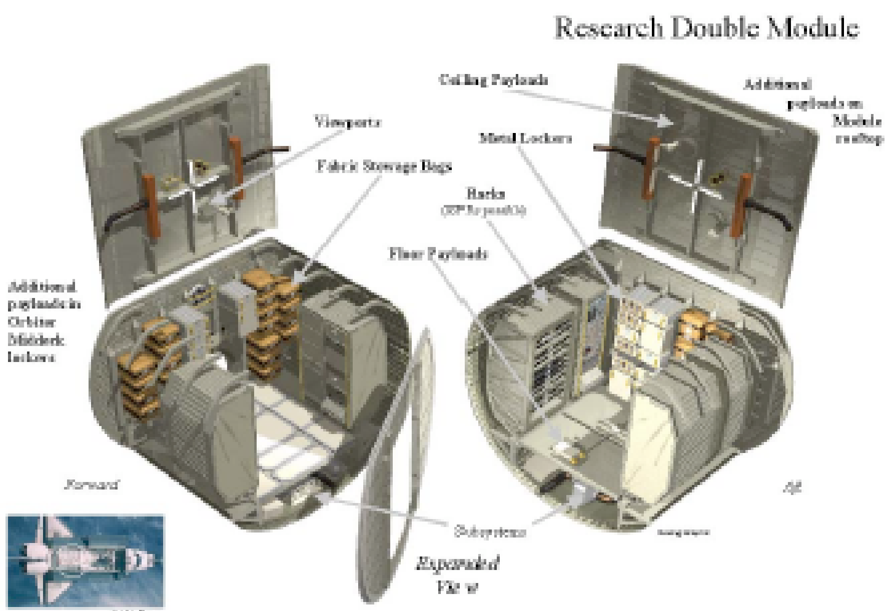
SPACEHAB's commercial payloads on the mission include:

1. Advanced Respiratory Monitoring System (ARMS), European Space Agency: ARMS is an investigation of pulmonary and cardiovascular changes in humans during rest and exercise in early and later phases of spaceflight. The ARMS facility measures gas compositions during inspiration and expiration of different gas mixtures, heart rate, blood pressure and respiratory rate. STS-107 is the first flight of ARMS. For more information, see the ARMS section in the NASA press kit.

2. Closed Equilibrated Biological Aquatic System (CEBAS), DLR (German Space Agency): CEBAS, a middeck payload, is a habitat for aquatic organisms and serves as a facility for conducting microgravity experiments in zoology, botany, developmental biology and ecosystems research. CEBAS flew on STS-89 and STS-90.

3. Miniature Satellite Threat Reporting System (MSTRS), U.S. Air Force: This payload is a communications technology demonstration developed by the Air Force Research Laboratory in Albuquerque, N.M. STS-107 is the first flight of MSTRS.

4. Commercial Macromolecular Protein Crystal Growth (CMPCG),University of Alabama-Birmingham Center for Biophysical Science and Engineering (UAB CBSE) and SPACEHAB: CPMG is a commercial facility sponsored by SPACEHAB, which has partnered with UAB CBSE to use the CMPCG facility for the production of large, high-quality protein crystals under controlled conditions in microgravity. Primary customers are the National Space Development Agency of Japan, Canadian Space Agency, and Donald Danforth Plant Science Center.



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5. Combined 2-Phase Loop Experiment (COM2PLEX), European Space Agency: The COM2PLEX rooftop test facility is designed to investigate the behavior of capillary-pumped loops in microgravity. The facility

will demonstrate three different two-phase loops by transporting different amounts of heat from evaporator to condenser and radiating heat into space. STS-107 is the first flight of COM2PLEX.

6. STARS-Bootes: For information see the STARS Student Experiments.

7. STARNAV Star Navigation Experiment, Texas A&M University: This experiment, a rooftop payload, is designed to validate a new algorithm for determining precise spacecraft attitude without prior knowledge of position and develop educational interest in space technology and astronomy.

8. Osteoporosis Experiment in Orbit (OSTEO), Canadian Space Agency: OSTEO is an in-vitro evaluation of bone cell activity in microgravity. Baseline bone cell activity and the effects of specific pharmaceutical agents will be assessed. This payload flew on STS- 95.

9. European Research In Space and Terrestrial Osteoporosis (ERISTO), European Space Agency in coordination with the Canadian Space Agency: ERISTO, an in-vitro evaluation of bone cell activity in microgravity, uses the same facility hardware as the OSTEO experiment. STS-107 is the first flight of ERISTO.

10. Physiology and Biochemistry 4 (JSC-HLS/PhAB4), NASA Johnson Space Center: This experiment package includes four life science investigations - Protein Turnover During Spaceflight, Calcium Kinetics During Spaceflight, Renal Stone Risk, and Viral Shedding. Experiment hardware includes blood collection kits; urine collection kits; saliva collection kits; tracer kits; a Portable Clinical Blood Analyzer; an Orbiter Centrifuge; an Enhanced Orbiter Refrigerator/Freezer (EOR/F) that flew on STS-55, STS-58, STS- 71, STS-74, STS-84, STS-89, and STS-95; and a Thermoelectric Holding Module (TEHM) that made multiple flights on the space shuttle middeck and is flying for the first time in a SPACEHAB Module on STS-107.

For more information: http://www.spacehab.com/sts107

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European Space Agency Payloads Overview

Advanced Protein Crystallization Facility (APCF)

Objective: To grow large, well ordered crystals of different proteins and viruses for analysis and characterization using a crystallization facility. Operations are fully automated with minimal crew interaction.

Facility for Adsorption and Surface Tension (FAST)

Objective: To measure the response of surface tension to carefully controlled dynamic changes in the surface area of bubbles or droplets using a multi-user facility. Operations are fully automated with minimal crew interaction.

BIOPACK

Fully automated, multi-user facility that provides capability to conduct biological experiments under varying gravity conditions using two standard facility containers. Facility includes an incubator with three centrifuges, a cooler and a freezer. Eight investigations are:

LEUKIN: Role of Interleukin-2 Receptor in signal transduction and gravisening threshold in T-Lymphocytes.

REPAIR: Fidelity of DNA double-strand break repair in human cells under microgravity.

CONNECT: Function of the focal adhesion of plaque of connective tissue in microgravity.

BIOKIN-3: Determination of the space influence on bacterial growth kinetics.

YSTRES: Yeast cell stress under microgravity.

BONES: The role of bone cells in the response of skeletal tissues in microgravity.

STROMA: Bone marrow stromal cells differentiation and mesenchymal tissue reconstruction in microgravity.

BACTER: Bacterial physiology and virulence on Earth and microgravity.

BIOBOX

Multi-user facility that hosts a variety of biological experiments with the overall goal of observing the effects of weightlessness on living systems. Operations are fully automated with the exception of facility activation and occasional filter cleaning. Four investigations are:

OBLAST: Comparative analysis of osteoblastic (bone-forming) cells at microgravity and 1G.

OCLAST: Microgravity effects on osteoclast (bone-removing) driven resorption in vitro.

OSTEOGENE: Identification of microgravity-related genes in osteoblastic cells.

RADCELLS: Biological dosimetry in space using haemopoetic stem cell functions.

For more on ESA experiments, see the SPACEHAB commercial experiments list in the SPACEHAB RDM section of NASA's press kit.

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FREESTAR

Goddard Space Flight Center (GSFC) Wallops Flight Facility (WFF) manages NASA's Shuttle Small Payloads Project (SSPP). The SSPP designs, develops, tests, integrates and flies a group of small payload carrier systems for the space shuttle. These carriers - the Hitchhiker, Getaway Specials (GAS), and Space Experiment Module (SEM) - support payloads supplied by NASA, other U.S. government agencies, universities, high schools, domestic commercial customers, and foreign nationals and governments. These carriers can support payloads that range in size between 50 lbs. (23 kg) and 4,000 lbs. (2,270 kg).

Payload Description

The FREESTAR payload will include six separate experiments mounted on a crossbay Hitchhiker Multipurpose Equipment Support Structure. The six experiments include:

1. Mediterranean Israeli Dust Experiment (MEIDEX) - MEIDEX is managed by the Israeli Space Agency and Tel-Aviv University. NASA/HQ Office of Earth Science sponsors MEIDEX.

2. Solar Constant Experiment-3 (SOLCON-3) - SOLCON-3 is managed by the Royal Meteorological Institute of Belgium. The SOLCON-3 experiment has previously flown on STS-85, International Extreme Ultraviolet Hitchhiker-3 on STS-95, the first Spacelab mission, the Eureca platform and on Atlas missions.

3. The second flight of the Shuttle Ozone Limb Sounding Experiment-02 (SOLSE-02) - SOLSE is managed by NASA/GSFC Atmospheric Chemistry and Dynamics Branch. The SOLSE experiment has previously flown on STS- 87. NASA/HQ Office of Earth Science sponsors the SOLSE experiments.

4. Critical Viscosity of Xenon-2 (CVX-2) - CVX-2 is managed by NASA Research Center. The CVX experiment has previously flown on STS-85. The CVX experiment series is sponsored by NASA/HQ Office of Biological and Physical Research.

5. Low Power Transceiver (LPT) is managed by NASA/GSFC Microwave Systems Branch. LPT is sponsored by NASA/HQ Office of Space Flight.

6. Space Experiment Module (SEM) – The SEM program is managed by the NASA/GSFC Shuttle Small Payloads Project Office.

MEIDEX

The primary mission of the Mediterranean Israeli Dust Experiment (MEIDEX) payload is to study the temporal and spatial distribution and physical properties of atmospheric desert dust over North Africa, the Mediterranean and the Atlantic Saharan regions. This aim is achieved by a remote sensing experiment operated by the astronauts aboard the space shuttle. In addition to the primary desert aerosol observations, MEIDEX will accomplish diverse secondary science objectives by performing slant visibility observations, sea-surface reflectivity observations, desert surface observations and observations of Transient Luminous Events, better known as sprites.

The MEIDEX experiment includes remote as well as in-situ measurements of light scattering by desert aerosol particles in six different wavelength intervals from the near Ultraviolet to the Solar Infrared. The wavelengths selected for space-borne remote measurements of desert aerosols include two wavelengths used by the Total Ozone Mapping Spectrometer instruments as well as four of those installed on the Moderate Resolution Imaging Spectroradiometer, an instrument aboard both NASA's Terra and Aqua spacecraft.

This facilitates the calibration of the TOMS-like information acquired by the instrument in the UV spectral region by that provided simultaneously by the MODISlike bands on the same instrument. The MEIDEX scientific initiative will also incorporate supporting ground-based and airborne measurements in order to provide both optical observations and direct sampling. The airborne measurements will be planned so as to fly under or in the vicinity of the shuttle orbits.

MEIDEX Physical Description

A Xybion IMC-201 radiometric camera equipped with six narrow-band filters centered at 340 nm, 380 nm, 470 nm, 555 nm, 660 nm, and 860 nm.

The Xybion camera has a field of view of 10.7 x 14.0° with a nadir footprint (looking straight down) of 52 x 68 km.

Second wide (60°) field of view video camera that operates as a viewfinder.

Both cameras are mounted in a single-axis gimbaled truss located in a standard Hitchhiker 5.0 cubic-foot canister equipped with a 5-inch extension and a Hitchhiker Motorized Door Assembly.

The MEIDEX canister is also equipped with a 16-inch quartz window with a broadband anti-reflective coating. Other Hitchhiker equipment consists of two Hitchhiker Video Interface Units.

SOLCON-3

History/Background

To understand the influence of the Sun on climate changes on Earth, it is necessary to make long-term, accurate measurements of the solar constant, the amount of solar energy received per unit surface at a distance of one astronomical unit (the average distance of Earth's orbit) from the Sun. The SOLCON instrument is a reference instrument for the measurement of the solar constant. It is flown regularly during short periods on the space shuttle.

SOLCON-3 Experiment Description

The SOLCON instrument is designed to accurately measure the solar constant and identify variations in the value during a solar cycle. SOLCON measures the solar irradiance forms in space to avoid perturbations by the atmosphere of the Earth. It is also used as a reference to construct a long duration time series of the solar irradiance. This data will ensure continuity of the solar constant level obtained by instruments mounted on free flyers, over climate time scale duration. Solar measurements are performed by determining the power difference required to bring two cavities into thermal balance when one is open to the Sun and the other is closed. The SOLCON-3 payload utilizes general space shuttle services including power control, command, and telemetry provided through the Hitchhiker carrier avionics equipment.

SOLCON- 3 Physical Description

-- Solcon-3 will be mounted on an HH Single Bay Pallet on top of the Hitchhiker Multipurpose Equipment Support Structure

-- Solcon-3 consists of a radiometer and a digital processor unit covered by a thermal blanket to provide Passive Thermal Control

-- The radiometer unit houses the Sun pointing monitor, shutter assembly, radiometer assembly and electronics

-- The digital processor unit houses the experiment control and interface to the Hitchhiker avionics

-- The radiometer unit consists of two channels through which solar radiation may be sensed

-- Each channel contains a radiation sensor and has two apertures

-- Independent shutters protect the first aperture of each channel. Each shutter seals out any solar radiation from the radiation sensor when closed and allows the sensor to receive solar radiation when open

-- An opening and closing outer cover on the radiometer unit provides protection from contamination during non-operating periods

SOLSE-2

History/Background

The discovery of the ozone hole in 1985 demonstrated the very large changes in ozone that were occurring in the lower stratosphere near 20 km, instead of the upper stratosphere as first expected, and where current ozone instruments are focused. The Shuttle Ozone Limb Sounding Experiment (SOLSE-2) will show that more information is available by looking at ozone from the side, at Earth's limb or atmospheric boundary. Ozone monitoring should be focused in the lower stratosphere by measuring ozone from a tangential perspective that is centered at the limb, which provides ozone profiles concentrated in the lower stratosphere. Stratospheric ozone depletion is a global concern because the ozone layer there keeps 95 percent of the UV radiation from striking the Earth.

The first flight of the Shuttle Ozone Limb Sounding Experiment (SOLSE) proved that this technique achieves the accuracy and coverage of traditional measurements, and surpasses the altitude resolution and depth of retrieval. SOLSE demonstrated that vertical profiles of ozone could be measured with high resolution using solar ultraviolet scattering from the Earth's atmospheric limb.

SOLSE-2 Experiment Description

SOLSE is an imaging spectrometer designed to produce high quality 2-dimensional images of the limb in visible and UV light while minimizing internal stray light. As one of the experiments flying aboard the Hitchhiker payload, the principle mission of SOLSE-2 is to demonstrate a new technique to measure the vertical distribution of ozone in the atmosphere. The ozone layer near the tangent point strongly absorbs radiation at particular wavelengths of light. SOLSE infers the presence of ozone with high altitude resolution by measuring the relative absence of radiation at those wavelengths according to height.

Using a limb viewing geometry, SOLSE-2 will demonstrate the feasibility of measuring limb-scattered radiation to retrieve ozone with improved vertical resolution than a traditional nadir looking instrument can achieve. Second, SOLSE will demonstrate the feasibility of using Charged Coupled Device technology to eliminate moving parts, which could lead to simpler, cheaper, ozone mapping instruments. The shuttle provides the perfect testbed to demonstrate new technology and measurement techniques without committing the funds for flight instrument. Once proven over a wider range of viewing conditions, the SOLSE-2 technique will be used to routinely measure ozone by the next generation weather satellites.

SOLSE-2 Physical Description

-- The instrumentation subsystem consists of a visible and UV spectrograph with a CCD array detector, photodiode array and visible light cameras, calibration lamp, optics and baffling

-- The experiment is housed in a Hitchhiker canister with canister extension ring and equipped with an Hitchhiker Motorized Door Assembly

-- The optical slit is masked with a linear attenuation filter that normalizes the intensity of the limb that varies by factor of 100 from top to bottom

-- A shutter controls the exposure of each frame

-- The filter wheel housing encloses 6 ion-assisted deposition filters at UV and visible wavelengths

CVX-2

History/Background

The Critical Viscosity of Xenon-1 Experiment first flew on STS-85 in 1997 as part of the Hitchhiker payload TAS-01. CVX revealed that when close to the liquid vapor critical point, xenon is partly elastic: it can “stretch” as well as flow. For STS-107, the hardware has been enhanced to determine if critical xenon is a shear thinning fluid. An understanding of shear thinning in a simple fluid will enable scientists to understand the phenomenon in more complex, industrially important fluids, such as: paints, emulsions, foams, polymer melts, pharmaceutical, food and cosmetic products.

CVX-2 Experiment Description

The Critical Viscosity of Xenon-2 Experiment will measure the viscous behavior of xenon - a heavy, inert gas used in flash lamps and ion rocket engines - at its critical point. The effects of gravity limit viscosity experiments on Earth. Xenon, near the critical point, will collapse under its own weight when exposed to Earth’s gravity, thereby increasing the density at the bottom. Experiments in the microgravity of orbit eliminate density differences and allow extended experiments to achieve the precision that scientists need.

Shear thinning occurs in complex fluids, such as paints and blood that become “thin” and flow easily under a shear stress such as stirring or pumping. CVX-2 will be the first experiment to examine the shear-thinning phenomenon in a simple fluid.

CVX-2 Physical Description

-- Viscometer comprised of a nickel screen that vibrates between two pairs of brass electrodes in a xenon bath

-- The grid is 7x 19 mm (0.28 x 0.74 in) and weighs less than 1 mg.

-- An electrode is positioned 4 mm (0.16 in) to each side of the screen

-- An electrical charge is applied by the electrodes that will oscillate the screen

-- The electrodes then measure the screen’s displacement

-- The sample cell is a copper cylinder, 62 mm long by 38 mm wide (2.45 x 1.5 in), that conducts heat and adds thermal inertia to ensure slow, even changes in temperature

-- The cell is enclosed in a three-layer thermostat to improve thermal control

-- CVX-2 is contained in two Hitchhiker canisters mounted on the Multi-Purpose Equipment Support Structure

-- One canister houses the Experiment Package. The second canister houses the Avionics Package which includes the data acquisition and control electronics, and the power conditioning systems

-- The experiment plan involves four “sweeps.” That is, the temperature will be gently moved up and down while the screen oscillates and data are continuously recorded

LPT

History/ Background

The paradigm of spacecraft design is changing throughout the space industry. Designs are requiring smaller, cheaper, and more capable systems. A key technology component that will enable these types of designs is a small, highly integrated, reprogrammable, multi-purpose communications and navigation payload that can withstand the radiation environments encountered over a variety of orbits.

LPT Experiment Description

The Low Power Transceiver (LPT) is a compact, flexible device that can be configured to perform custom communications and navigation functions in terrestrial, airborne, and space applications. The LPT is a collection of interchangeable hardware modules that form a software programmable platform for a variety of communication and navigation applications. The LPT can simultaneously process multiple radio frequencies (RF bands) in the transmittance or retrieval direction, and simultaneously process multiple data channels within each RF band; further, its modular architecture provides a flexible arrangement of signal processing resources. This technology thrust strives to return the maximum possible scientific information from instruments on board a spacecraft to the customer/principal investigator on Earth. GSFC engineers are working rapidly to prototype and demonstrate applicable Internet technologies and methodologies and to infuse them into flight missions where they will significantly reduce development costs and greatly increase mission flexibility. Furthermore, they expect these technologies to enable entirely new, distributed, system and mission models in the future.

LPT Physical Description

-- One thermally conductive box containing the LPT electronics stack.

The LPT experiment will be mounted on two HH Single Bay Pallets, one of which is shared with SOLCON-3, on top of the HH MPESS.

LPT has been integrated with a commercial processor board functioning as the flight computer, along with an three S-Band Receive Antenna, and one LBand Antenna or Low Gain Transmit Antenna, all mounted to the top of the HH Multi-purpose Equipment Support Structure (MPESS) via a HH Single Bay Pallet (SBP).

The flight computer will use GPS-Enhanced Orbit Navigation System (GEONS) software to process the Global Positing System (GPS) data.

The flight computer will run the Linux operating system, and use Mobile IP over all of the RF links.

The LPT TDRSS (and GN) forward link frequency is 2106.40625 MHz and the TDRSS (and GN) return link frequency is 2287.5 MHz.

Two Standard Switch Panel (SSP) switches will be incorporated to prohibit inadvertent Radio Frequency (RF) transmission from the antenna.

SEM-14 EXPERIMENTS

“Garden from the Stars” - Central Park Middle School, Schenectady City School District, and Farnsworth Middle School, Guilderland Central School District, Guilderland, N.Y.

The experiment involves sending selected seeds, representative of wildflowers from the ecologically unique and sensitive land area of the Albany Pine Bush Preserve, into space to measure effects of spaceflight and zero gravity on growth of plants. It is hypothesized that there will be measurable differences in growth of plants from “space” seeds compared with plants grown from “nonspace” control seeds. These differences may include germination period, size of plant, number of petals, shape of leaves, and color variations. Plants grown from the “space” seeds will be donated to the City of Schenectady’s Central Park Gardens and some will be returned to the Pine Bush to help in restoration of the native plant population.

“United Voyager, Moving and Shaking at M.S. 135 & M.S. 143” - Frank D. Whalen Middle School and Peter Tetard Middle School, New York, N.Y.

Students from Frank D. Whalen Middle School & Peter Tetard Middle School in New York City will partner in this experiment. They will be investigating cosmic radiation, g-forces of space travel, and effects of space travel on plant growth patterns. The plant growth investigation will use tomato seeds (native to the Bronx) along with soil samples. Other sample materials will include chalk, marbles, gum, gum/taffy, iron filings, small magnets, candles, crayons, film, yeast, and a pendulum watch. Control groups will be maintained on Earth and used to determine the changes caused by the spaceflight.

“Wearable Radiation Protection” - The Mott Hall-CCNY STARS Program, the Mott Hall School-IS223 & The City College of New York, New York, N.Y.

Living and non-living things that travel outside of the Earth’s atmosphere and the Earth’s magnetic field will be subjected to levels of radiation that are higher than those to which they are exposed on the surface of the Earth. This experiment tests the effectiveness of various flexible materials as a barrier to this radiation. Natural and synthetic fabrics made of organic and inorganic materials will be wrapped around dosimeters that measure exposure to radiation. It will then be possible to see if any of the tested materials provide a significant amount of protection against radiation when worn. The students in the SEM team are participating in a program called the Mott Hall-CCNY STARS (Student Apprenticeships in Research). STARS is a partnership between the City College of New York and The Mott Hall School. Each year eighth-graders spend three hours a week working with mentors in CCNY science and engineering research laboratories. The goal of STARS is to empower and encourage minority students to pursue careers in science and engineering. The Mott Hall School - IS 223 is a public school in Community School District 6 in the North Harlem/Washington Heights neighborhood of New York City. It is a grade 4-8 magnet school for 450 students offering advanced studies in math, science and technology. Most of the students, 85 percent of the student population, are first- or second- generation immigrants from Latin America, especially the Dominican Republic. About 10 percent are African Americans. The others are almost all immigrants from other countries.

“NYC KISS (Kids Investigations in Space Science)” - American Museum of Natural History, Rose Center for Earth and Space, New York, N.Y.

The NYC KISS program consists of the Rose Center for Earth and Space, part of the American Museum of Natural History, working in conjunction with six New York City educators to introduce hundreds of New York City schoolchildren to space and the hazards and beauties that it holds. Experiments will determine how the space environment will change a variety samples. Experiment samples will include DNA samples, composting materials, magnets, film, sunscreen, and other passive material samples.

“VIRUS- T4” - Bishop Borgess High School & Academy, Redford, Mich.

Students will study two different aspects of the effect of the Near-Earth Space Environment (NESE) on biological materials. In one experiment, they will study the degradation of antibiotic activity in NESE compared to control (terrestrial) samples. They will perform standard Kyrby-Bauer antibiotic sensitivity tests on the NESE and terrestrial samples of various antibiotics. The second experiment will measure the viability of the T4 Virus samples exposed to the NESE (X-rays and Gamma Rays) and compare that to the viability of terrestrial samples.

A radiation dosimetry badge will be enclosed in the module for measuring radiation exposure. Students will perform a standard dilution plaque assay on both the space and terrestrial samples, under the direction of a trained microbiologist. Students will learn experimental design and data interpretation, and will calculate antibiotic and virus viability using their math skills. They will also study the effects of radiation on fluorescent dyes to determine if they will glow brighter after exposure to the NESE. The students will communicate their results in a written report, in which data will be presented in tabular and graphic forms. This will also include a brief oral presentation.

“OGRE” - Ogdensburg Public School, K-8, Ogdensburg, N.J.

Students at the Ogdensburg School are preparing an experiment that will test the affects of radiation and weightlessness on florescent minerals. Ogdensburg is famous for its Sterling Hill Mine where there is an abundance of florescent minerals. These minerals have been displayed in the Smithsonian Institute in Washington, D.C., the Museum of Natural History in New York and other museums around the world. Students will be collecting mineral samples and dividing them into a control group, which will stay on Earth, and an experimental group, that will fly in the space shuttle. They will photograph both groups of minerals under ultraviolet light, so they can compare their luminescence once the minerals return from space. Mineral spectrographs will be taken before and after flight using the Cary Variance Florescent Mineral Spectrophotometer at Varian technologies. The mass of the minerals will also be measured to see if any changes occur from the space environment.

“Worms & Mold in Space” - East Norriton Middle School, Norristown, Pa.

The first part of this experiment addresses food preservation as it’s affected by zero gravity and above normal levels of radiation. Five samples of bread will be sent into space while five identical samples will be maintained on Earth for control purposes. Examination and comparison of variables and controls will hopefully show if zero gravity and radiation had any effects on bread mold growth and life activities. Data will then possibly be applied to future NASA missions. The second part of the experiment will investigate mealworms. Mealworms are popular sources of food for reptilian pets and they also go through a metamorphosis. Their food and oxygen requirements are minimal. The hope is that the samples will survive the trip and return to Earth for comparison with the earthbound control group. Mutations and compatibility with populations left on Earth will be examined.

“C.D. in Space?” - Country Centre 4-H Space Science Project, Sacramento, Calif.

“CD in Space” is an extension of the Country Centre 4-H Space Science “A Seed for Larger Service” project. This hands-on 4-H space science project encourages experiencing math, science, scientific research and the scientific process in an after school setting. The experiment team is comprised of one 4-H space science project leader and 14 youth ranging between the ages of 5 and 16 who reside in Sacramento County. Other individuals involved include professionals in the greater community to consult and aid in the experiment process. The purpose of this experiment is to test how radiation, vibration and temperature extremes in the space environment might affect a compact disc. A control group of CDs will remain on Earth and, using technology and scientific methods of analysis, the youths will compare the control group with the flight group.

“How Do Our Space Beans Grow?” - J.M. Bailey School Kindergarten, Bayonne, N.J.

The kindergarten students at John M. Bailey School in Bayonne, N.J., will send bean seeds into space. This experiment will be done in conjunction with the life science curriculum “PLANTS -Seeds and Plant Growth.” Children will discover if a change in environment will affect the growth rate of seeds. Will seeds kept in the dark germinate? Will it make a difference if they are in air, sand, soil or water? After seeds return from space, they will be planted along with a control group of seeds kept on Earth. Both sets of seeds will be monitored for rate of growth. Children will compare the development of buds, flowers and leaves. Math skills will be incorporated through measuring and graphing plant growth. Children will keep a journal to record observations and data during the project.

"St. John's Seeds" - St. John the Baptist Preschool, New Freedom, Pa.

The experiment will investigate how the space environment will affect tomato seeds. The students suspect that the seeds will grow "funny" on their return. The students will get to see first-hand the effects of space travel. The group will be connecting this experiment to units on spring and the life cycle of the seed.

"Natural Space Art (NSA)" - Shoshone-Bannack High School, Fort Hall, Idaho

Students and staff at the Shoshone-Bannock High School located on the Fort Hall Indian Reservation at Fort Hall, Idaho, are planning an experiment that will investigate if urine-filtered water will mix with paint dyes. The team will be building on past space science projects and experiments. The team will fly the mixtures to see how they react in space. Students and staff will also paint small objects like canvas, wood, rocks, and metal with the mixtures and see how they survive the extreme temperatures of space. The team will run a control in the lab and compare results. Some of the questions to be investigated include: Will the rigors of spaceflight affect the painted materials? Will solutions of urine, water and dyes be usable once returned back from space? Could astronauts use filtered urine water for art purposes in space?

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STS-107 National Space Development Agency of Japan (NASDA) Space Experiment Project

Mission Overview

The National Space Development Agency of Japan (NASDA) will implement protein crystal growth experiments for about 16 days on space shuttle mission STS-107 prior to actual utilization of the Japanese Experiment Module (JEM) "KIBO." Biological fundamental research experiments and experiments on medical applied research for pharmaceuticals will be conducted with the Commercial Macromolecular Protein Crystal Growth (CMPCG) equipment. NASDA is also providing an opportunity for a space education program in protein crystal growth for high school students.

In addition, the Biospecimen Sharing Program (BSP) will clarify the effects of space on living organisms using rodents carried aboard the space shuttle in the Animal Enclosure Module (AEM).

The experiments using the space environment will produce significant results for protein research and the BSP.

Significance of Protein Research

Today we recognize numerous growing threats to human bodies including aging, viruses, various diseases, and chemical substances such as environmental hormones, which are strongly related to various functions of proteins, important components of living organisms. The functions of proteins heavily depend on their three-dimensional structure. Clarifying the protein's functions and its structure at the atomic level will contribute to research in bioscience and medicine.

Decoding of the human genome was almost completed in June 2000, and analyses of protein functions and structures have received much attention as post-genomesequence research. Structure-Based Drug Design (SBDD), which applied the protein research in a medical development for disease treatment, has attracted many pharmaceutical companies.

Protein Crystallization in Space

High-quality single-protein crystals suitable for research are essential for highly detailed protein structure analysis by X-ray diffraction, the instrument used for determining the 3-dimensional structure of macromolecules. On Earth, gravity causes crystal sedimentation and convection, which affect the quality of crystals. The microgravity environment of space has been used to grow high-quality crystals; however, there are still more challenges to growing high-quality crystals with high probability. Hence experiments in space must be conducted continuously to clarify the crystallization process.

Protein crystal growth experiments will be performed to clarify functions of various biologically important proteins and differences between proteins crystallized in space and on the Earth. High-quality crystals produced in space provide a better understanding of the relation between protein functions and structures and of conditions necessary for growing crystals of high quality. Science research themes are: study of the relationship between crystallization condition and crystal quality for Cytochrome; high-quality GCS crystal growth in microgravity; high-quality NfsB crystal growth in microgravity; crystallization of high-quality Congerin and Congerin mutants in microgravity; and crystallization of complex protein crystals in microgravity.

Applied research themes for the STS-107 experiments are: applied research on protein crystallization in space for designing anti-inflammatory and anti-somnolent drugs; molecular design of novel drugs for parasitic diseases based on the crystal structure; drug discovery study for specific inhibitor of geriatric diseases; and studies on crystallization of a photoreceptor protein.

NASDA is developing common and basic techniques leading to success for space experiments. Such techniques would enable the prediction of optimum experimental conditions in space from the results of ground experiments. Protein crystal growth experiments will be performed to verify the developed optimal techniques for microgravity experiments using vapor diffusion.

NASDA will also provide an opportunity for high school students to conduct protein crystal growth experiments using CMPCG aboard the space shuttle. Students will learn the significance of research on proteins and microgravity by conducting preparative and space experiments and writing papers on their analyses.

Animal Research

The International Space Station will be assembled at the beginning of the 21st Century. The advance of humans into space will then have finally started in earnest. It is essential to perform animal studies using mammalians, such as rodents, to ensure safe human space activities. Detailed analysis of the effects of the space environment on mammalian physiology is very important from the life science and medical viewpoints.

Biospecimen Sharing Program (BSP)

Rodent experiments will be performed to clarify functions of various biologically significant differences between space and Earth environments. Nine experiments in the following four scientific fields will be performed on STS-107 by Japanese principal investigators. The four fields are bone and muscle, metabolism and endocrinology, neural system and radiation biology. The nine experiments are:

-- Effects of spaceflight on the gene expression of skeletal muscle in rats

-- Effects of spaceflight on the characteristics of fast and slow hindimb muscles of rats

-- Osteoactivin: A novel glycoprotein inhibiting adhesion of osteoblastic cells to bone matrix

-- Analysis of gene and protein expressions of cytochrome P450 and stress- associated molecules in rat livers after spaceflight

-- The effects of microgravity on mRNA expression in the vestibular endorgans

-- Effect of space environment on the metabolism of nicotinamide adenine dinucleotide (NAD) metabolism in rats

-- Gene expression of p53-regulated gene after exposure to space environment in rat

-- Effects of spaceflight on spermatogenesis in rat-expression and quantification factors implicated spermatogenesis

-- Effects of microgravity on the fiber component of the aortic depressor nerve in the Fisher 344 rat

Commercial Macromolecular Protein Crystal Growth (CMPCG)

CMPCG equipment provided by the University of Alabama at Birmingham and SPACEHAB, Inc. will be carried aboard the space shuttle. The CMPCG consists of 1,008 crystal growth cells, using vapor diffusion methods, trays for loading the cells, and an incubator for cell-temperature control. NASDA will use 306 of the 1,008 cells for crystal growth experiments.

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Animal Enclosure Module (AEM)

The Animal Enclosure Module (AEM) provided by NASA Ames Research Center will be carried aboard the space shuttle for the experiments on rodents.

Hardware Description

The AEM is a rodent-housing facility that supports up to six 250-gram rats. The unit fits inside a standard space shuttle middeck or SPACEHAB locker with a modified locker door. The AEM remains in the stowage locker during launch and landing. On orbit, the AEM may be removed partway from the locker and the interior viewed or photographed through a Lexan cover on the top of the unit. With the addition of an Ambient Temperature Recorder, temperatures at up to four locations within the unit can be recorded automatically.

Subsystems

Air Quality: Cabin air is exchanged with the AEM through a filter system. Four fans create a slight negative pressure inside the AEM, ensuring an inward flow of air and particulate entrapment by the treated outlet filter. Cabinet air is drawn through front panel inlet slots, then along the side plenum walls to the rear of the AEM, then through the inlet filter, across the cage/animal habitat area, through the exhaust filter, and exits the front of the AEM. High-efficiency air (inlet and outlet) filters (electrostatic and phosphoric acid-treated Fiberglas pads) prevent the escape of particulate matter into the cabin atmosphere. Treated charcoal inside the filters helps contain animal odor and neutralize urine within the AEM. The filter system is rated for 21 days of odor control.

Lighting: Four internal incandescent lamps (two used as backup) provide illumination and are controlled by an automatic timer to provide a standard 12:12 light/dark cycle. The timer is programmable for other light/dark cycles and a backup battery maintains the timer if AEM power is disrupted. Only two lamps are used during the light cycle to keep cage compartment heating to a minimum. The lamps are covered with clear caps to protect them from animal debris and breakage.

Food: Rodent food bars are attached to four slide-in food bar plates inside the rodent cage. The food, a sterilized laboratory formula (either standard or principal investigator- formulated), is molded into rectangular bars accessible to the animals at all times during the mission.

Water Box: The AEM accommodates an internal water supply containing four lixit drinking valves and two flexible plastic bladders for water storage. Remaining water can be observed through the Lexan window on top of the water box.

Water Refill Box: This water refill box (WRB) is used for in-flight refill of drinking water in the AEM. Water can be pumped from the refill box to the AEM by the WRB’s peristatic pump. The bladder in the box can hold up to 3 liters. The box also can be refilled from the orbiter galley if necessary.

Specifications: Dimensions: 17(W) x 20(D) x 9.6 (H) inches Weight: 55 lbs (including rodents, food and water) Power: 35 W (2 lights only)

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STARS Student Experiments

SPACEHAB's complement of commercial experiments includes six educational experiments designed and developed by students in six different countries under the auspices of Space Technology and Research Students (STARS), a global education program managed by SPACEHAB subsidiary Space Media. The student investigators who conceived these experiments will monitor their operations in space. The experiments will be housed in BioServe Space Technologies' Isothermal Containment Module (ICM --a small temperature-controlled facility that provides experiment support such as physical containment, lighting, and video imaging) and stowed in a middeck-size locker aboard the Research Double Module.

Astrospiders - Spiders in Space

Glen Waverely Secondary College, Melbourne, Australia http://www.gwsc.vic.edu.au/stars/index.htm

Spider silk is one of the strongest materials on Earth. Each fiber can stretch 40 percent of its length and absorb 100 times as much energy as steel without breaking. The spider's unique method of silk production is comparable to methods for producing advanced materials such as carbon fiber and Kevlar. While artificial fibers can be expensive and environmentally unfriendly, spiders can manufacture superior materials in the relatively benign environment of their internal organs. The spider species chosen for flight is the Garden Orb Weaver (Eriophora biapicata), because it builds a perfect orb web, renews its web every night, is nonpoisonous, has a placid nature, and is commonly found in Australia and New Zealand while similar species are found in North America.

The hypothesis for this experiment is that the spider will build a different web than the sort of web it would make on Earth. The web's makeup may also be affected. The aim of this experiment is to investigate how a spider adapts to life in microgravity, determine how spiders spin their webs in microgravity, observe how spiders eat in a weightless environment, and capture web samples for analysis on Earth.

The Victorian Department of State and Regional Development is sponsoring this experiment. The Melbourne Zoo and the RMIT University are providing assistance.

Silkworm Life Cycle During Spaceflight Jingshan School, Beijing, China

The objective of this experiment is to observe and characterize the effects of spaceflight on the development of silkworm eggs, larvae, pupae, and adults. Upon

their return to Earth, the silkworms and the silk they produce in space will be examined and compared to equivalent organisms and silk grown under identical environmental conditions on the ground.

The hypothesis for this experiment is that silkworm larvae will develop differently in a low-gravity environment, possibly due to the direct effects of microgravity or to indirect effects such as altered eating habits or other behavioral changes; that microgravity will affect the placement and construction of the silkworms' cocoons as well as the process of emergence for adult moths; and that microgravity will affect the development of silkworm eggs, particularly during the first hours of cell division.

China Time Network is providing support to Jingshan School for this experiment.

Chemical Garden Ort-Matzkin School, Haifa, Israel

This experiment is designed to allow investigators to observe the growth of cobalt and calcium chloride salt filaments in a sodium silicate solution. In Earth gravity, thin crystal filaments grow towards the surface of the aqueous medium. Investigators surmise that this preference toward upward growth may be negated during spaceflight, allowing them to investigate the growth mechanisms of crystalline fibers.

Investigators anticipate that, in space, the crystalline fibers or filaments will grow differently in microgravity because the fiber growth mechanisms are gravitropic. One hypothesis is that air bubbles often appearing at the tips of growing filaments could act as a buoyant force, pulling filaments toward the top of the aqueous medium. A second hypothesis involves the effects of hydrostatic pressure differential. Typically, filaments grow in small stages, appearing somewhat like a continual stack of tiny spheres. The pressure differential between the top and the bottom of a sphere may cause the top of the sphere to crack and act as the nucleation site for the next sphere. In either case, elimination of the gravity field should provide insight into the growth mechanisms of salt filaments.

Technion University is providing support to this experiment.

Flight of the Medaka Fish Tokyo Institute of Technology, Tokyo, Japan

This experiment will examine the effect of microgravity on a closed aquatic environment including Medaka fish embryos during a 16-day spaceflight.

Student investigator Maki Nihori of Ochanomizu University has hypothesized that Medaka fish fry will develop faster in microgravity, possibly due to lower expenditure of energy. She also anticipates that Medaka fish fry hatched in microgravity will behave normally and have an adaptation period followed by normal swimming behavior after returning to Earth.

Sponsors and partners for this experiment include the Tokyo Institute of Technology Foundation, the Japanese Space Promotion Center, and the Japan-U.S. Science, Technology and Space Applications Program. Paragon Space Development Corp. of Tucson, Arizona, is providing its Autonomous Biological System, a self-contained life support system, for this experiment; Paragon also provided the student investigator with a two-month internship in ecosystems research.

Spice Bees in Space Liechtenstein Gymnasium, Liechtenstein

This experiment studies the behavior of carpenter bees. Female carpenter bees construct nests by boring tunnels in flower stalks or wood. When the bees construct tunnels in wood, their chewing can be heard from several feet away. A female bee may construct several tunnels a season. Each finished tunnel branches into a series of cells, in which the female deposits pollen and nectar and then lays eggs on the food mass.

Investigators hypothesize that carpenter bees will exhibit different behaviors in microgravity than they do on Earth. Their tunneling habits will likely be altered since they may find it difficult to determine their gravity vectors in space. Tunnels drilled in space therefore may take on a different shape than those made on the ground.

The VP Bank of Liechtenstein is sponsoring this experiment.

Ants in Space Fowler High School, Syracuse, New York

The objective of this experiment is to observe and characterize the effects of spaceflight on the tunneling behavior of harvester ants, focused on their activity level and social interactions. Upon their return to Earth, the ants and their tunnels will be examined and compared to an equivalent colony kept under similar environmental conditions on the ground. A special transparent gel will serve as the ants' tunneling medium, food and water source, and antifungal material.

The hypothesis for this experiment is that the ants will tunnel at a slower rate in microgravity than they do on Earth. Investigators anticipate that ants will tunnel and forage differently in microgravity, possibly due to the direct effects of microgravity or indirect effects such as altered eating habits or other behaviors. As the ants begin to build their tunnels as a means of foraging for food, microgravity may affect the ants' placement and construction of tunnels as well as their foraging habits. Further, microgravity may affect the structure of tunnels once they are made, particularly during the latter stages of flight. Because ants are highly social and collectively industrious creatures, some changes in colony behavior can be expected. The stresses involved in adapting to microgravity may cause deterioration in the social fabric of the colony and changes in collective behavior.

Syracuse University is providing support to this experiment.

Contacts for more information:

U.S. “Ants in Space” experiment: Prof. Eric Spina Syracuse University Phone: 315-443-3604 efspina@syr.edu

Israeli “Chemical Garden” experiment: Prof. Yigal Khomem Technion University, Tel Aviv Phone: 011/972-4829-4581, x. 91 khomem@techunix.technion.ac.il

Japanese “Medaka Fish” experiment: Dr. Osamu Odawara, odawara@echem.titech.ac.jp

Australian “Astrospiders” experiment: Mr. Kevin Manning Phone: 011-61-3-5995-1255 aei@hqspacehab.com

Liechtenstein “Spice Bees” experiment, Liechtenstein Gymnasium: Mr. Manfred Schlapp Phone: 011-42-3-236-0606 Manfred@schlapp.li

Chinese "Silk Worms in Space” experiment: Mr. Hu Ji, China Time Network, Phone: 011-86-1-0639-1688, x. 309 huji@chinatimenet.com

For more information on STARS student experiments see: http://www.spacehab.com/stars

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Detailed Test Objectives (DTOs) and Detailed Supplementary Objectives (DSOs)

Single String Global Positioning System (DTO 700-14)

The purpose of this experiment is to demonstrate the performance and operations of the GPS during orbiter ascent, entry and landing phases utilizing a modified military GPS receiver processor and the existing orbiter GPS antennas.

Crosswind Landing Performance (DTO 805—DTO of Opportunity)

The purpose of this experiment is to demonstrate the capability to perform a manually controlled landing in the presence of a crosswind.

Pharmacokinetics & Contributing Physiologic Changes During Spaceflight – Protocol B (DSO 632)

Changes in gastrointestinal function and physiology as a result of spaceflight affect drug absorption and the bioavailability of oral medications, which can compromise therapeutic effectiveness. This DSO will lead to the design and development of effective pharmocological countermeasures and therapeutic adjustments for spaceflight.

Spatial Reorientation Following Spaceflight (DSO 635)

A previous observation suggested that discordant sensory stimuli caused by an unusual motion environment disrupted spatial orientation and balance control in a returning crewmember by triggering a state change in central vestibular processing. The findings of the current investigation are expected to demonstrate the degree to which challenging motion environments may affect post-flight (re)adaptation to gravity.

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STS-107 Flight Plan

Editor's Note
Due to post Sept. 11 security precautions, NASA for the moment is not releasing the shuttle's exact launch time until 24 hours before liftoff. The following flight plan is targeted on the publicly announced opening of a four-hour window that begins at 10 a.m. on Jan. 16. As such, the times below could be off by as much as four hours in a worst-case scenario. Times given in EST and mission elapsed time.

TIME	DD	HH	MM	EVENT
01/16/03				
Thu 10:39 AM	00	00	00	STS-107 launch
Thu 10:48 AM	00	00	09	Main engine cutoff
Thu 11:29 AM	00	00	50	OMS-2 burn to circularize orbit
Thu 11:29 AM	00	00	50	Begin post insertion timeline
Thu 12:09 PM	00	01	30	Payload bay door opening
Thu 01:09 PM	00	02	30	Radiator deploy
Thu 01:09 PM	00	02	30	Spacehab activation begins
Thu 01:09 PM	00	02	30	SEE setup
Thu 01:24 PM	00	02	45	Group B computer powerdown to conserve power
Thu 01:34 PM	00	02	55	Color printer setup
Thu 01:39 PM	00	03	00	GIRA installation
Thu 02:39 PM	00	04	00	Spacehab setup (part 1)
Thu 02:39 PM	00	04	00	Blue shift sleep begins
Thu 02:59 PM	00	04	20	SOLSE activation; ARMS setup
Thu 03:54 PM	00	05	15	Red shift meals begin
Thu 03:59 PM	00	05	20	MEIDEX computer setup
Thu 04:39 PM	00	06	00	Spacehab setup (part 2)
Thu 04:49 PM	00	06	10	LPT maneuver
Thu 04:59 PM	00	06	20	Animal Enclosure Module (AEM) check
Thu 04:59 PM	00	06	20	Spacehab activation (part 3)
Thu 05:09 PM	00	06	30	ARMS rebreath 1A
Thu 05:49 PM	00	07	10	MCC: STAR operations
Thu 06:19 PM	00	07	40	Elevon park
Thu 08:39 PM	00	10	00	Blue shift wakeup
Thu 09:09 PM	00	10	30	Shift handover
Thu 09:39 PM	00	11	00	Red shift sleep begins
Thu 10:39 PM	00	12	00	Spacehab setup (part 4)
Thu 11:54 PM	00	13	15	Refrigerator activation
Thu 11:59 PM	00	13	20	Local area network setup
01/17/03				
Fri 12:19 AM	00	13	40	ARMS ergometer setup
Fri 12:49 AM	00	14	10	MEIDEX checkout
Fri 04:29 AM	00	17	50	Blue shift meals begin
Fri 05:39 AM	00	19	00	Red shift wakeup
Fri 06:04 AM	00	19	25	MEIDEX operations begin
Fri 07:14 AM	00	20	35	Brown exercises
Fri 07:39 AM	00	21	00	Red shift science ops begin
Fri 07:49 AM	00	21	10	McCool exercises
Fri 08:19 AM	00	21	40	Husband exercises
Fri 10:09 AM	00	23	30	Shift handover
Fri 11:39 AM	01	01	00	Blue shift sleep begins
Fri 12:44 PM	01	02	05	MEM setup
Fri 01:24 PM	01	02	45	MEM activation 1
Fri 01:44 PM	01	03	05	Red shift meals begin
Fri 06:09 PM	01	07	30	Crew choice video downlink

TIME	DD	HH	MM	EVENT
Fri 06:19 PM	01	07	40	Ramon exercises
Fri 06:44 PM	01	08	05	Clark exercises
Fri 07:39 PM	01	09	00	Blue shift wakeup
Fri 08:34 PM	01	09	55	Shift handover
Fri 09:04 PM	01	10	25	Blue shift science ops begin
Fri 09:39 PM	01	11	00	Red shift sleep begins
Fri 11:14 PM	01	12	35	McCool exercises
Fri 11:34 PM	01	12	55	Brown breakfast
01/18/03				
Sat 01:59 AM	01	15	20	McCool, Anderson meal
Sat 04:19 AM	01	17	40	Brown meal
Sat 05:39 AM	01	19	00	Red shift wakeup
Sat 07:04 AM	01	20	25	Shift handover
Sat 07:04 AM	01	20	25	Shift handover
Sat 10:39 AM	02	00	00	Husband exercises
Sat 10:39 AM	02	00	00	Blue shift sleep begins
Sat 01:29 PM	02	02	50	Red shift meals begin
Sat 03:04 PM	02	04	25	Red shift media interviews
Sat 04:24 PM	02	05	45	Chawla exercises
Sat 05:14 PM	02	06	35	Crew choice video downlink
Sat 06:39 PM	02	08	00	Blue shift wakeup
Sat 08:09 PM	02	09	30	Shift handover
Sat 09:39 PM	02	11	00	Red shift sleep begins
Sat 09:39 PM	02	11	00	Blue shift science ops begin
Sat 09:39 PM	02	11	00	Anderson exercises
Sat 10:39 PM	02	12	00	McCool exercises
Sat 11:44 PM	02	13	05	Brown exercises
01/19/03				
Sun 01:29 AM	02	14	50	Blue shift meals begin
Sun 05:39 AM	02	19	00	Red shift wakeup
Sun 07:19 AM	02	20	40	Shift handover
Sun 07:19 AM	02	20	40	Shift handover
Sun 07:39 AM	02	21	00	Red shift science ops begin
Sun 08:34 AM	02	21	55	Ramon exercises
Sun 09:39 AM	02	23	00	Husband exercises
Sun 09:39 AM	02	23	00	Blue shift sleep begins
Sun 11:39 AM	03	01	00	Red shift meals begin
Sun 02:19 PM	03	03	40	Crew choice video downlink
Sun 05:39 PM	03	07	00	Blue shift wakeup
Sun 07:59 PM	03	09	20	Shift handover
Sun 08:29 PM	03	09	50	Blue shift media interviews
Sun 08:49 PM	03	10	10	McCool exercises
Sun 09:39 PM	03	11	00	Red shift sleep begins
Sun 09:39 PM	03	11	00	Anderson exercises
Sun 11:24 PM	03	12	45	Crew choice video downlink
01/20/03				
Mon 12:19 AM	03	13	40	Brown exercises
Mon 01:24 AM	03	14	45	Blue shift meals begin
Mon 05:39 AM	03	19	00	Red shift wakeup
Mon 07:24 AM	03	20	45	Shift handover
Mon 07:54 AM	03	21	15	Chawla exercises
Mon 08:14 AM	03	21	35	Red shift science ops begin
Mon 09:09 AM	03	22	30	Blue shift sleep begins
Mon 09:39 AM	03	23	00	Husband exercises

TIME	DD	HH	MM	EVENT
Mon 11:34 AM	04	00	55	Clark exercises
Mon 01:09 PM	04	02	30	Red shift meals begin
Mon 05:09 PM	04	06	30	Blue shift wakeup
Mon 07:24 PM	04	08	45	Shift handover
Mon 07:54 PM	04	09	15	Blue shift science ops begin
Mon 08:04 PM	04	09	25	Anderson exercises
Mon 09:09 PM	04	10	30	Red shift sleep begins
Mon 10:04 PM	04	11	25	Brown exercises
01/21/03				
Tue 12:59 AM	04	14	20	Blue shift meals begin
Tue 03:24 AM	04	16	45	McCool exercises
Tue 05:09 AM	04	18	30	Red shift wakeup
Tue 06:39 AM	04	20	00	Shift handover
Tue 07:44 AM	04	21	05	Red shift science ops begin
Tue 08:39 AM	04	22	00	Chawla exercises
Tue 08:39 AM	04	22	00	Blue shift sleep begins
Tue 10:39 AM	05	00	00	Red shift media interviews
Tue 11:24 AM	05	00	45	Red shift meals begin
Tue 02:24 PM	05	03	45	Ramon exercises
Tue 03:49 PM	05	05	10	Clark exercises
Tue 04:39 PM	05	06	00	Blue shift wakeup
Tue 06:24 PM	05	07	45	Shift handover
Tue 06:54 PM	05	08	15	Blue shift science ops begin
Tue 07:34 PM	05	08	55	Anderson exercises
Tue 08:04 PM	05	09	25	Brown exercises
Tue 08:39 PM	05	10	00	Red shift sleep begins
Tue 09:09 PM	05	10	30	Crew choice video downlink
01/22/03				
Wed 12:09 AM	05	13	30	Blue shift meals begin
Wed 01:09 AM	05	14	30	Blue shift off duty time begins
Wed 04:39 AM	05	18	00	Red shift wakeup
Wed 06:09 AM	05	19	30	Shift handover
Wed 06:39 AM	05	20	00	Red shift off duty time begins
Wed 08:09 AM	05	21	30	Blue shift sleep begins
Wed 11:39 AM	06	01	00	Red shift meals begin
Wed 12:39 PM	06	02	00	Red shift science ops resume
Wed 01:39 PM	06	03	00	Ramon exercises
Wed 04:09 PM	06	05	30	Chawla exercises
Wed 04:09 PM	06	05	30	Blue shift wakeup
Wed 04:54 PM	06	06	15	Husband exercises
Wed 06:04 PM	06	07	25	Shift handover
Wed 06:34 PM	06	07	55	Blue shift science ops begin
Wed 08:09 PM	06	09	30	Red shift sleep begins
Wed 10:14 PM	06	11	35	Anderson exercises
Wed 11:49 PM	06	13	10	Blue shift meals begin
01/23/03				
Thu 04:09 AM	06	17	30	Red shift wakeup
Thu 04:39 AM	06	18	00	McCool exercises
Thu 05:39 AM	06	19	00	Shift handover
Thu 06:04 AM	06	19	25	Red shift science ops begin
Thu 07:39 AM	06	21	00	Blue shift sleep begins
Thu 09:54 AM	06	23	15	Clark exercises
Thu 10:54 AM	07	00	15	Red shift meals begin
Thu 03:39 PM	07	05	00	Blue shift wakeup

TIME	DD	HH	MM	EVENT
Thu 03:49 PM	07	05	10	Husband exercises
Thu 04:39 PM	07	06	00	Chawla exercises
Thu 05:39 PM	07	07	00	Shift handover
Thu 06:09 PM	07	07	30	Blue shift science ops begin
Thu 07:39 PM	07	09	00	Red shift sleep begins
Thu 09:54 PM	07	11	15	Blue shift meals begin
01/24/03				
Fri 12:29 AM	07	13	50	Brown exercises
Fri 03:39 AM	07	17	00	Red shift wakeup
Fri 05:14 AM	07	18	35	Shift handover
Fri 05:59 AM	07	19	20	Red shift science ops begin
Fri 07:39 AM	07	21	00	Blue shift sleep begins
Fri 08:54 AM	07	22	15	Chawla exercises
Fri 10:39 AM	08	00	00	Red shift meals begin
Fri 03:24 PM	08	04	45	Husband exercises
Fri 03:39 PM	08	05	00	Blue shift wakeup
Fri 04:19 PM	08	05	40	Ramon exercises
Fri 05:19 PM	08	06	40	Shift handover
Fri 05:49 PM	08	07	10	Blue shift science ops begin
Fri 05:49 PM	08	07	10	McCool exercises
Fri 07:39 PM	08	09	00	Red shift sleep begins
Fri 10:39 PM	08	12	00	Blue shift meals begin
01/25/03				
Sat 01:49 AM	08	15	10	Blue shift media interviews
Sat 02:09 AM	08	15	30	Brown exercises
Sat 02:54 AM	08	16	15	Anderson exercises
Sat 03:24 AM	08	16	45	McCool exercises
Sat 03:39 AM	08	17	00	Red shift wakeup
Sat 05:14 AM	08	18	35	Shift handover
Sat 06:09 AM	08	19	30	Red shift science ops begin
Sat 07:39 AM	08	21	00	Blue shift sleep begins
Sat 09:09 AM	08	22	30	Clark exercises
Sat 09:49 AM	08	23	10	Ramon exercises
Sat 10:39 AM	09	00	00	Red shift meals begin
Sat 01:49 PM	09	03	10	Crew choice video downlink
Sat 03:19 PM	09	04	40	Husband exercises
Sat 03:39 PM	09	05	00	Blue shift wakeup
Sat 04:14 PM	09	05	35	Chawla exercises
Sat 05:14 PM	09	06	35	Shift handover
Sat 06:09 PM	09	07	30	Brown exercises
Sat 06:14 PM	09	07	35	Blue shift science ops begin
Sat 07:39 PM	09	09	00	Red shift sleep begins
Sat 09:54 PM	09	11	15	Blue shift meals begin
01/26/03				
Sun 03:14 AM	09	16	35	McCool exercises
Sun 03:39 AM	09	17	00	Red shift wakeup
Sun 05:19 AM	09	18	40	Shift handover
Sun 05:49 AM	09	19	10	Red shift science ops begin
Sun 07:39 AM	09	21	00	Blue shift sleep begins
Sun 08:34 AM	09	21	55	Crew choice video downlink
Sun 09:19 AM	09	22	40	Husband exercises
Sun 11:29 AM	10	00	50	Red shift meals begin
Sun 03:39 PM	10	05	00	Blue shift wakeup
Sun 04:19 PM	10	05	40	Clark exercises

TIME	DD	HH	MM	EVENT
Sun 05:19 PM	10	06	40	Shift handover
Sun 05:49 PM	10	07	10	Blue shift science ops begin
Sun 06:09 PM	10	07	30	McCool exercises
Sun 06:54 PM	10	08	15	Anderson exercises
Sun 07:39 PM	10	09	00	Red shift sleep begins
Sun 10:39 PM	10	12	00	Blue shift meals begin
01/27/03				
Mon 03:39 AM	10	17	00	Red shift wakeup
Mon 05:09 AM	10	18	30	Shift handover
Mon 06:39 AM	10	20	00	Radiator deploy
Mon 06:44 AM	10	20	05	Red shift science ops begin
Mon 06:54 AM	10	20	15	Husband exercises
Mon 07:29 AM	10	20	50	Ramon exercises
Mon 07:39 AM	10	21	00	Blue shift sleep begins
Mon 09:19 AM	10	22	40	Clark exercises
Mon 11:04 AM	11	00	25	Red shift meals begin
Mon 12:24 PM	11	01	45	Red shift media interviews
Mon 02:09 PM	11	03	30	Chawla exercises
Mon 03:39 PM	11	05	00	Blue shift wakeup
Mon 05:39 PM	11	07	00	Shift handover
Mon 05:59 PM	11	07	20	Blue shift off duty time begins
Mon 07:39 PM	11	09	00	Red shift sleep begins
Mon 10:39 PM	11	12	00	Blue shift meals begin
01/28/03				
Tue 01:14 AM	11	14	35	Anderson exercises
Tue 01:44 AM	11	15	05	McCool exercises
Tue 02:44 AM	11	16	05	Brown exercises
Tue 03:39 AM	11	17	00	Red shift wakeup
Tue 05:34 AM	11	18	55	Shift handover
Tue 06:04 AM	11	19	25	Red shift off duty time begins
Tue 07:39 AM	11	21	00	Blue shift sleep begins
Tue 10:39 AM	12	00	00	Red shift meals begin
Tue 01:14 PM	12	02	35	Clark exercises
Tue 02:04 PM	12	03	25	Ramon exercises
Tue 03:39 PM	12	05	00	Blue shift wakeup
Tue 05:09 PM	12	06	30	Shift handover
Tue 06:09 PM	12	07	30	Blue shift science ops begin
Tue 06:39 PM	12	08	00	Red shift sleep begins
Tue 09:19 PM	12	10	40	Anderson exercises
Tue 10:04 PM	12	11	25	Blue shift meals begin
Wed 01:09 AM	12	14	30	McCool exercises
Wed 02:39 AM	12	16	00	Red shift wakeup
Wed 04:39 AM	12	18	00	Shift handover
Wed 05:29 AM	12	18	50	Crew news conference
Wed 06:14 AM	12	19	35	Husband exercises
Wed 07:39 AM	12	21	00	Blue shift sleep begins
Wed 10:04 AM	12	23	25	Red shift meals begin
Wed 11:59 AM	13	01	20	Crew choice video downlink
Wed 01:29 PM	13	02	50	Chawla exercises
Wed 03:39 PM	13	05	00	Blue shift wakeup
Wed 05:09 PM	13	06	30	Shift handover
Wed 06:19 PM	13	07	40	Blue shift science ops begin
Wed 06:39 PM	13	08	00	Red shift sleep begins
Wed 10:09 PM	13	11	30	Blue shift meals begin
Wed 11:34 PM	13	12	55	Blue shift media interviews

TIME	DD	HH	MM	EVENT
01/30/03				
Thu 12:24 AM	13	13	45	McCool exercises
Thu 02:39 AM	13	16	00	Red shift wakeup
Thu 03:09 AM	13	16	30	Anderson exercises
Thu 04:49 AM	13	18	10	Shift handover
Thu 05:19 AM	13	18	40	PILOT landing practice (Husband/Chawla)
01/30/03				
Thu 05:19 AM	13	18	40	PILOT landing practice (McCool)
Thu 07:16 AM	13	20	37	Orbit adjustment rocket firing
Thu 08:39 AM	13	22	00	Blue shift sleep begins
Thu 08:54 AM	13	22	15	Clark exercises
Thu 10:24 AM	13	23	45	Red shift meals begin
Thu 11:49 AM	14	01	10	Crew choice video downlink
Thu 12:19 PM	14	01	40	Chawla exercises
Thu 12:49 PM	14	02	10	Husband exercises
Thu 04:39 PM	14	06	00	Blue shift wakeup
Thu 05:09 PM	14	06	30	Shift handover
Thu 05:39 PM	14	07	00	Red shift sleep begins
Thu 07:04 PM	14	08	25	McCool exercises
Thu 07:34 PM	14	08	55	Brown exercises
Thu 08:04 PM	14	09	25	Anderson exercises
Thu 08:34 PM	14	09	55	ARMS teardown
Thu 11:24 PM	14	12	45	Blue shift meals begin
01/31/03				
Fri 01:39 AM	14	15	00	Red shift wakeup
Fri 01:54 AM	14	15	15	MIST shutdown
Fri 03:39 AM	14	17	00	PILOT landing practice (Husband/Chawla)
Fri 03:39 AM	14	17	00	PILOT landing practice (McCool)
Fri 04:44 AM	14	18	05	Deorbit review
Fri 05:14 AM	14	18	35	Flight control system checkout
Fri 05:34 AM	14	18	55	Cabin stow begins
Fri 06:24 AM	14	19	45	Reaction control system hotfire
Fri 06:39 AM	14	20	00	Clark exercises
Fri 07:09 AM	14	20	30	Husband exercises
Fri 08:39 AM	14	22	00	Chawla exercises
Fri 08:39 AM	14	22	00	Blue shift sleep begins
Fri 09:19 AM	14	22	40	Ramon exercises
Fri 11:39 AM	15	01	00	Red shift meals begin
Fri 12:39 PM	15	02	00	Cabin stow resumes
Fri 01:54 PM	15	03	15	Zeolite crystal growth stow
Fri 04:39 PM	15	06	00	Blue shift wakeup
Fri 05:09 PM	15	06	30	Shift handover
Fri 05:39 PM	15	07	00	Red shift sleep begins
Fri 06:54 PM	15	08	15	Anderson exercises
Fri 07:34 PM	15	08	55	McCool exercises
Fri 07:39 PM	15	09	00	Cabin stow resumes
Fri 08:14 PM	15	09	35	Spacehab teardown begins
Fri 08:19 PM	15	09	40	Brown exercises
Fri 09:09 PM	15	10	30	Ergometer stow
02/01/03				
Sat 12:29 AM	15	13	50	Spacehab entry preps
Sat 01:39 AM	15	15	00	Red shift wakeup
Sat 01:59 AM	15	15	20	Printer stow
Sat 02:14 AM	15	15	35	Group B computer powerup

TIME	DD	HH	MM	EVENT
Sat 02:54 AM	15	16	15	IMU alignment
Sat 03:34 AM	15	16	55	GIRA stow
Sat 03:49 AM	15	17	10	Begin deorbit timeline
Sat 04:29 AM	15	17	50	Radiator stow
Sat 07:51 AM	15	21	12	Deorbit ignition
Sat 08:49 AM	15	22	10	Landing

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Space Shuttles for Dummies

After more than 110 shuttle flights and only one failure, launchings appear fairly routine. They are not. The shuttle weighs 4.5 million pounds at launch and it hits 140 mph - going straight up - in about 10 seconds. The shuttle burns its fuel so fast that in less than 100 seconds it weighs half what it did at launch. In eight-and-a-half minutes, the vehicle is traveling some 17,000 mph, or five miles per second. That's about eight times faster than a rifle bullet, fast enough to fly from Los Angeles to New York in 10 minutes. Calling a shuttle launch "routine" misses the mark. The margin for error is very slim indeed and the astronauts face a limited number of survivable abort options.

The shuttle makes the climb to orbit using two solid-fuel boosters and three hydrogen-fueled main engines. Contrary to popular myth, the shuttle pilots do little more than monitor their instruments and computer displays during ascent; the shuttle's four flight computers do all the piloting barring a malfunction of some sort that might force the crew to take manual control.

Based on the type of main engines aboard Discovery, NASA puts the odds of a catastrophic failure that would destroy the vehicle at about 1-in-438.

The main engines generate a combined 37 million horsepower, which is equivalent to the output of 23 Hoover Dams. They are ignited at 120 millisecond intervals starting 6.6 seconds prior to launch. Computers bolted to each powerplant monitor engine performance 50 times per second and, after all three are running smoothly, the boosters are ignited. Pressure inside the hollow boosters jumps from sea level to more than 900 pounds per square inch in a quarter of a second as the propellant ignites. Liftoff is virtually instantaneous.

The boosters burn for about two minutes and five seconds. They are far more powerful than the three main engines and provide all the shuttle's steering during the initial minutes of flight using hydraulic pistons that move the nozzles at the base of each rocket. After the boosters are jettisoned, the shuttle's three liquid-fueled engines provide steering and flight control.

The engines are throttled down to 65 percent power about 40 seconds into flight to lower the stress on the shuttle as it accelerates through the region of maximum aerodynamic pressure (715 pounds per square foot at 48 seconds). After that, the engines are throttled back up to 104 percent. All three engines shut down about eight and a half minutes after takeoff, putting the shuttle in a preliminary orbit. The empty external fuel tank is then jettisoned and breaks up in the atmosphere over the Indian or Pacific oceans. The initial orbit is highly elliptical and the shuttle's two orbital maneuvering rockets are fired about 43 minutes after launch to put the craft in a circular orbit.

Space Shuttles Abort Scenarios

There are no survivable booster failures like the one that destroyed Challenger 73 seconds after liftoff in 1986. Like a holiday bottle rocket, the boosters cannot be shut down once they are ignited. They are rigged with plastic explosives to blow open their cases and eliminate forward thrust should a catastrophic failure send a shuttle veering out of control toward populated areas or sea lanes. In that case, the crew is considered expendable. There is no survivable way to separate from the boosters while they are operating. They simply have to work.

But the shuttle system was designed to safely handle a single main engine failure at any point after startup. In all cases, such "intact" aborts begin after the solid-fuel boosters have been jettisoned. In other words, if an abort is declared 10 seconds after liftoff, it will not actually go into effect until 2 minutes and 30 seconds after launch.

An engine failure during the startup sequence will trigger a "redundant set launch sequencer abort," or RSLS abort. If one or more engine experiences problems during startup, the shuttle's flight computers will issue immediate shut-down commands and stop the countdown before booster ignition. This has happened five times in shuttle history. If an RSLS abort occurs, launch would be delayed at least three weeks to service and repair the main engines.

While in-flight abort regimes overlap to a degree, a return to the launch site (RTLS) is only possible during the first four minutes of flight. Beyond that point, a shuttle has flown too far to make it back to Florida with its remaining fuel. But in practice, an RTLS is only a threat in the first 2.5 minutes or so of flight. After that, a crew can press on to an emergency landing in Spain or Africa, the preferred option if there's a choice because it puts less stress on the shuttle.

A trans-Atlantic abort (TAL) is an option throughout ascent but after about five minutes, the shuttle is going fast enough to attempt an abort to a lower-than-planned orbit, depending on the shuttle's altitude and velocity at the time of the failure. If the shuttle crew has a choice between an RTLS and a TAL, they will select the TAL option. If the choice is between TAL and ATO, they will select the abort to orbit.

Here are the actual numbers for a recent shuttle flight (velocity includes a contribution from Earth's rotation at 28.5 degrees north latitude):

TIME	EVENT	MPH
0:10	THE SHUTTLE ROLLS TO "HEADS DOWN" ORIENTATION	920
0:40	START THROTTLE DOWN	1,405
0:48	MAXIMUM AERODYNAMIC PRESSURE	1,520
0:53	START THROTTLE UP TO 104%	1,589
2:04	SOLID-FUEL BOOSTERS ARE JETTISONED	3,818
2:10	THE SHUTTLE CAN NOW ABORT TO SPAIN OR AFRICA	3,955
3:45	THE SHUTTLE CAN NO LONGER RETURN TO KSC	5,591
4:12	THE SHUTTLE CAN NOW ABORT TO ORBIT	6,273
5:13	SHUTTLE CAN REACH NORMAL ORBIT WITH TWO ENGINES	8,045
5:48	THE SHUTTLE ROLLS TO "HEADS UP" ORIENTATION	9,205
6:32	SHUTTLE CAN REACH ORBIT WITH ONE ENGINE	11,114
7:24	ENGINES THROTTLE DOWN TO LIMIT G LOADS ON CREW	13,977
8:24	MAIN ENGINE CUTOFF	17,727

An RTLS abort is considered the riskiest of the abort procedures because the shuttle crew must reverse course to head back for Florida, which puts severe stresses on the vehicle. TAL is the preferred abort mode for early engine failures. A second engine failure during an RTLS makes the chances of a success slim while a TAL abort can be flown in many instances with two failures.

Here's a bit more detail. More extensive information is available in the SRH abort appendix.

1. Redundant Set Launch Sequencer Abort (RSLS)

An on-the-launch-pad engine shutdown is known as a "redundant set launch sequencer" abort, also known as an "RSLS" abort. Whenever this happens, at least one of the shuttle's three main engines, or its associated valves, its control computer or a related system, has failed to perform properly during the 6.6-second start sequence.

There have been five previous RSLS aborts in the history of the shuttle program. Three have occurred in the post-Challenger era (Columbia, 3/22/93; Discovery, 8/12/93; Endeavour, 8/18/94).

An RSLS abort does not necessarily threaten the safety of the shuttle crew, but hydrogen gas can be released through the engine nozzles during shutdown. Hydrogen burns without visible sign of flame and it's possible a brief pad fire can follow the engine cutoff.

But the launch pad is equipped with a sophisticated fire extinguishing system and other improvements implemented in the wake of the 1986 Challenger accident that will automatically start spraying the orbiter with water if a fire is detected. Fire detection sensors are located all over the pad.
An RSLS abort would delay another attempt to launch the shuttle on for at least three weeks and probably four because of time needed to inspect/replace the ship's engines. Any time the engines are started, they must be inspected and serviced just as if the shuttle had taken off and flown a normal mission. This takes time.

2. Return to Launch Site (RTLS) Abort

In this scenario, the shuttle suffers a main engine failure during the first few minutes of flight, before the ship has gained the altitude and velocity needed to reach emergency runways in Spain or Africa.

The RTLS flight plan calls for the shuttle to continue flying away from Florida until the fuel left in its external tank just equals the amount needed to make it back to the Kennedy Space Center. At that point, with the shuttle still riding beneath the external tank and the astronauts in a heads-down position, the spacecraft would pitch around at 10 degrees per second, its nose rotating through vertical in a sort of reverse somersault to put the crew in a heads up position on top of the tank with the spaceship flying backwards (!).

Just before the start of this "powered pitch around," the RTLS flight plan calls for the pilots to fire the shuttle's two maneuvering rockets to burn up excess fuel. Thruster firings after pitch-around complete the fuel dump, lightening the orbiter by up to 20,000 pounds, depending on when the abort was declared, and changing the ship's center of gravity as required for atmospheric entry.

Once the thrust from the operating main engines reversed the shuttle's direction, the crew is clear to rocket back to the Florida coast where the tank can be safely ditched in the Atlantic Ocean before a powerless glide to touchdown on the spaceport's 3-mile-long shuttle runway.

The entire procedure lasts about a half hour. Whether a crew could actually pull off this maneuver is debatable. But in the simulator, at least, it works.

3. East-Coast Abort and Landing (ECAL)

When the shuttle was originally designed, multiple main engine failures early in flight meant a ditching somewhere in the Atlantic Ocean. After Challenger, the shuttle was rigged with a bailout system to give the crew a better chance of survival. In the space station era, an additional option was implemented to give of a shuttle with multiple engine failures a chance to reach an East Coast runway.

To reach the space station, the shuttle must launch into to the plane of its orbit. That plane is tilted 51.6 degrees to the equator. As a result, shuttles bound for the station take off on a northeasterly trajectory that parallels the East Coast of the United States. Should two or three engines fail before the shuttle is going fast enough to reach Europe or to turn around and return to Florida, the crew would attempt a landing at one of 15 designated East Coast runways, 10 in the United States and five in Canada.

First, the shuttle's flight computers would pitch the nose up to 60 degrees to burn off fuel and yaw the ship 45 degrees to the left of its ground track to begin moving it closer to the coast. The shuttle also would roll about its vertical axis to put the crew in a "heads up" orientation on top of the external fuel tank. Based on velocity, fuel remaining and other factors, the shuttle eventually would pitch down and jettison the external tank. From there, the flight computers would attempt to steer the ship to the designated runway using angle of attack as the primary means of bleeding off energy.

An ECAL abort is a high-risk, last-resort option and would only be implemented if the only other alternative was to ditch in the ocean.

4. Trans-Atlantic Landing (TAL) Abort

In a TAL abort, the shuttle's two remaining engines continue firing, but they are throttled down somewhat to allow time for excess fuel to be burned by the orbiter's two maneuvering engines and by 18 smaller rockets to evenly distribute weight in the shuttle for landing. The shuttle is then steered on a ballistic trajectory to a point that would allow a relatively normal shuttle landing in Spain or Africa.

Depending on the weight of the shuttle and when the engine failure occurs, the ship's two operating engines shut down at an altitude of about 330,000 feet – more than 62 miles up – with the shuttle traveling at a blistering 16,300 mph, slightly less than orbital velocity.

The TAL abort flight plan calls for the shuttle to roll about its long axis shortly before engine shutdown to put the astronauts in a "heads up" position atop the external tank. The tank is then jettisoned after engine cutoff. From that point on, landing resembles normal shuttle descents.

NASA maintains three TAL landing sites:

1. ZARAGOZA, Spain: The Zaragoza Air Base, used by the U.S. Air Force and Spanish military forces, was designated a TAL site in 1983. The base has two parallel runways, one 9,923 feet long and the other 12,109 feet long. The longer runway is preferred for shuttle landings. CURRENT STATUS: OPERATIONAL

2. BEN GUERIR, MOROCCO**:** The 14,000 foot runway at Ben Guerir was modified by NASA to support shuttle landings. Running exactly north-south, the runway is equipped with special navigation aids and lighting equipment required by space shuttle crews. As a military base, the Ben Guerir complex is surrounded by fencing with guard towers spaced along the boundary. The nearest town of any size is Marrakech with a population of 265,000. CURRENT STATUS: UNAVAILABLE

3. MORON, Spain: An 11,840-foot runway.

Assuming a successful landing, NASA would need nearly two months to move in the special cranes and other material needed to get the 110-ton shuttle onto the back of a 747 transport jet for a flight back from Africa or Spain to the states, knocking the spacecraft out of action indefinitely and reducing the agency's fleet to just three operational shuttles. CURRENT STATUS: OPERATIONAL

5. Abort to Orbit (ATO)

An abort-to-orbit is the most benign abort mode available to shuttle crews. Depending on the nature of the failure, they still would be able to carry out a nearly normal mission.

Aside from the Jan. 28, 1986, Challenger disaster, the only other in-flight engine shutdown in the history of the shuttle program occurred July 29, 1985, when Challenger's No. 1 engine shut down five minutes and 45 seconds after liftoff because of a faulty temperature sensor on the engine's high-pressure fuel turbopump. In that case, Challenger was able to abort to a lower-than-planned orbit and, after extensive replanning, complete its Spacelab mission.

6. Non-Intact Aborts (bailout scenarios)

During the early phases of flight, two or more engine failures, depending on when they happened, could leave the shuttle without enough power to make it to a runway. In that case, the crew would have to "ditch" the orbiter somewhere in the ocean. Given that shuttles land at more than 200 mph, ditching is not considered a survivable option.

In the wake of the Challenger disaster, NASA examined several possible escape systems ranging from ejection seats to simply jumping out the side hatch for a parachute descent. The agency ultimately settled on a bail out system that required modifications to let a crew blow the side hatch safely away from the shuttle during descent.

In the current system, a 248-pound, 8.75-foot telescoping pole is mounted along the ceiling of the crew cabin's lower deck. In a bailout, the pole extends through the open hatch. An astronaut then hooks his or her parachute harness to the pole and slides down it for a safe descent (without the pole, an astronaut probably would be blown into the left wing or the aft rocket pod).

To go along with the system, shuttle crews now take off and land wearing bulky, bright orange spacesuits capable of keeping them alive at altitudes up to 100,000 feet. The 70-pound suits feature a built-in life preserver and air supply with backpacks housing a parachute and a small, collapsible life raft.

To operate the system, an astronaut seated on the shuttle's lower deck pulls a handle that opens a vent at an altitude of about 40,000 feet to let cabin air pressure equalize at around 30,000 feet. The commander then orients the shuttle so that its rate of descent is just right to maintain the proper airspeed of between 185 knots and 195 knots. He then puts the shuttle on autopilot and climbs down to the lower deck.

At that point, the side hatch is jettisoned and the crew begins to bail out. As soon as the astronaut hits the water, the parachute is automatically cut free, a life preserver inflates and the life raft automatically fills with air. Assuming bail out started at 20,000 feet or so, all crew members would be clear of the shuttle by the time it had descended to an altitude of 10,000 feet. Each astronaut would hit the water about a mile apart from each other along the line following the shuttle's flight path.

7. Challenger Remembered

Eleven men and women have died in spaceflight since Yuri Gagarin became the first man in space in 1961: Four Russians and the seven Americans launched aboard Challenger at 11:38 a.m. EST on Jan. 28, 1986. It was the 25th shuttle launch.

Challenger was destroyed 73 seconds after liftoff when an O-ring seal in the ship's right-side booster failed, allowing a jet of 5,000-degree flame to eat through the wall of the rocket and into the ship's external fuel tank. The tank failed and Challenger disintegrated 73 seconds after liftoff in the worst disaster in space history. Despite the impression given by video replays of the disaster, Challenger did not "explode." The shuttle was destroyed by aerodynamic forces.

Killed were commander Francis "Dick" Scobee, co-pilot Mike Smith, Judy Resnik, Ellison Onizuka, Ron McNair, engineer Greg Jarvis and New Hampshire high school teacher Christa McAuliffe.

A presidential commission blamed the Challenger accident on a booster design error, "flawed" decision making by NASA managers and a series of more subtle problems that combined to make the disaster virtually inevitable. Shuttle flights resumed Sept. 29, 1988, after extensive design and management changes to improve safety and reliability. There have been 66 post-Challenger flights, all successful.