

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE SHUTTLE MISSION STS-51L

PRESS KIT
JANUARY 1986



TRACKING AND DATA RELAY SATELLITE (TDRS B)
TEACHER IN SPACE PROJECT

STS-51L INSIGNIA

S85-46260 – The STS-51L crewmembers designed this insignia which will represent their participation in NASA's mission aboard the Challenger, depicted launching from Florida and soaring into space to carry out a variety of goals. Among the prescribed duties of the five astronauts and two payload specialists will be observation and photography of Halley's Comet, backdropped against the U.S. flag in the insignia. Surnames of the crewmembers encircle the scene, with the payload specialists being recognized below. Surname of the first teacher in space, Sharon Christa McAuliffe, is followed by a symbolic apple.

The NASA insignia design for space shuttle flights is reserved for use by the astronauts and for other official use as the NASA Administrator may authorize. Public availability has been approved only in the form of illustrations by the various news media. When and if there is any change in this policy, which we do not anticipate, it will be publicly announced.

PHOTO CREDIT: NASA or National Aeronautics and Space Administration.

CONTACTS

Charles Redmond/Sarah Keegan
Headquarters, Washington, DC
(Phone: 202/453-8536)

Leon Perry
Headquarters, Washington, DC
(Phone: 202/453-1547)

Barbara Schwartz
Johnson Space Center, Houston, TX
(Phone: 713/483-5111)

Jim Ball
Kennedy Space Center, FL
(Phone: 305/867-2468)

James Elliott
Goddard Space Flight Center, Greenbelt, MD
(Phone: 301/344-6256)

Bob Ruhl
Marshall Space Flight Center, Huntsville, AL
(Phone: 205/453-0034)

CONTENTS

GENERAL RELEASE	5
GENERAL INFORMATION	7
51-L MISSION – QUICK LOOK	8
51-L BRIEFING SCHEDULE	9
TRAJECTORY SEQUENCE OF EVENTS	10
SUMMARY OF MAJOR ACTIVITIES	11
51-L PAYLOAD AND VEHICLE WEIGHTS SUMMARY	12
TRACKING AND DATA RELAY SATELLITE SYSTEM AND TDRS-B	14
INTERTIAL SUPPER STAGE	17
SPARTAN-HALLEY MISSION	18
MISSION OPERATIONS	20
TEACHER IN SPACE PROJECT	22
SHUTTLE STUDENT INVOLVEMENT PROGRAM	24
COMET HALLEY ACTIVE MONITORING PROGRAM	26
PHASE PARTITIONING EXPERIMENT	27
FLUID DYNAMICS IN SPACE	28
U.S. LIBERTY COINS	29
51-L FLIGHT CREW DATA	30

TEACHER IN SPACE AND COMET HALLEY STUDY HIGHLIGHT 51-L FLIGHT

The launch of a high school teacher as America's first private citizen to fly aboard the Shuttle in NASA's Space Flight Participant Program will open a new chapter in space travel when Challenger lifts off on the 25th Space Shuttle mission.

A science payload programmed for 40 hours of comet Halley observations and the second of NASA's Tracking and Data Relay Satellites (TDRS-B) will be aboard for Challenger's 10th flight, targeted for launch at 3:43 p.m. EST on Jan. 24.

Challenger's liftoff will mark the first use of Pad 39-B for a Shuttle launch. Pad B was last used for the Apollo Soyuz Test Project in July 1975 and has since been modified to support the Shuttle program.

Four Shuttle veterans will be joined by rookie astronaut Michael Smith, teacher observer Christa McAuliffe and Hughes payload specialist Gregory Jarvis for a mission that will extend just beyond six days.

Commanding the seven-member crew will be Francis R. Scobee, who served as pilot aboard Challenger on mission 41-C. Michael Smith will be 51-L pilot.

Mission specialists Judith Resnik, Ellison Onizuka and Ronald McNair each will be making their second trip into space.

Challenger will be launched into a 177-statute-mile circular orbit inclined 28.45 degrees to the equator for the 6-day 34-minute mission. The orbiter is scheduled to make its end-of-mission landing on the 3-mile-long Shuttle Landing Facility at Kennedy Space Center.

Deployed on the first day of the flight, TDRS_B will join TDRS-1 in geosynchronous orbit to provide high-capacity communications and data links between Earth and the Shuttle, as well as other spacecraft and launch vehicles.

After deployment from the Shuttle cargo bay, TDRS-B will be boosted to geosynchronous transfer orbit by the Inertial Upper Stage (IUS). Its orbit will be circularized and it will be positioned over the Pacific Ocean at 171 degrees west longitude.

TDRS-1, launched from Challenger in April 1983 on the sixth Space Shuttle flight, is located over the Atlantic Ocean at 41 degrees west longitude.

With the addition of the second satellite, real-time coverage through the single ground station and White Sands, NM, is expected to be available for about 85 percent of each orbit of a user spacecraft.

The TDRS satellites, built by TRW Space Systems, are owned by Space Communications Company (SPACECOM) and leased by NASA for a period of 10 years. A third TDRS satellite will be launched on a later mission to serve as an in-orbit spare.

Spartan-Halley is the second payload in the NASA-sponsored Spartan program for flying low-cost experiment packages aboard the Shuttle.

The scientific objective of Spartan-Halley is to measure the ultraviolet spectrum of comet Halley as the comet approaches the point of its orbit that will be closest to the sun.

The Spartan mission peculiar support structure will be deployed from the Shuttle cargo bay and retrieved later in the mission for return to Earth.

Ultraviolet measurements and photographs of comet Halley will be made by instruments on the Spartan support structure during 40 hours of free flying in formation with the Shuttle.

Several middeck experiments, including those associate with the Teacher in Space Project, and three student experiments complete Challenger's payload manifest.

Teacher observer Christa McAuliffe will perform experiments that will demonstrate the effects of microgravity in hydroponics, magnetism, Newton's laws, effervescence, chromatography and the operation of simple machines.

The Teacher in Space experiments will be filmed for use after the flight in educating students.

McAuliffe also will assist in operating three student experiments being carried aboard Challenger. These experiments include a study of chicken embryo development in space, research on how microgravity affects a titanium alloy and an experiment in crystal growth.

The Fluid Dynamics Experiment, a package of six experiments, will be flown on the middeck. They involve simulating the behavior of liquid propellants in low gravity. The fluid dynamics experiments will be conducted by Hughes payload specialist Gregory Jarvis.

Among the fluid investigations will be simulations to understand the motion of propellants during Shuttle Frisbee deployments, which have been employed for the Hughes Leasat satellites.

Another middeck experiment will be the Radiation Monitoring Experiment consisting of hand-held and pocket monitors to measure radiation levels at various times in orbit. This is the seventh flight for the RME.

Challenger will perform its deorbit maneuver and burn over the Indian Ocean on orbit 96 with landing at Kennedy occurring on orbit 97 at a mission elapsed time of six days, 34 minutes.

Touchdown on the Florida runway should come at 4:17 p.m. EST on Jan. 30.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS.)

GENERAL INFORMATION

NASA Select Television Transmission

NASA-Select television coverage of Shuttle mission 51-L will be carried on a full satellite transponder:

Satcom F-2R, Transponder 13, C-Band
Orbital Position: 72 degrees west longitude
Frequency: 3954.5 MHz vertical polarization
Audio Monaural: 6.8 MHz

NASA-Select video also is available at the AT&T Switching Center, Television Operation Control in Washington, DC, and at the following NASA locations:

NASA Headquarters, Washington, DC
Langley Research Center, Hampton, VA
John F. Kennedy Space Center, FL
Marshall Space Flight Center, Huntsville, AL
Johnson Space Center, Houston, TX
Dryden Flight Research Facility, Edwards, CA
Ames Research Center, Mountain Valley, CA
Jet Propulsion Laboratory, Pasadena, CA

The schedule for television transmissions from the orbiter and for the change-of-shift briefings from Johnson Space Center will be available during the mission at Kennedy Space Center, Marshall Space Flight Center, Johnson Space Center, and NASA Headquarters.

The television schedule will be updated daily to reflect changes dictated by mission operations. Television schedules also may be obtained by calling COMSTOR (713/280-8711). COMSTOR is a computer database service requiring the use of a telephone modem.

Special Note to Broadcasters

Beginning Jan. 22 and continuing throughout the mission, approximately 7 minutes of audio interview material with the crew of 51-L will be available to broadcasters by calling 202/269-6572.

Briefings

Flight control personnel will be on 8-hour shifts. Change-of-shift briefings by the off-going flight director will occur at approximately 8-hour intervals.

SHUTTLE MISSION 51-L – QUICK LOOK

Crew: Francis R. Scobee, Commander
Michael J. Smith, Pilot
Judith A. Resnik, Mission Specialist
Ellison S. Onizuka, Mission Specialist
Ronald E. McNair, Mission Specialist
Gregory Jarvis, Payload Specialist
S. Christa McAuliffe, Teacher Observer

Orbiter: Challenger (OV-099)

Launch Site: Pad 39B, Kennedy Space Center, FL

Launch Date/Time: Jan. 24, 1986 – 3:43 p.m. EST

Orbital Inclination: 28.45 degrees

Insertion Orbit: 153.5 n. mi. circular

Mission Duration: 6 days, 34 minutes

Orbits: 96 full orbits; landing on 97

Landing Date/Time: January 30, 1986, 4:17 p.m. EST

Primary Landing Site: Kennedy Space Center, FL, Runway 33
Weather Alternate: Edwards Air Force Base, CA, Runway 17
Return To Launch Site: Kennedy Space Center
Abort-Once-Around: Edwards Air Force Base
Trans-Atlantic Abort: Dakar, Senegal

Cargo and Payloads: Tracking and Data Relay Satellite (TDRS-B)
Spartan-Halley Mission
Teacher in Space Project
Comet Halley Active Monitoring Program
Fluid Dynamics Experiment
Phase Partitioning Experiment
Radiation Monitoring Experiment
3 Student Experiments

51-L BRIEFING SCHEDULE

Time (EST)	Briefing	Origin
T-1 Day		
9:00 a.m.	TDRS-B	KSC
9:45 a.m.	Spartan-Halley Mission	KSC
10:30 a.m.	Teacher in Space	KSC
11:15 a.m.	Shuttle Student Involvement Program	KSC
12:00 noon	Fluid Dynamics Experiment	KSC
3:00 p.m.	Pre-Launch Press Conference	KSC
T-Day		
Launch + 1 hour	Post-launch Briefing	KSC
Launch Through End of Mission		
Times announced on NASA Select	Flight Director Change-of-Shift Briefings	JSC
Landing Day		
Landing + 1 hour	Post-landing Briefing	KSC

51-L TRAJECTORY SEQUENCE OF EVENTS

Event	Orbit	Tig Met (d:h:m)	Burn Duration Min-sec	Delta v (fps)	Post burn Apogee/perigee (s mi)
Launch		0:00:00			
OMS-1	1	0:00:10	2:26	223	
OMS-2	1	0:00:44	2:03	185	153x154
Deploy TDRS	7	0:10:02			153x154
RCS-1 Separation	7	0:10:03	09	2.2	153x154
OMS-3 Separation	8	0:10:21	26	40.0	153x177
OMS-4	21	1:06:00	27	43.3	153x153
Deploy Spartan	37	05:51			151x153
RCS Separation	37	2:06:01	08	2.0	152x154
Aft RCS Sep	53	3:06:06	16	4.3	150x153
Aft RCS	63	3:21:08	16	4.2	148x152
Aft RCS	64	3:23:12	00	0.2	148x152
Aft RCS	65	4:00:08	12	3.2	150x153
TPF	66	4:01:28	19	5.0	150x154
Deorbit				285.0	
Entry Interface					
Landing	97				

SUMMARY OF MAJOR ACTIVITIES

MET

Flight Day 1

Payload bay doors open

Tracking and Data Relay Satellite (TDRS) and Inertial Upper Stage (IUS) checkout

TDRS deploy

0/10:01

Flight Day 2

Comet Halley Active Monitoring Program (CHAMP) data take

Spartan health check

Fluid Dynamics Experiment (FDE)

Teacher in Space activities

Flight Day 3

Spartan deploy preparations

2/04:40

Spartan deploy

2/06:51

Student Experiments

FDE

Flight Day 4

CHAMP data take

Student Experiments

FDE

Teacher in Space activities

Flight Day 5

Spartan rendezvous

4/01:32

Spartan capture

4/02:15

FDE

Student Experiments

Flight Day 6

RCS hot fire

FCS checkout

Teacher lesson (Field Trip)

4/21:00

Teacher lesson (Exploration)

4/23:00

Flight Day 7

Landing at KSC

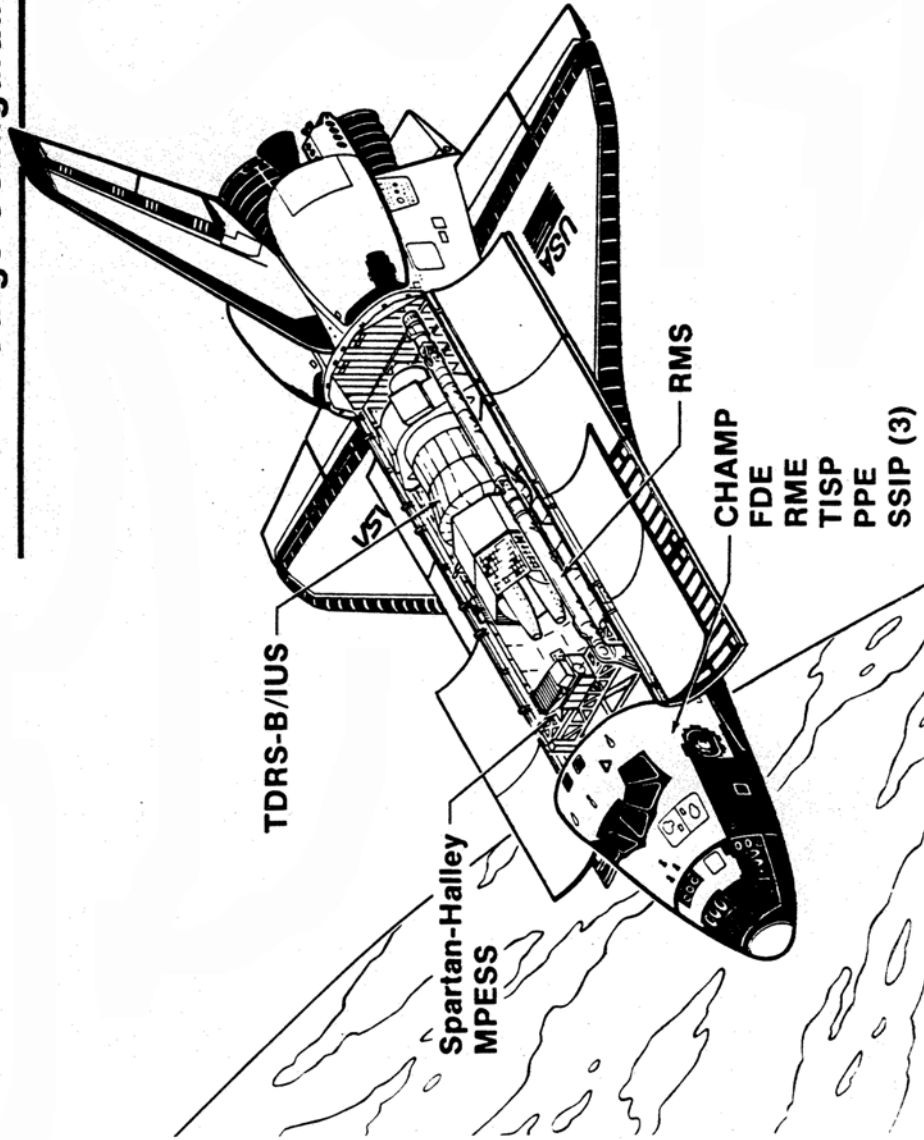
6/00:34

51-L PAYLOAD AND VEHICLE WEIGHTS SUMMARY

	<u>Pounds</u>
Orbiter Without Consumables	176,403
TDRS-B/IUS	37,636
Total Payload Including Other Experiments	48,361
Orbiter Including Cargo at SRB Ignition	268,471
Total Vehicle at SRB Ignition	4,529,122
Orbiter Landing Weight	199,700

NASA

**National STS Program
STS 51-L Cargo Configuration**



TRACKING AND DATA RELAY SATELLITE SYSTEM (TDRSS) AND TDRS-B

The Tracking and Data Relay Satellite (TDRS-B) is the second TDRSS advanced communications spacecraft to be launched from the orbiter Challenger. The first was launched during Challenger's maiden flight in April 1983.

TDRS-1 is now in geosynchronous orbit over the Atlantic Ocean just east of Brazil (41 degrees west longitude). It initially failed to reach its desired orbit following successful Shuttle deployment because of booster rocket failure. A NASA-industry team conducted a series of delicate spacecraft maneuvers over a 2-month period to place TDRS-1 into the desired 22,300-mile altitude.

Following its deployment from the orbiter, TDRS-B will undergo a series of tests prior to being moved to its operational geosynchronous position over the Pacific Ocean south of Hawaii (171 degrees W. longitude).

A third TDRSS satellite is scheduled for launch in July 1986, providing the Tracking and Data Relay Satellite System with an on-orbit spare located between the two operational satellites.

TDRS-B will be identical to its sister satellite and the two-satellite configuration will support up to 23 user spacecraft simultaneously, providing two basic types of service: a multiple access service which can relay data from as many as 19 low-data-rate user spacecraft at the same time and a single access service which will provide two high-data-rate communications relays from each satellite.

TDRS-B will be deployed from the orbiter approximately 10 hours after launch. Transfer to geosynchronous orbit will be provided by the solid propellant Boeing/U.S. Air Force Inertial Upper Stage (IUS). Separation from the IUS occurs approximately 17 hours after launch.

The concept of using advanced communication satellites was developed following studies in the early 1970s which showed that a system of communication satellites operated from a single ground terminal could support Space Shuttle and other low Earth-orbit space missions more effectively than a world-wide network of ground stations.

NASA's Space Tracking and Data Network ground stations eventually will be phased out. Three of the network's present 12 ground stations – Madrid, Spain; Canberra, Australia; and Goldstone, CA – have been transferred to the Deep Space Network managed by the Jet Propulsion Laboratory in Pasadena, CA, and the remainder – except for two stations considered necessary for Shuttle launch operations – will be closed or transferred to other agencies after the successful launch and checkout of the next two TDRS satellites.

The ground station network, managed by the Goddard Space Flight Center, Greenbelt, MD, provides communications support for only a small fraction (typically 15-20 percent) of a spacecraft's orbital period. The TDRSS network of satellites, when established, will provide coverage for almost the entire orbital period of user spacecraft (about 85 percent).

A TDRSS ground terminal has been built at White Sands, NM, a location that provides a clear view to the TDRSS satellites and weather conditions generally good for communications.

The NASA Ground Terminal at White Sands provides the interface between the TDRSS and its network elements, which have their primary tracking and communication facilities at Goddard. Also located at Goddard is the Network Control Center, which provides system scheduling and is the focal point for NASA communications with the TDRSS satellites and network elements.

The TDRSS satellites are the largest privately-owned telecommunications spacecraft ever built, each weighing about 5,000 lb. Each satellite spans more than 57 ft., measured across its solar panels. The single-access antennas, fabricated of molybdenum and plated with 14k gold, each measure 16 ft. in diameter, and when deployed, span more than 42 ft. from tip to top.

The satellite consists of two modules. The equipment module houses the subsystems that operate the satellite. The telecommunications payload module has electronic equipment for linking the user spacecraft with the ground terminal. The spacecraft has seven antennas.

The TDRS spacecraft are the first designed to handle communications through S, Ku and C frequency bands.

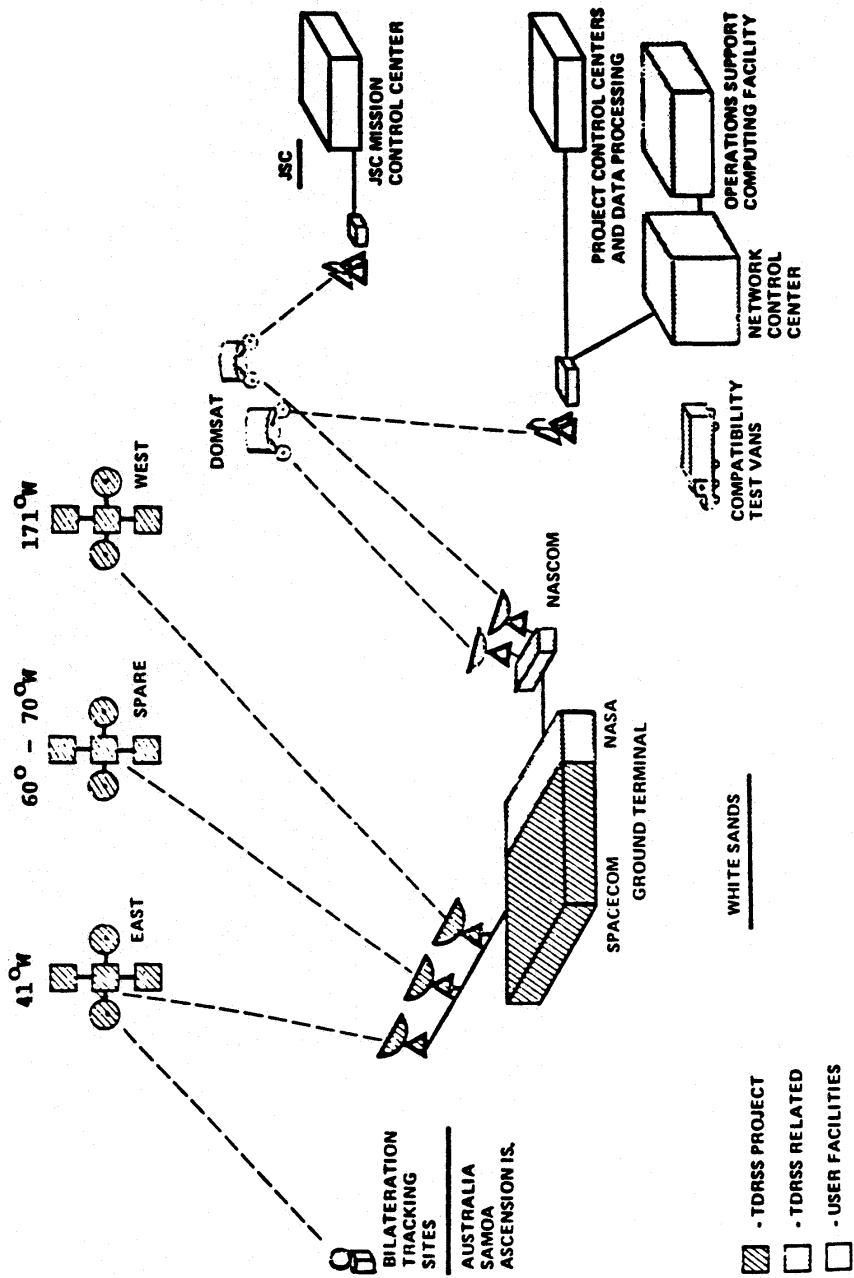
Under contract, NASA has leased the TDRSS service from the Space Communications Co. (Spacecom), Gaithersburg, MD, the owner, operator and prime contractor for the system.

TRW Space and Technology Group, Redondo Beach, CA, and the Harris Government Communications System Division, Melbourne, FL, are the two primary subcontractors to Spacecom for spacecraft and ground terminal equipment, respectively. TRW also provided the total software for the ground segment operation and did the integration and testing for the ground terminal and the TDRSS, as well as the systems engineering.

Primary users of the TDRSS satellite have been the Space Shuttle, Landsat Earth resources satellites, the Solar Mesosphere Explorer, the Earth Radiation Budget Satellite, the Solar Maximum Mission satellite and Spacelab.

Future users include the Hubble Space Telescope, scheduled for launch Oct. 27, 1986; the Gamma Ray Observatory, due to be launched in 1988; and the Upper Atmosphere Research Satellite in 1989.

TDRSS SYSTEM ELEMENTS



INERTIAL UPPER STAGE

The Inertial Upper Stage (IUS) will be used to place NASA's second Tracking and Data Relay Satellite (TDRS-B) into geosynchronous orbit. The first TDRS was launched by an IUS aboard Challenger in April 1983 during mission STS-6.

The 51-L crew will deploy IUS/TDRS-B approximately 10 hours after liftoff from a low-Earth orbit of 153.5 nautical miles. Upper stage airborne support equipment, located in the orbiter payload bay, positions the combined IUS/TDRS-B into the proper deployment attitude – an angle of 59 degrees – and ejects it into low-Earth orbit. Deployment from the orbiter will be by a spring eject system.

Following deployment from the payload bay, the orbiter will move away from the IUS/TDRS-B to a safe distance. The first stage will fire about 55 minutes after deployment.

Following the aft (first) stage burn of two minutes, 26 seconds, the solid fuel motor will shut down and the two stages will separate. After coasting for several hours, the forward (second) stage motor will ignite at six hours, 14 minutes after deployment to place the spacecraft into its desired orbit. Following a one-minute, 49-second burn, the forward stage will shut down as the IUS/TDRS-B reaches the predetermined geosynchronous orbit position.

Six hours, 54 minutes after deployment from Challenger, the forward stage will separate from TDRS-B and perform an anti-collision maneuver with its onboard reaction control system.

After the IUS reaches a safe distance from TDRS-B, the upper stage will relay performance data back to a NASA tracking station and then shut itself down seven hours, five minutes after deployment from the payload bay.

As with the first NASA IUS launched in 1983, the second has a number of features which distinguish it from other previous upper stages. It has the first completely redundant avionics system ever developed for an unmanned space vehicle. The system has the capability to correct in-flight features within milliseconds.

Other advanced features include a carbon composite nozzle throat that makes possible the high-temperature, long-duration firing of the IUS motors and a redundant computer system in which the second computer is capable of taking over functions from the primary computer if necessary.

The IUS is 17 ft. long, 9 ft. in diameter and weighs more than 32,000 lb., including 27,000 lb. of solid fuel propellant. The IUS consists of an aft skirt; an aft stage containing 21,000 lb. of solid propellant fuel, generating 45,000 lb. of thrust; an interstage; a forward stage containing 6,000 lb. of propellant, generating 18,500 lb. of thrust; and an equipment support section. The equipment support section contains the avionics which provide guidance, navigation, telemetry, command and data management, reaction control and electrical power.

Solid propellant rocket motors were selected in the design of the IUS because of their compactness, simplicity, inherent safety, reliability and lower cost.

The IUS is built by Boeing Aerospace Corp, Seattle, under contract to the U.S. Air Force Systems Command. Marshall Space Flight Center, Huntsville, AL, is NASA's lead center for IUS development and program management of NASA-configured IUSs procured from the Air Force.

SPARTAN-HALLEY MISSION

For the Spartan-Halley mission, NASA's Goddard Space Flight Center and the University of Colorado's laboratory for Atmospheric and Space Physics (LASP) have recycled several instruments and designs to produce a low-cost, high-yield spacecraft to watch Halley's Comet when it is too close to the sun for other observatories to do so.

IT will record ultraviolet light emitted by the comet's chemistry when it is closest to the sun and most active so that scientists may determine how fast water is broken down by sunlight, search for carbon and sulfur atoms and related compounds, and understand how the tail evolves.

Principal investigator is Dr. Charles Barth of the University of Colorado LASP. Mission manager is Morgan Windsor of Goddard Space Flight Center.

The Instruments

Two spectrometers, derived from backups for a Mariner 9 instrument which studied the Martian atmosphere in 1971, have been rebuilt to survey Halley's Comet in ultraviolet light from 128 to 340 nanometers (nm) wavelength, stopping just above the human eye's limit of about 400 nm.

Each spectrometer uses the Ebert-Fastie design: an off-axis reflector telescope, with magnesium fluoride coatings to enhance transmission which focuses light from Halley, via a spherical mirror and a spectral grating, on a coded anode converter with 1,024 detectors in a straight line. The grating is ruled at 2,400 lines per millimeter.

The detectors are made of cesium iodide (CsI) for the G-spectrometer (128-168 nm) and cesium telluride (CsTe) for the F-spectrometer (180-340 nm). The system has a focal length of 250 mm and an aperture of 50 mm.

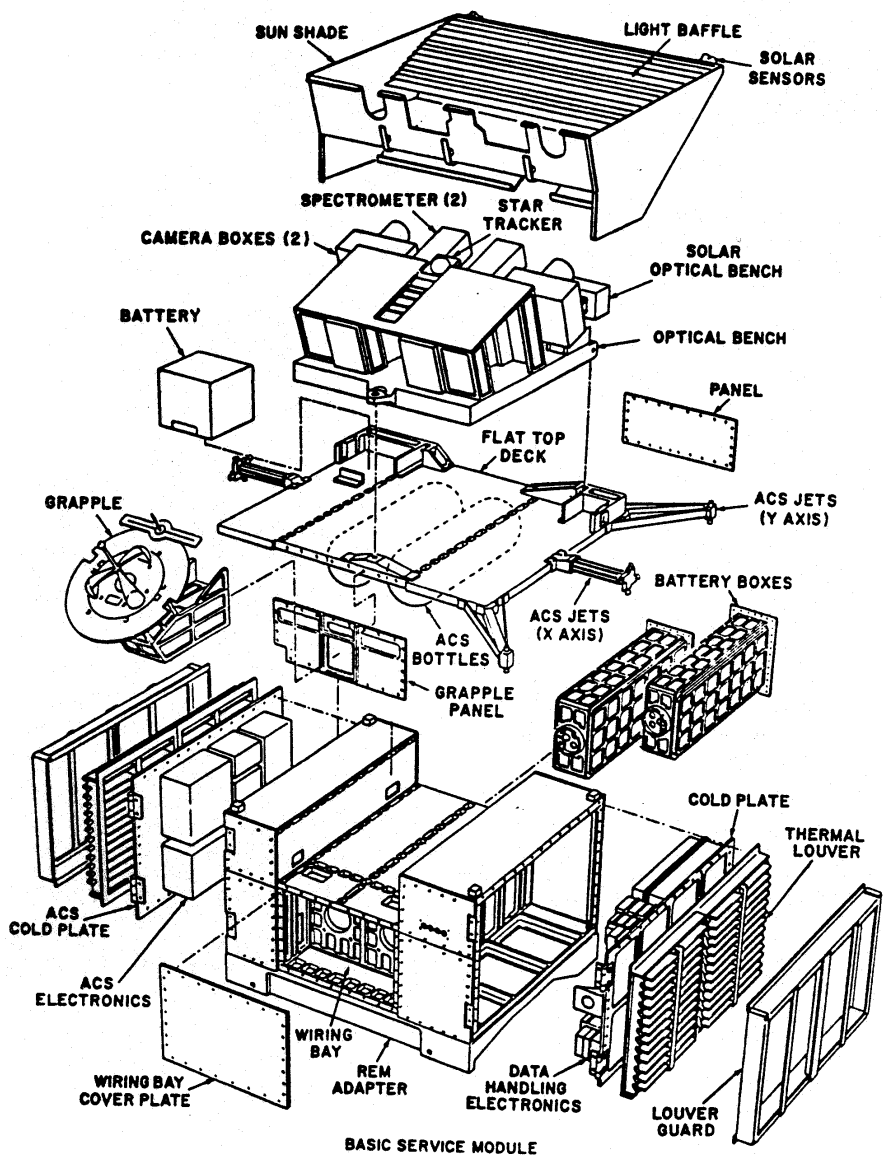
The F-spectrometer grating can be rotated to cover its wider range in six 40 nm sections. A slit limits its field of view to a strip of sky 1 by 80 arc-minutes (the apparent diameter of the moon is about 30 arc-minutes). The G-spectrometer has a 3 x 80 arc-minute slit because emissions are fainter at shorter wavelengths.

With Halley as little as 10 degrees away from the sun, two sets of baffles must be used to reduce stray light. An internal set is part of the Mariner design. A new external set serves both instruments. It has two knife-edge baffles 38.5 inches away from the spectrometer entrances, and 20 secondary baffles to stop earthlight. Together, the two baffle sets reduce stray light by a factor of a trillion. It is this system that will make it possible for Spartan-Halley to observe the comet while so close to the sun. In addition, internal filters reduce solar Lyman-alpha light (121.6 nm), scattered by the Earth's hydrogen corona, which would saturate the instruments.

Two film cameras, boresighted with the spectrometers, will photograph Halley to assure pointing accuracy in post-flight analysis and to match changes in the tail with spectral changes. The 35 mm Nikon F3 cameras have 105 mm and 135 mm lenses and are loaded with 65-frame rolls of QX-851 thin-base color film. The cameras will capture large-scale activity such as the separation angle between the dust and ion tails, bursts from the nucleus, and asymmetries in the shape of the coma.

The whole instrument package is mounted on an aluminum optical bench – 35 by 37 inches and weighing 175 lb. – attached to the Spartan carrier. This provides a clean interface with the carrier and aligns the spectrometers with the Spartan attitude control sensors. A 15-inch-high housing covers the spectrometers and the cameras.

The instrument package is controlled by a LASP-developed microprocessor which stores the comet Halley ephemeris and directs the Spartan carrier attitude control system.



SPARTAN-HALLEY

MISSION OPERATIONS

Halley's Comet will be of greatest scientific interest from Jan. 20 to Feb. 22; perihelion is on Feb. 9. At that time, Halley will be 139.5 million miles from Earth and 59.5 million mi. from the sun. The Shuttle will go into an orbit 176 miles high and inclined 28.5 degrees to the equator. This will have Halley visible for more than 3,000 seconds per orbit (about 56 percent of the orbit), including more than 90 seconds with the sun occulted by the Earth.

After a predeployment health check of Spartan voltages and currents, the Shuttle robot arm will pick up the spacecraft and hold it over the side. Upon release, Spartan will perform a 90-second "pirouette" to confirm that it is working and the Shuttle will back away to at least five miles so light reflected from the Shuttle does not confuse Spartan's sensors. After two orbits of preparation, the 40-hour science mission will begin. A backup timer will ensure that the spectrometer doors open 70 minutes after release.

Spartan-Halley will conduct 20 orbits of science observations interspersed with five orbits of attitude control updates. A typical science orbit will start with four 100-second calibration scans of Earth's atmosphere, followed by a 900-second tail scan. Observing will be interrupted for 15 minutes of pointing updates and housekeeping. It then resumes with four 200-second scans of the coma, followed by sunset and four coma scans while the sun is occulted. At the end of the mission Spartan-Halley will be retrieved by the Shuttle robot arm and placed in the payload bay.

After the mission, the processed film and data tapes will be returned to the University of Colorado team for scientific analysis.

The Science

Current theories hold that comets are "dirty snowballs" made up largely of water ice and lightweight elements and compounds left over from the creation of the solar system. Remote sensing of the chemistry of Halley's Comet, by measuring how sunlight is reflected, will help in assaying the comet. The "dirt" in the snowball is detectable in visible light, and the "snow" (water ice) and other gases are detectable, indirectly, in ultraviolet.

The most important objective of the Spartan-Halley mission is to obtain ultraviolet spectra of comet Halley when it is less than 67 million miles from the sun. As Halley nears the sun, temperatures rise, releasing ices and clathrates, compounds trapped in ice crystals.

The highest science priority for Spartan is to determine the rate at which water is broken down (dissociated) by sunlight. This must be measured indirectly from the spectra of hydroxyl radicals (OH) and atomic oxygen which are the primary and secondary products. The hydroxyl coma of the comet will be more compact than the atomic oxygen coma because of its short life when exposed to sunlight. Hydrogen, the other product, will not be detectable because of the Lyman-alpha filters in the spectrometers.

Heavier compounds will be sought by measuring spectral lines unique to carbon, carbon monoxide (CO), carbon dioxide (CO₂), sulfur, carbon sulfide (CS) molecular sulfur (S₂), nitric oxide (NO) and cyanogen (CN), among others.

Spartan-Halley's spectrometers will not produce images, but will reveal the comet's chemistry through the ultraviolet spectral lines they record. With these data, scientists will gain a better understanding of how:

- # Chemical structure of the comet evolves from the coma and proceeds down the tail;
- # Species change with relation to sunlight and dynamic processes within the comet; and
- # Dominant atmospheric activities at perihelion relate to the comet's long-term evolution.

Other observatories will be studying Halley's comet, but only Spartan can observe near perihelion.

The Spartan Program

The Spartan-Halley 200 carrier measures 52 by 43 by 51 in. and weighs 2,250 lb. without payload. The attitude control system and other components use elements from the sounding rocket program. All data are stored on a Bell & Howell MARS 1400 recorder; 500 megabytes of storage are available to the experimenter. The spacecraft sits on the Spartan Flight Support Structure and is held in place by a release-and-engage mechanism.

TEACHER IN SPACE PROJECT

Project History

President Reagan announced on Aug. 27, 1984, that a teacher would be chosen as the first private citizen to fly on the Space Shuttle. The Teacher in Space Project is part of NASA's Space Flight participant Program designed to expand Shuttle opportunities to a wider segment of private citizens with the purpose of communicating the experience and flight activities to the public through educational and public information programs.

The Council of Chief State School Officers (CCSSO) was selected by NASA to coordinate the selection process. The Council is a non-profit organization comprised of the public officials responsible for education in each state.

In November 1984, an Announcement of Opportunity was distributed, listing the eligibility requirements and a description of the selection process and criteria, medical requirements and responsibilities of the teacher selected to fly on the Shuttle mission.

Applications were accepted from Dec. 1, 1984 to Feb. 1, 1985. More than 11,000 teachers from the 50 states, Puerto Rico, Guam, the Virgin Islands, Department of Defense overseas schools, Department of State overseas schools and Bureau of Indian Affairs schools applied for the flight. State, territorial and agency review panels each selected two nominees for a total of 114 nominees.

The 114 nominees met in Washington, DC from June 22-27, 1985, for a National Awards Conference which focused on various aspects of space education.

During their stay in Washington, all nominees met formally and informally with the National Review Panel, which selected the 10 finalists.

On July 1, 1985, the 10 finalists were announced and on July 7 they traveled to Johnson Space Center for a week of thorough medical examinations and briefings about space flight.

From July 15-18, each of the finalists was interviewed by a NASA Evaluation Committee made up of senior NASA officials. The committee made recommendations to the NASA Administrator who selected Christa McAuliffe and Barbara Morgan as the primary and backup candidates for the NASA Teacher in Space Project.

Live Lessons

Teacher observer Christa McAuliffe will conduct two lessons on Flight Day 6 of the mission. The first lesson will begin at approximately 11:40 a.m. EST; the second is scheduled for approximately 1:40 p.m. EST.

The first lesson entitled "The Ultimate Field Trip" will allow students to compare daily life on the Shuttle with that on Earth. Conducting a tour of the Shuttle for viewers, McAuliffe will explain crewmembers' roles, show the location of computers and controls and describe experiments being conducted on the mission. She also will demonstrate how daily life in space is different from that on Earth in the preparation of food, movement, exercise, personal hygiene, sleep and the use of leisure time.

The second lesson, "Where We've Been, Where We're Going, Why?" will help the audience understand why people use and explore space by demonstrating the advantages of manufacturing in the microgravity environment, highlighting technological advances that evolve from the space program and projecting the future of humans in space.

Mission Watch

Classrooms with access to a satellite dish or cable network that carries NASA Select television will have, in addition to the live broadcast, the opportunity to participate in a "Mission Watch" which covers aspects of the entire Shuttle flight. The Mission Watch during 51-L will start the day before the launch and continue through the conclusion of the mission and will be carried only on NASA select. Barbara Morgan, backup candidate for the NASA Teacher in Space Project, will act as moderator for the Mission Watch broadcast to schools. Morgan will give daily briefings on that day's planned events and update viewers on McAuliffe's activities.

Classroom Earth, a Spring Valley, IL, organization dedicated to direct satellite transmission to elementary and secondary schools, will serve as the center for information and materials for schools that wish to use satellite dish antennas to receive both the live broadcast and the Mission Watch.

Specific information about the satellite transmission is available by writing to Classroom Earth, Spring Valley, IL, 61362 or by calling 815/664-4500.

In-Flight Activities

During the 51-L mission, McAuliffe will be involved in several activities which will be filmed and later used in educational products.

- Magnetism – Photograph and observe the lines of magnetic force in three dimensions in a microgravity environment.
- Newton's Law – Demonstrate Newton's first, second and third laws in microgravity.
- Effervescence – Understand why products may or may not effervesce in a microgravity environment.
- Simple Machines/Tools – Understand the use of simple machines/tools and the similarities and differences between their uses in space and on Earth.
- Hydroponics in Microgravity – Show the effect of microgravity on plant growth, growth of plants without soil (hydroponics) and capillary action.
- Chromatographic Separation of Pigments – Demonstrate chromatography in a microgravity environment and show capillary action (the mechanism by which plants transports water and nutrients).

SHUTTLE STUDENT INVOLVEMENT PROGRAM

Utilizing a Semi-Permeable Membrane to Direct Crystal Growth

This is an experiment proposed by Richard S. Cavoli, formerly of Marlboro Central High School, Marlboro, NY. Cavoli is now enrolled at Union College, Schenectady, NY.

The experiment will attempt to control crystal growth through the use of a semi-permeable membrane. Lead iodide crystals will be formed as a result of a double replacement reaction. Lead acetate and potassium iodide will react to form insoluble lead iodide crystals, potassium ions and acetate ions. As the ions travel across a semi-permeable membrane, the lead and iodide ions will collide, forming the lead iodide crystal.

Cavoli's hypothesis states that the shape of the semi-permeable membrane and the concentrations of the two precursor compounds will determine the growth rate and shape of the resulting crystal without regard to other factors experienced in earthbound crystal growing experiments.

Following return of the experiment apparatus to Cavoli, an analysis will be performed on the crystal color, density, harness, morphology, refractive index, and electrical and thermal characteristics. Crystals of this type are useful in imaging systems for detecting gamma and X-rays and could be used in spacecraft sensors for astrophysical research purposes.

Cavoli's high school advisor is Annette M. Saturnelli of Marlboro Central High School and his college advisor and experiment sponsor is Dr. Charles Seaise of Union College.

Effects of Weightlessness on Grain Formation and Strength in Metals

This is an experiment proposed by Lloyd C. Bruce formerly of Sumner High School, St. Louis. Bruce is now a sophomore at the University of Missouri.

The experiment proposes to heat a titanium alloy metal filament to near the melting point to observe the effect that weightlessness has on crystal reorganization within the metal. It is expected that heating in microgravity will produce larger crystal grains and thereby increase the inherent strength of the metal filament. The experiment uses a battery supply, a timer and thermostat to heat a titanium alloy filament to 1,000 degrees C. At a temperature of 882 degrees C, the titanium-aluminum alloy crystal lattice network undergoes a metamorphosis from closely packed hexagonal crystals to centered cubic crystals.

Following return of the experiment gear to Sumner, he will perform an analysis comparing the space-tested alloy sample with one heated on Earth to analyze any changes in strength, size and shape of the crystal grains, and any change in the homogeneity of the alloy. If necessary microscopic examination, stress testing and X-ray diffraction analysis also will be used. Any changes between the two samples could lead to variations on this experiment to be proposed for future Shuttle flights. A positive test might lead to a new and stronger titanium-aluminum alloy or a new type of industrial process.

Bruce's student advisor is Vaughan Morrill of Sumner High School. His sponsor is McDonnell Douglas Corp., St. Louis, and his experiment advisor is Julius Bonini of McDonnell Douglas.

Chicken Embryo Development in Space

This is an experiment of John C. Vellinger, formerly of Jefferson High School, Lafayette, IN, to determine any effects of spaceflight on the development of a fertilized chicken embryo. Vellinger is now a sophomore at Purdue University.

The experiment will fly 12 White Leghorn chicken eggs which have been fertilized immediately prior to launch to see if any changes in the developing embryo can be attributed to weightlessness or space radiation effects. The development of a chicken embryo is greatest during the first several weeks following fertilization.

Eight eggs will be subjected to both weightlessness and radiation from space. The four remaining eggs will have lead shields placed around them to assist in determining any peculiar effects from space radiation. All 12 eggs will be placed in an incubator box and sent aboard Challenger while a similar group of 12 eggs will remain on Earth as a control group. Vellinger's hypothesis is that chickens could form a basis for food developed and grown in space but only if their development from fertilized eggs proceeds normally.

Upon return to Earth, the space incubators will remain at KSC for a period of about 10 days to allow the chicks to hatch. Vellinger will attend to the earthbound eggs much as a mother hen would, turning them five times a day to counter the effects of Earth's gravity on the yolk sack. Following hatching of both groups, Vellinger will attempt to determine if there are any statistically significant differences between the bone structure, nervous systems and internal organs of the two groups.

Vellinger's student advisor is Stanley W. Poelstra of Jefferson High School. Kentucky Fried Chicken, Louisville, is sponsoring the experiment and Dr. Lisbeth Kraft, NASA Ames Research Center, Mountain View, CA, is serving as technical advisor.

COMET HALLEY ACTIVE MONITORING PROGRAM (CHAMP)

Objectives of the CHAMP payload include investigating the dynamical/morphological behavior as well as the chemical structure of Halley's Comet. Photographic images and spectra will be obtained through Columbia's windows using hand-held 35 mm camera and associated equipment. A crew member will enclose himself in a camera shroud to eliminate all cabin light interference. Using International Halley Watch standard comet filters, several image-intensified monochromatic exposures will be made. In addition, spectra of the comet will be photographed using a grating and image intensifier.

Similar observations were made on the last flight and will be made on the March flight to study the variations of the comet with time. CHAMP requires no spacecraft power or other systems support and is stored in two-thirds of one middeck locker.

The principal investigators for CHAMP are S. Alan Stern, Laboratory for Atmospheric and Space Physics (LASP), University of Colorado-Boulder and Dr. Stephen Mende, Lockheed Palo Alto Research Laboratory. Mission management support is provided by the Engineering Directorate, Johnson Space Center for the Office of Space Science and Applications, NASA Headquarters.

PHASE PARTITIONING EXPERIMENT

Phase partitioning is a selective, gentle and inexpensive technique, ideal for the separation of biomedical materials such as cells and proteins. It involves establishing a two-phase system by adding various polymers to a water solution containing the materials to be separated. Two phase systems most familiar are oil and water or cream and milk. When two phase polymer systems are established, the biomedical materials they contain tend to separate or “partition” into the different phases.

Theoretically, phase partitioning should separate cells with significantly higher resolution than is presently obtained in the laboratory. It is believed that when the phases are emulsified on Earth, the rapid, gravity-driven fluid movements, occurring as the phases coalesce, tend to randomize the separation process. It is expected that the theoretical capabilities of phase partitioning systems can be more closely approached in the weightlessness or orbital spaceflight where gravitational effects of buoyancy and sedimentation are minimized.

The first exploratory flight of Phase Partitioning Experiment (PPE) equipment involves the use of a small, hand-held device, a little larger than a cigarette box and weighing about one pound. This unit will fit within a small part of a standard middeck locker. The unit has 15 chambers to allow the test of different volume ratios and compositions of the phases and differences in wall coatings within the chambers.

The Microgravity Science and Applications Division of the Office of Space Science and Applications, NASA Headquarters, sponsors the experiment. Marshall Space Flight Center is responsible for mission implementation.

FLUID DYNAMICS IN SPACE

Hughes payload specialist Greg Jarvis will perform experiments to investigate fluid dynamics in microgravity. These experiments will improve Hughes' understanding of how fluids act in orbiting spacecraft and may lead to the design of more efficient and less costly spacecraft.

Hughes is now designing larger, more massive spacecraft to take advantage of the Shuttle capabilities. This evolution in design has led to the replacement of solid rocket motors with highly efficient liquid propulsion systems for transfer orbit maneuvers. Spacecraft design has always taken into account the possible destabilizing effects of liquid propellants. However, as the quantity of liquid increases it becomes more important to understand the interaction between the fluid and the spacecraft.

There are two categories of experiments to be performed: fluid behavior in enclosed tanks and fluid motion interactions with spacecraft motions.

For the enclosed tank experiments, Jarvis will try to determine the behavior of a fluid in a partially-filled tank for different levels of fill. A metal base plate will be used to support the experiment and will be attached with Velcro tape to the cabin walls of Challenger. A metal shaft attaches to the base plate and supports a hub assembly connecting to two-6-inch diameter tanks.

The tanks and hub do not move in one of these experiments and are set spinning at about 10 revolutions/minute in a second experiment. Throughout these experiments, Jarvis will record the fluid motions using orbiter video cameras and recorders. A third experiment in this series will use a spring to spin up the hub assembly (much as a helicopter toy uses a spring to impart a one-time spin-up). Once spun up, the hub assembly will be videotaped to record the transfer of motion from the simulated spacecraft to the fluid inside. The spheres are transparent so the motions of the fluid inside can be seen readily.

Another set of experiments will observe the effects of energy dissipation between spacecraft motions and fluid motions within the spacecraft. In these experiments, a four-tank spherical tank model will first be attached to the hub and used for observations. This model consists of four 3-1/4-inch diameter clear plastic tanks. Following those, an ellipsoidal centerline tank model will be used. The ellipsoidal tank is 3-1/4-in. long by 4-1/4-in. in diameter.

This experiment will measure transmitted motions from the simulated spacecraft tanks to the fluids in the tanks using very sensitive accelerometers which transmit their information via infrared light emitting diodes (similar to the way most television and video recorder remote control units work).

This technique removes any potential drag which might result from cabling between the moving tank models and the instrument recorders. For this series of experiments, the models will be spun up to about 100 revolutions a minute by Jarvis.

A third series of experiments will measure the fluid dynamics of "Frisbee" style deployed satellites using a cradle model in lieu of the base plate used in earlier experiments.

The videotapes and recorded accelerometer data will be analyzed by Hughes engineers once the mission is over.

U.S. LIBERTY COINS

Two complete sets of the newly-minted U.S. Liberty coins will become the first legal tender American coinage to make a trip into orbit on mission 51-L.

The Liberty coins – a silver dollar, half dollar and \$5 gold coin – are being minted by authorization from Congress to honor the Statue of Liberty's centennial anniversary in 1986 and to help raise funds for the restoration and future maintenance of the statue and Ellis Island. They are the first and only government-issue coins to feature the Statue of Liberty.

School children in grades 4 through 8 will be given the chance to learn about coins and American history in a special education package – Commemorating Liberty Through Coins – which will be delivered to every public, private and parochial school in the nation in early March 1986.

The U.S. Liberty coins will be available at financial institutions and department stores across the country in April 1986.

STS-51L CREWMEMBERS



S85-44253 – The official portrait of the STS-51L crewmembers includes, in the back row (l.-r.) mission specialist Ellison S. Onizuka, Teacher in Space Participant Sharon Christa McAuliffe, payload specialist Greg Jarvis and mission specialist Judy Resnik. In the front row (l.-r.) pilot Mike Smith, mission commander Dick Scobee, and mission specialist Ron McNair.

No copyright is asserted for this photograph. If a recognizable person appears in the photo, use for commercial purposes may infringe a right of privacy or publicity. It may not be used to state or imply the endorsement by NASA or by any NASA employee of a commercial product, process or service, or used in any other manner that might mislead. Accordingly, it is requested that if this photograph is used in advertising and other commercial promotion, layout and copy be submitted to NASA prior to release.

PHOTO CREDIT: NASA or National Aeronautics and Space Administration.

BIOGRAPHICAL DATA

FRANCIS R. (DICK) SCOBEE is spacecraft commander. Born May 19, 1939, in Cle Elum, WA, he became a NASA astronaut in 1978. He received a B.S. degree in aerospace engineering from the University of Arizona in 1965.

Scobee was a reciprocating engine mechanic in the Air Force. He was commissioned in 1965, and after receiving his wings in 1966, completed a number of assignments, including a combat tour in Vietnam. He attended the Aerospace Research Pilot School at Edwards Air Force Base, flying such varied aircraft as the Boeing 747, the X-24B, the transonic aircraft technology (TACT) F-111 and the C-5. He has logged more than 6,500 hours in 45 types of aircraft.

Scobee was pilot of STS 41-C in 1984. During this mission the crew deployed the Long Duration Exposure Facility (LDEF); and retrieved, repaired aboard the orbiting Challenger, and returned to orbit, the ailing Solar Maximum Mission satellite.

MICHAEL J. SMITH, Commander, USN is pilot. Born April 30, 1945, in Beaufort, NC, he became a NASA astronaut in 1980.

Smith received a B.S. degree in naval science from the U.S. Naval Academy and an M.S. degree in aeronautical engineering from the U.S. Naval Postgraduate School.

Smith flew A-6 intruders and completed a Vietnam cruise while assigned to Attack Squadron 52 aboard the USS Kitty Hawk. He was awarded the Navy Distinguished Flying Cross, three Air Medals, 13 Strike Flight Air Medals, the Navy Commendation Medal with "V", the Navy Unit Citation and the Vietnamese Cross of Gallantry with Silver Star.

He has flown 28 different types of civilian and military aircraft, logging over 4,300 hours – 4,000 in jet aircraft.

JUDITH A. RESNIK, Ph.D., is one of three mission specialists aboard 51-L. She was born April 5, 1949 in Akron, OH. She received a B.S. degree in electrical engineering from Carnegie-Mellon University and a Ph.D. in electrical engineering from the University of Maryland. She became an astronaut in 1978.

Resnik worked for RCA, Moorestown, NJ, designing circuits and developing custom integrated circuitry for phased-array radar control systems. She was a biomedical engineer and staff fellow in the laboratory of neurophysiology at the National Institutes of Health, Bethesda, MD. She also served as senior systems engineer in product development with Xerox Corp., El Segundo, CA.

Resnik was mission specialist on STS 41-D. During this mission, the crew deployed three satellites. Resnik has logged 144 hours, 57 minutes in space.

BIOGRAPHICAL DATA

RONALD E. MCNAIR, Ph.D., mission specialist, became an astronaut in 1978. Born Oct 21, 1950, in Lake City, SC, he received a B.S. degree in physics from North Carolina A&T State University and a Ph.D. in physics from the Massachusetts Institute of Technology.

While at MIT, McNair performed some of the earliest development of chemical HF/DF and high pressure CO lasers. He became a staff physicist with Hughes Research Laboratories in Malibu, CA, and conducted research on electro-optic laser modulation for satellite-to-satellite space communications.

McNair was a mission specialist on Shuttle mission 41-B. During the flight, two Hughes 376 communications satellites were deployed. It was the first flight of the Manned Maneuvering Unit and first use of the Canadian arm (operated by McNair) to position an EVA crewman around Challenger's payload bay. McNair has 191 hours in space.

ELLISON S. ONIZUKA, Lt. Col., USAF, is a mission specialist. He became an astronaut in 1978. Born June 24, 1946 in Kealahou, Kona, HI, he received B.S. and M.S. degrees in aerospace engineering from the University of Colorado. He became a NASA astronaut in 1978.

Onizuka was an aerospace flight test engineer with the Sacramento Air Logistics Center at McClellan Air Force Base. He participated in flight test programs and systems safety engineering for the F-84, F-100, F105, F-111, EC-121T, T-33, T-39, T-28 and A-1 aircraft. He has logged more than 1,700 hours flying time.

Onizuka was a mission specialist on STS 51-C, the first dedicated Department of Defense mission. He has logged 74 hours in space.

GREGORY B. JARVIS, payload specialist was born Aug. 24, 1944 in Detroit. He received a B.S. degree in electrical engineering from the State University of New York at Buffalo; an M.S. degree in electrical engineering from Northeastern University, Boston; and has completed the course work for an M.S. degree in management science at West Coast University, Los Angeles. Jarvis was selected as a payload specialist candidate in 1984.

Jarvis worked at Raytheon, Bedford, MA, designing circuits on the SAM-D missile. Later, as a communications payload engineer in the Satellite Communications Program Office, he worked on advanced tactical communications satellites. He later joined Hughes Aircraft Co.'s Space and Communications Group where he worked as subsystem engineer on the MARISAT Program.

He was test and integration manager for the F-1, F-2 and FD-3 spacecraft and cradle in 1983. The F-1 and F-2 Leasat spacecraft were successfully deployed.





S. CHRISTA MCAULIFFE is the Teacher in Space participant. Born Sept. 2, 1948, in Boston, she received a B.A. degree from Framingham State College and a masters degree in education from Bowie State University, Bowie, MD.

McAuliffe has taught English and American History since 1970. Until her selection as NASA Teacher in Space, she taught economics, law, American history, and a course she developed, "The American Woman," to 10th through 12th grade students.

McAuliffe was selected as primary candidate for the NASA Teacher in Space Project in July 1985.

SHUTTLE FLIGHTS AS OF JANUARY 1986

24 TOTAL FLIGHTS OF THE SHUTTLE

											
	<table border="1" style="margin: auto;"> <tr><td>STS-61A</td></tr> <tr><td>10/30/85 - 11/06/85</td></tr> <tr><td>STS-51F</td></tr> <tr><td>07/29/85 - 08/06/85</td></tr> </table>	STS-61A	10/30/85 - 11/06/85	STS-51F	07/29/85 - 08/06/85						
STS-61A											
10/30/85 - 11/06/85											
STS-51F											
07/29/85 - 08/06/85											
<table border="1" style="margin: auto;"> <tr><td>STS-61C</td></tr> <tr><td>01/12/86 - 01/18/86</td></tr> </table>	STS-61C	01/12/86 - 01/18/86	<table border="1" style="margin: auto;"> <tr><td>STS-51B</td></tr> <tr><td>04/29/85 - 05/06/85</td></tr> </table>	STS-51B	04/29/85 - 05/06/85						
STS-61C											
01/12/86 - 01/18/86											
STS-51B											
04/29/85 - 05/06/85											
<table border="1" style="margin: auto;"> <tr><td>STS-9</td></tr> <tr><td>11/28/83 - 12/08/83</td></tr> </table>	STS-9	11/28/83 - 12/08/83	<table border="1" style="margin: auto;"> <tr><td>STS-41G</td></tr> <tr><td>10/05/84 - 10/13/84</td></tr> </table>	STS-41G	10/05/84 - 10/13/84	<table border="1" style="margin: auto;"> <tr><td>STS-51-I</td></tr> <tr><td>08/27/85 - 09/03/85</td></tr> </table>	STS-51-I	08/27/85 - 09/03/85			
STS-9											
11/28/83 - 12/08/83											
STS-41G											
10/05/84 - 10/13/84											
STS-51-I											
08/27/85 - 09/03/85											
<table border="1" style="margin: auto;"> <tr><td>STS-5</td></tr> <tr><td>11/11/82 - 11/16/82</td></tr> </table>	STS-5	11/11/82 - 11/16/82	<table border="1" style="margin: auto;"> <tr><td>STS-41C</td></tr> <tr><td>04/06/84 - 04/13/84</td></tr> </table>	STS-41C	04/06/84 - 04/13/84	<table border="1" style="margin: auto;"> <tr><td>STS-51G</td></tr> <tr><td>06/17/85 - 06/24/85</td></tr> </table>	STS-51G	06/17/85 - 06/24/85			
STS-5											
11/11/82 - 11/16/82											
STS-41C											
04/06/84 - 04/13/84											
STS-51G											
06/17/85 - 06/24/85											
<table border="1" style="margin: auto;"> <tr><td>STS-4</td></tr> <tr><td>06/27/82 - 07/04/82</td></tr> </table>	STS-4	06/27/82 - 07/04/82	<table border="1" style="margin: auto;"> <tr><td>STS-41B</td></tr> <tr><td>02/03/84 - 02/11/84</td></tr> </table>	STS-41B	02/03/84 - 02/11/84	<table border="1" style="margin: auto;"> <tr><td>STS-51D</td></tr> <tr><td>04/12/85 - 04/19/85</td></tr> </table>	STS-51D	04/12/85 - 04/19/85			
STS-4											
06/27/82 - 07/04/82											
STS-41B											
02/03/84 - 02/11/84											
STS-51D											
04/12/85 - 04/19/85											
<table border="1" style="margin: auto;"> <tr><td>STS-3</td></tr> <tr><td>03/22/82 - 03/30/82</td></tr> </table>	STS-3	03/22/82 - 03/30/82	<table border="1" style="margin: auto;"> <tr><td>STS-8</td></tr> <tr><td>08/30/83 - 09/05/83</td></tr> </table>	STS-8	08/30/83 - 09/05/83	<table border="1" style="margin: auto;"> <tr><td>STS-51C</td></tr> <tr><td>01/24/85 - 01/27/85</td></tr> </table>	STS-51C	01/24/85 - 01/27/85			
STS-3											
03/22/82 - 03/30/82											
STS-8											
08/30/83 - 09/05/83											
STS-51C											
01/24/85 - 01/27/85											
<table border="1" style="margin: auto;"> <tr><td>STS-2</td></tr> <tr><td>11/12/81 - 11/14/81</td></tr> </table>	STS-2	11/12/81 - 11/14/81	<table border="1" style="margin: auto;"> <tr><td>STS-7</td></tr> <tr><td>06/18/83 - 06/24/83</td></tr> </table>	STS-7	06/18/83 - 06/24/83	<table border="1" style="margin: auto;"> <tr><td>STS-51A</td></tr> <tr><td>11/08/84 - 11/16/84</td></tr> </table>	STS-51A	11/08/84 - 11/16/84	<table border="1" style="margin: auto;"> <tr><td>STS-61B</td></tr> <tr><td>11/26/85 - 12/03/85</td></tr> </table>	STS-61B	11/26/85 - 12/03/85
STS-2											
11/12/81 - 11/14/81											
STS-7											
06/18/83 - 06/24/83											
STS-51A											
11/08/84 - 11/16/84											
STS-61B											
11/26/85 - 12/03/85											
<table border="1" style="margin: auto;"> <tr><td>STS-1</td></tr> <tr><td>04/12/81 - 04/14/81</td></tr> </table>	STS-1	04/12/81 - 04/14/81	<table border="1" style="margin: auto;"> <tr><td>STS-6</td></tr> <tr><td>04/04/83 - 04/09-83</td></tr> </table>	STS-6	04/04/83 - 04/09-83	<table border="1" style="margin: auto;"> <tr><td>STS-41D</td></tr> <tr><td>08/30/84 - 09/04-84</td></tr> </table>	STS-41D	08/30/84 - 09/04-84	<table border="1" style="margin: auto;"> <tr><td>STS-51J</td></tr> <tr><td>10/03/85 - 10/07/85</td></tr> </table>	STS-51J	10/03/85 - 10/07/85
STS-1											
04/12/81 - 04/14/81											
STS-6											
04/04/83 - 04/09-83											
STS-41D											
08/30/84 - 09/04-84											
STS-51J											
10/03/85 - 10/07/85											
<p>OV-102 Columbia (7 flights)</p>	<p>OV-099 Challenger (9 flights)</p>	<p>OV-103 Discovery (6 flights)</p>	<p>OV-104 Atlantis (2 flights)</p>								