NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE SHUTTLE MISSION STS-41C

PRESS KIT
MARCH 1984

LDEF DEPLOY; SOLAR MAX REPAIR

STS-41C INSIGNIA

S84-25522 -- The insignia features a helmet visor of an astronaut performing an extravehicular activity. In the visor are reflected the sun's rays, the Challenger and its remote manipulator system deploying the long duration exposure facility, the Earth and blue sky, and another astronaut working at the damaged Solar Maximum Satellite. The scene is encircled by the names of the crewmembers.

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SOLAR MAX REPAIR, LDEF DEPLOYMENT HIGHLIGHT SHUTTLE FLIGHT

On mission 41-C in April, the eleventh flight of the Space Shuttle, Challenger's five man crew will attempt the first on-orbit repair of a crippled spacecraft that was launched more than four years ago. Launch of the mission is currently set for April 6 at 8:59 a.m. EST with the landing on April 12 at 8:10 a.m. EST. Both launch and landing will be at the Kennedy Space Center, Fla.

Making its fifth trip into space, Challenger will be launched into its highest orbit yet so it can rendezvous with a wobbling solar flare-studying satellite called Solar Maximum Mission. The Manned Maneuvering Unit, the gas-powered jetpacks that were test flown for the first time on the last Shuttle flight in February, will be used to fly out to the slowly spinning satellite, dock with it, and stop its motion.

The Solar Maximum Satellite will be hauled into the cargo bay by the robot arm. Challenger then will serve as an orbiting service station for astronauts to repair the satellite's fine-pointing system and a couple of instruments during two six-hour space walks. Solar Max will be placed back in orbit to continue its study of the violent nature of the sun's solar activity and its effects on our own planet.

Astronaut Robert Crippen, as commander of the 41-C mission, will make his third trip into space aboard the Shuttle. Other members of the crew, pilot Dick Scobee and mission specialists George Nelson, Terry Hart and James van Hoften, will all be making their first space flight.

Another goal on this mission is the deployment of a large experiment carrier named the Long Duration Exposure Facility (LDEF). Specially suited for carrying dozens of diverse, passive experiments, the large cylindrical payload will be left in space for nearly a year. A subsequent Shuttle flight will bring the reusable structure back to Earth.

A repeat passenger on flight 41-C is the Cinema 360 camera, making the second of three scheduled flights. Mounted in the cargo bay, the 35 mm movie camera will record the historic rescue mission through the eye of a "fisheye" lens.

Challenger will carry a second film camera in the cabin, provided by the IMAX Corporation, which will record the drama on 70 mm film, designed for projection on very large screens.

A Shuttle Student Involvement Project Experiment, developed by a l9-year-old student, will study the honeycomb structure built by bees in zero gravity.

Challenger's liftoff from Complex 39's Pad A will be the first to employ a "direct insertion" ascent technique that will put the spacecraft into an elliptical orbit with a high point of about 287 miles and an inclination to the equator of 28.5 degrees. Only one burn of the vehicle's powerful orbital maneuvering system engines will be required to place it in the proper orbit.

The 50-foot long Remote Manipulator System will be used to release the Long Duration Exposure Facility into orbit on the second day of the flight, approximately 27 hours after liftoff. With no propulsion systems onboard, the 9 meter (30 foot) long, 42 m (14 ft.) diameter payload will drift 548 kilometers (296 miles) above the globe for the next 10 and 1/2 months.

Experiments carried aboard the reusable facility are organized into four major groups: material structures, power and propulsion, electronics and optics, and science. Many of the experiments are basically simple, and some will be completely passive in orbit.

The 57 separate experiments involve more than 200 investigators from the United States and eight other countries and were furnished by government laboratories, private companies and universities. Results of the experiments' long-term exposure to the harsh space environment will be analyzed after the facility is brought back down to Earth by the Shuttle, and the experiments have been returned to the investigators.

Solar Maximum Mission, the first satellite designed specifically to study solar flares, was launched by NASA on Feb. 14, 1980. It was the first satellite built with the Multi-Mission Modular Spacecraft body, designed for retrieval by the Shuttle for servicing and/or repair.

After eight months of successful operation, part of the attitude control system failed. Ground controllers put the satellite in a slow spin to keep it in a stable sun-pointed orbit. But this rendered four of its onboard scientific instruments useless because they require very precise pointing to collect usable data. Failure of the attitude control system was followed by problems with three scientific instruments.

Challenger will intercept Solar Max on the third day of the flight, about 48 hours into the mission. At that point, Challenger will be about 16.6 km (9 mi) from the wobbling satellite.

Challenger will move toward the satellite until the orbiter is about 61 m (200 ft) away. Astronaut Nelson will snap himself into one of the Manned Maneuvering Units. A special fixture will be connected to the front of Nelson's maneuvering backpack that will allow him to dock to the slowly rotating satellite.

Nelson will then fly out to the crippled satellite and dock with it. The backpack's attitude control system will fire to stop the motion of the Solar Max. Challenger will then move close enough for the robot arm to reach out and grab the satellite and pull it into the cargo bay.

The Flight Support System (FSS) will keep the 2,270 kilogram (5,000 pound) satellite firmly planted in the cargo bay while Nelson and van Hoften start the repairs.

If the satellite cannot be repaired, the FSS provides the structural retention that will allow Challenger to return Solar Max to Earth.

Astronaut van Hoften will use the remote manipulator arm like a space-age cherry picker to replace the attitude control module with the spare plug-in unit.

Next, van Hoften will install a baffle on the X-Ray polychromator experiment's vent port to redirect propane gas away from the other sensitive instruments on the satellite.

The first EVA will conclude with preparations to remove the main electronics box.

Nelson and van Hoften will return to the cargo bay on day five to complete the repair of the Solar Maximum satellite during another six-hour space walk.

Solar Max will be released back into space by the robot arm on day six of the flight. Challenger will stay nearby for the next eight hours while the Solar Max is put through a final series of tests

Documenting the drama of the Solar Max rescue mission will be two special camera systems. One of the cameras, provided by Cinema 360, Inc. was flown on the last Shuttle flight. Footage taken on three flights by the modified 35 mm camera, fitted with an ultra wide-angle lens, will be assembled into a half-hour documentary called "The Space Shuttle: An American Adventure." The 360-degree film system is designed for projection onto the domes of specially equipped planetariums.

A second camera, furnished by IMAX Systems Corporation, is part of another unique motion picture projection system. The IMAX camera will catch the rescue mission on a 70 mm film frame that is 10 times the size of a standard 35 mm frame and three times the size of a conventional 70 mm frame.

This will be the first of three Shuttle flights that will carry IMAX cameras.

Besides the five-man astronaut crew, Challenger will have 3,300 other living passengers onboard. A Shuttle Student Involvement Project being carried out on this mission will study the honeycomb structures built by bees in zero-gravity compared to structures built by bees on Earth. The experiment is the proposal of Dan Poskevich, a student at Tennessee Technological Institute in Cooksville, Tenn. All 3,300 bees will be housed in a specially designed bee-box which will be mounted in the Challenger's middeck. Honeywell Inc., Minneapolis, is sponsoring the experiment.

Challenger's return home will begin approximately 142 hours after it began. An approximate 2 and 1/2 minute long burst from its orbital maneuvering engines during its 91st revolution around the Earth will start the descent process. In a repeat performance of the Shuttle's historic first landing in February at the same site from which it was launched, Challenger is scheduled to return to Kennedy Space Center. Landing is scheduled for orbit 92 and the prime runway will be the north-to-south runway, No. 15. Touchdown is scheduled for 143 hours and 11 minutes mission elapsed time.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS.)

41-C BRIEFING SCHEDULE

Time	Briefing	Origin
T-1 Day		
8:30 a.m. EST	Mission Summary	KSC
9:15 a.m. EST	Solar Max Repair	KSC
10:15 a.m. EST	LDEF	KSC
11:00 a.m. EST	IMAX	KSC
11:30 a.m. EST	Student Experiment	KSC
1:30 p.m. EST	Prelaunch Press Conference	KSC
T-Day		
10:00 a.m. EST (approximately)	Post Launch Press Conference	KSC (local only)
Launch Through End-of-Mission		
Times announced on NASA select	Flight Director Change of Shift Briefings	JSC
T+5 Days		
9:50 a.m. EST (approximately)	Inflight Press Conference	JSC
Landing Day		
9:15 a.m. EST (approximately)	Post Landing Press Conference	KSC
Landing + 1 Day		
11:00 a.m. EST	Orbiter Status	KSC

GENERAL INFORMATION

NASA Select Television Transmission

The schedule for television transmissions from the Challenger for the change of shift briefings from the Johnson Space Center, Houston, will be available during the mission at the Kennedy

Space Center, Fla.; Marshall Space Flight Center, Huntsville, Ala.; Johnson Space Center and NASA Headquarters, Washington, D.C. The television schedule will be updated on a daily basis to reflect any changes dictated by mission operations.

Status Reports

Status reports on countdown progress, mission progress, on-orbit activities and landing preparations will be produced by the appropriate NASA news center (Kennedy for launch and landing; Johnson for mission and postlanding).

Briefings

Flight control personnel will be on eight-hour shifts. Change-of-shift briefings by the MOCR Flight Director will occur at approximately eight-hour intervals, if required.

Miscellaneous

Information about pre-launch countdown activities, tracking and data information, Huntsville operations and other activities related to the mission will be made available to the media at news centers in separate publications.

SHUTTLE MISSION 41-C -- QUICK LOOK FACTS

Crew: Robert L. Crippen, Commander
Francis R. Scobee, Pilot
Terry J. Hart, Mission Specialist 1
James D. van Hoften, Mission Specialist 2
George D. Nelson, Mission Specialist 3

Orbiter: Challenger OV-099)

Launch site: Pad 39A, Kennedy Space Center, Fla.,

Launch date/time: April 6, 1984; 8:59 a.m. EST*

Orbital inclination: 28.5 degrees Altitude: 250 nautical miles

Mission duration: 6 flight days/143 hours, 12 minutes
91 full orbits; land on 92nd

Landing date/time: April 12, 1984, 8:10 a.m. EST*
5 days, 23 hours, 12 minutes MET

Primary landing site: Kennedy Space Center, Fla.

Payloads: Long Duration Exposure Facility
Fixed Service Structure (for Solar Max Repair)
Radiation Monitoring Equipment
Student Experiment - Comparison of Honeycomb Structures
IMAX (cabin camera)
Cinema 360 (payload bay camera)

Mission Firsts: First repair of a satellite in orbit
First direct insertion ascent
First flight of the Long Duration Exposure Facility

Highlights: Solar Maximum Repair Mission
Long Duration Exposure Facility deployment

Principal Mission Activity: The primary objective of flight 41-C is to retrieve, Mission repair and restore to operation the Solar Maximum Mission Activity: satellite, launched Feb. 14, 1980. Two spacewalks are required -- the first is to retrieve the satellite and begin repair operations; a second is required, after one day's rest, to replace the Main Electronics Box.

The Long Duration Exposure Facility, a free-flying satellite, provides accommodations for experiments requiring long term exposure to the space environment. The LDEF will be carried to orbit, deployed and retrieved on a later flight and the experiments returned to the investigators for data analysis.

*Subject to change; mission elapsed times are approximate.

SUMMARY OF MAJOR ACTIVITIES

Flight Day 1
Fixed Service Structure checkout and positioning
Cinema 360 camera (payload bay)

Flight Day 2
Long Duration Exposure Facility deployment
IMAX camera (cabin)
Cinema 360 camera (payload bay)

Flight Day 3
Solar Maximum Mission repair activities:
Rendezvous with Solar Max spacecraft
Spacewalk to stabilize the satellite
Grapple and berth operations
Position Solar Max on Fixed Service Structure for repairs
IMAX camera (cabin)
Cinema 360 camera (payload bay)

Flight Day 4
Student Experiment: Honeycomb Structures
IMAX camera (cabin)

Flight Day 5
Second extravehicular activity
Solar Maximum Mission repair activities:
Spacewalk to changeout Main Electronic Box
Grapple and unberth Solar Max satellite
IMAX camera (cabin)
Cinema 360 camera (payload bay)

Flight Day 6
Solar Maximum Mission satellite deployment
Radiation Monitor activities
IMAX camera (cabin)
Cinema 360 camera (payload bay)

Flight Day 7
Landing

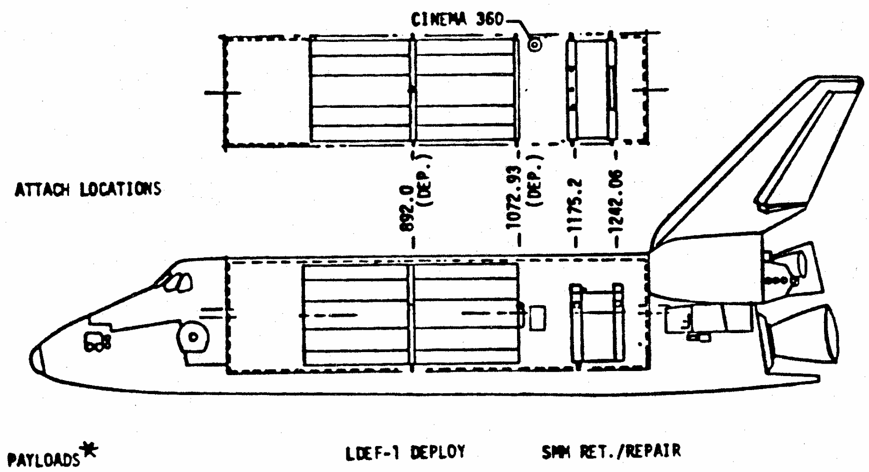
CONFIGURATION

Challenger has the 15.2 m (50 ft.) Canadian-built manipulator arm which will be used for Long Duration Exposure Facility deployment, Solar Max capture, repair activities and Solar Max Deployment. Also in the payload bay is the Flight Support System, a special cradle for the Solar Max satellite. It will be used to stabilize the satellite during repair work and may be used for rigid stowage in the payload bay in the event the satellite is returned to Earth. Two manned Maneuvering Units are in the payload bay, as is the Cinema-360 camera.

The student experiment is carried in the forward middeck. The IMAX camera is located in the crew cabin and unstowed after orbit is achieved.

Major component weights are: LDEF-1, 9,670 kg (21,322 lb.); Flight Support System for Solar Max Mission, 4,043 kg (8,915 lb.); Manned Maneuvering Unit/Flight Support System, 527 kg (1,152 lb.); Cinema-360, 273 kg (602 lb.); IMAX, 102 kg (226 lb.); and the SSIP student experiment, 23 kg (50 lb.).

Liftoff weight of Challenger at SRB ignition is 115,330 kg (254,258 lb.).



*COMMENTS: MMU, MINI-MADS INSTALLED
MIDDECK EXP.-RME IMAX
OEX - ACIP
OTHER-STUDENT EXP., 2 MMU'S, MFR
DIRECT INSERTION LAUNCH

CARGO ARRANGEMENT

41-C FLIGHT SEQUENCE OF EVENTS

Event	MET (hr:min:sec)	V fps	HP/HA n. mi.
Launch	00:00:00		
MECO	00:08:12		30/285
ET SEP	00:08:30	4.0	30/285
RCS burn for MPS dump	00:10:12	3.0	30/286
OMS-2	00:43:53		
Burn duration	00:01:22	160.5	120/286
NC-1 (OMS-3)	05:20:06		
Burn duration	00:00:05	10.0	123/286
NPC	09:21:56	0.0	123/286
HA (RCS)	24:32:18		
Burn duration	00:00:04	1.1	123/285
NSR (OMS-4)	25:18:23		
Burn duration	00:02:15	269.2	280/285
LDEF deploy	27:47:12		
Sep burn from LDEF (RCS)	28:14:12		
Burn duration	00:00:01	0.3	280/285
NC-2 (OMS-5)	31:15:56		
Burn duration	00:00:04	8.6	275/283
NC-3 (RCS)	43:55:34		
Burn duration	00:00:09	3.1	274/283
NH (OMS-6)	44:43:04		
Burn duration	00:00:10	19.3	270/276
NC-4 (OMS-7)	45:30:28		
Burn duration	00:00:05	10.7	267/273
MC (RCS)	46:08:28		
Burn duration	00:00:04	1.2	268/273
305 m (1,000 ft.) from SMM on +V-bar	47:22:00		
91 m (300 ft.) from SMM on +V-bar	48:00:00		
EVA-1 begins	48:20:00		
SMM berth	49:12:00		
EVA-1 ends	S4:20:00		
Reboost 1	69:30:00	0.0	268/273
Reboost 2	70:15:00	0.0	268/273
EVA-2 begins	71:30:00		
EVA-2 ends	77:30:00		
SMM deploy	94:13:00		
SEP (RCS)	94:28:00		
Burn duration	00:00:02	0.5	268/274
Deorbit for KSC-15	19:59:05		
Burn duration	00:03:28	43.0	
Entry interface	120:37:07		
Landing			
KSC-15	121:07:07		
EDW-22	120:58:08		

*All times subject to change

LONG-DURATION EXPOSURE FACILITY (LDEF)

Background

NASA's Long-Duration Exposure Facility (LDEF) is a large structure that will put 57 scientific, applications and technology experiments into Earth orbit for a period of almost one year .

The LDEF experiments range in research interest from materials to medicine to astrophysics. All of them require freeflying exposure in space, but no extensive electrical power, data handling or attitude control systems. Many of the experiments are relatively simple and some will be completely passive while in orbit. The results of their exposure in space will be analyzed in post-fight laboratory investigations after LDEF is returned to Earth.

Deployment

LDEF will be deployed into a circular orbit on the second day of the 41-C mission, beginning at about one day, 15 minutes mission elapsed time, when the orbiter's Remote Manipulator Systems (RMS) is activated by mission specialist Terry Hart. The RMS end effector will engage a grapple fixture on the LDEF structure to activate an experiment-initiation system (EIS), which will turn on those experiments that require power. The RMS will then move to a second LDEF grapple fixture to begin the deployment.

Five support trunnion latches that hold LDEF in the payload bay will be released and the RMS will begin to maneuver the structure out of the bay and into position for deployment. At this time, the orbiter will be traveling almost on its back, in relation to Earth, with the tail section down and forward and the forward end up and aft.

LDEF will be placed in a gravity-gradient stabilized attitude, inclined approximately 28.5 degrees to Earth, and at an altitude of 250 nautical miles (288 statute miles). Once LDEF is positioned, the orbiter will stabilize itself and the payload before LDEF is released. After deployment is completed, the orbiter will fire small thrusters to separate itself from LDEF at a speed of half a foot per second. The orbiter will then track LDEF for about an hour.

While in orbit, one end of LDEF will point toward Earth and the other end will point toward space. One side of the structure's circumference will point in the direction of orbit; the opposite side will be the trailing edge.

LDEF orbital vector data will be provided to NASA by the North American Aerospace Defense Command (NORAD). Intensive C-band radar tracking will begin 72 hours before the launch of Shuttle mission 51-D (scheduled to retrieve LDEF in February 1985) to provide the accurate data required for orbiter and LDEF rendezvous.

Like the Shuttle, the LDEF structure is reusable. Repeat missions are being planned, each containing a different complement of experiments. LDEF missions could be flown as often as every 18 months, and a structure could be kept in orbit for years, with some experiments being changed during periodic visits by a Shuttle orbiter.

Structure

LDEF is a 12-sided, open-grid structure made of aluminum rings and longerons (fore-and-aft framing members). The structure is 9.14 m (30 ft.) long, 4.27 m (14 ft.) in diameter and weighs 3,360 kg (8,000 lb.).

LDEF's center ring frame and end frames are of welded and bolted construction. The longerons are bolted to both frames, and intercostals (crosspieces between longerons) are bolted to the longerons to form intermediate rings. The main load of LDEF is transmitted to the orbiter through two side support trunnions on the center ring.

LDEF holds 86 experiment trays, 72 around the circumference, six on the Earth-pointing end and eight on the space-pointing end. A typical tray measures 127 x 86.4 cm (50 x 34 in.) and is available in one of three depths: 7.6, 15.2 and 30.5 cm (3, 6 and 12 in.). The trays are made of aluminum and can hold experiments that weigh from 81.6 to 90.7 kg (180 to 200 lbs.). Some experiments fill more than one tray, some fill only part of a tray. All of the trays and their experiments weigh only 6,078 kg (13,400 lbs.). Total weight of the structure, trays and experiments is 9,707 kg (21,400 lbs.).

LDEF has no central power system. Experiments that require power or data recording systems had to provide their own, although NASA developed a standard Experiment Power and Data System (EPDS) that was made available to investigators. An EPDS can accommodate analog and digital data with a tape recorder that has a l0-million bit storage capacity and is powered by lithium-sulfur dioxide batteries. The experiment initiation system, triggered by the orbiter RMS, is the only electrical connection between LDEF and the active experiments.

An Experiment Exposure Control Canister (EECC) was developed for those experiments that require protection from contamination during launch and reentry. The EECC is a sealable drawer that can be opened and closed at set times. An electrical signal will open a canister and a programmable timer will trigger its closing with a self-contained operating system. Each canister fills one-third of a 15.2 cm (6-in.)-deep tray and can handle an experiment weighing up to 10 kg (22 lb.).

The LDEF structure, unmanned and passively stabilized, offers a vibration-free, low-acceleration exposure in the space environment for relatively simple experiments. Because of its passivity, LDEF also will have very low contamination levels surrounding it in free flight.

Experiments

The LDEF experiments are divided into four groups: materials and structures, power and propulsion, science and electronics and optics. The 57 experiments on the first LDEF mission involve 194 principal investigators, who represent 16 U.S. universities, 13 private companies, eight NASA centers, eight Department of Defense laboratories, and 34 similar research organizations in Canada, Denmark, the Federal Republic of Germany, France, Ireland, The Netherlands, Switzerland and the United Kingdom.

The interstellar gas, micrometeoroid and cosmic ray experiments are examples of scientific investigations that may provide better understanding of the origin and evolution of the universe, the solar system and Earth.

The crystal growth experiment is an example of an applied scientific investigation. Superior crystals may provide valuable information about their unique properties and possible applications in new devices. Studies conducted in the environment of space may also lead to the discovery of new ways to manufacture crystals on Earth.

The LDEF technology experiments are the beginnings of broad NASA research programs to test in space new technologies required for future space missions. These experiments cannot be done on Earth, and could not be done in space without the Shuttle and LDEF. The technology experiments are expected to provide three specific kinds of information: flight data that can reduce the risk of using a new technology in space; evidence that new technologies may be used sooner than has been predicted; and data on new technology that can only be developed in space.

One LDEF experiment, called the Space-Exposed Experiment Developed for Students (SEEDS), is designed to involve several million students in a national project to generate interest in science and related studies.

Students from elementary through university levels are being invited to participate in post-flight investigations that will use several million plant seeds that are exposed to the space environment in the seeds in space experiment. Student groups will be provided with kits that contain packages of exposed and control seeds. The students will conduct classroom experiments, including design, data gathering, sample comparison and final reporting of results.

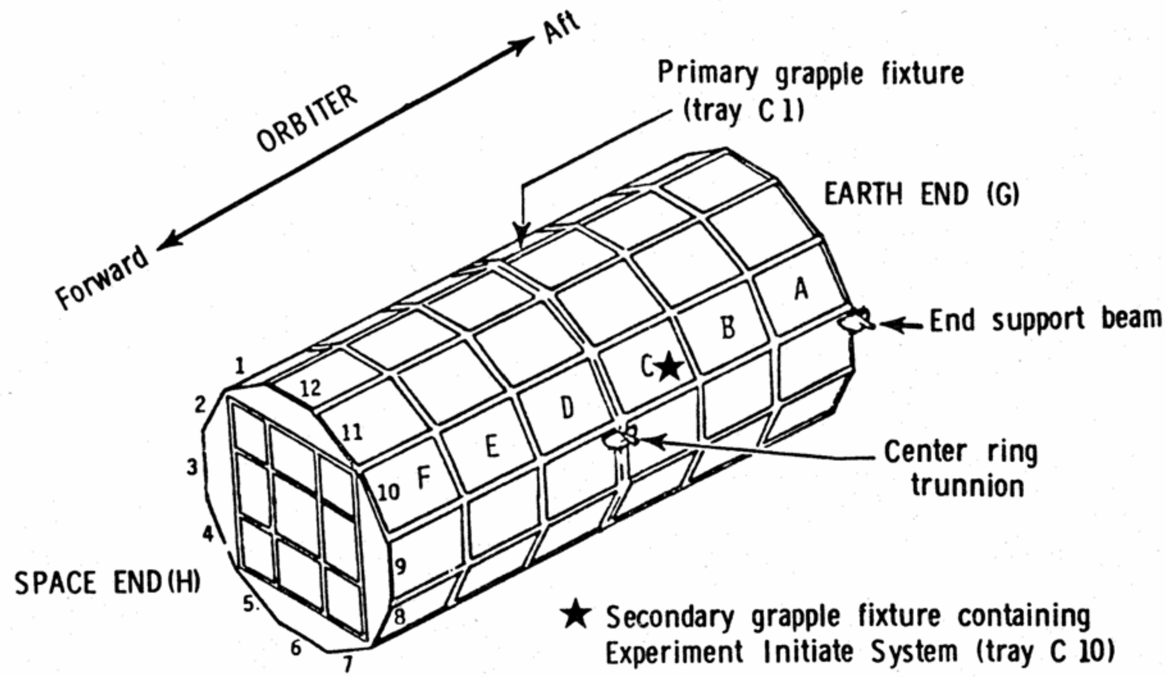
The low cost of an LDEF experiment--ranging from less than $10,000 to about $400,000--encourages high-risk/high-return and makes experiments particularly attractive to students and research groups with no experience in space experimentation. Investigators can take advantage of NASA and private industry expertise to develop relatively inexpensive investigations.

The LDEF structure was designed and built at the Langley Research Center, Hampton, Va. Experiment trays were provided to investigators, who built their own experiments, installed them in trays and tested them. To help reduce costs, each investigator established the amount of reliability, quality control and testing required to insure proper operation of his experiment.

After the experiments were completed, they were shipped to Kennedy Space Center for integration on LDEF. NASA is responsible for physical and engineering integration of the experiments with the structure, including various thermal, structural and safety analyses.

The LDEF project is managed by the Langley Center for NASA's Office of Aeronautical and Space Technology in Washington, D.C.

LDEF CONFIGURATION



★ Secondary grapple fixture containing Experiment Initiate System (tray C 10)

MANNED MANEUVERING UNIT

Resembling its ancestor flown inside the Skylab orbital Workshop in the early 1970s, the Manned Maneuvering Unit (MMU) is a self-contained backpack with nitrogen gas propulsion that will allow orbiter crews to move outside the payload bay to other parts of the orbiter or to other spacecraft. The MMU latches to the spacesuit (Extravehicular Mobility Unit-EMU) backpack and can be donned and doffed by an astronaut unassisted.

MMU controls follow the layout familiar to spacecraft crews: the left hand controller governs fore-aft, right-left, up-down translations, while the right hand controller handles roll, pitch and yaw motions. The controllers may be used singly or in combination to give a full range of movement within the operating logic of 729 command combinations, including attitude hold.

Thrust impulses are from 24 dry nitrogen gas thrusters each with 7.56 newtons thrust. Two 25-by-76 cm (9.8-by-30 in.) Kevlar filament-wrapped aluminum nitrogen tanks each hold 5.9 kg (13 lb.) of nitrogen when fully charged. Two 16.8-volt, 752 watt-hour silver zinc batteries supply MMU electrical power, enough for one six-hour EVA. The nitrogen tanks may be recharged in less than 20 minutes at the payload bay MMU service rack.

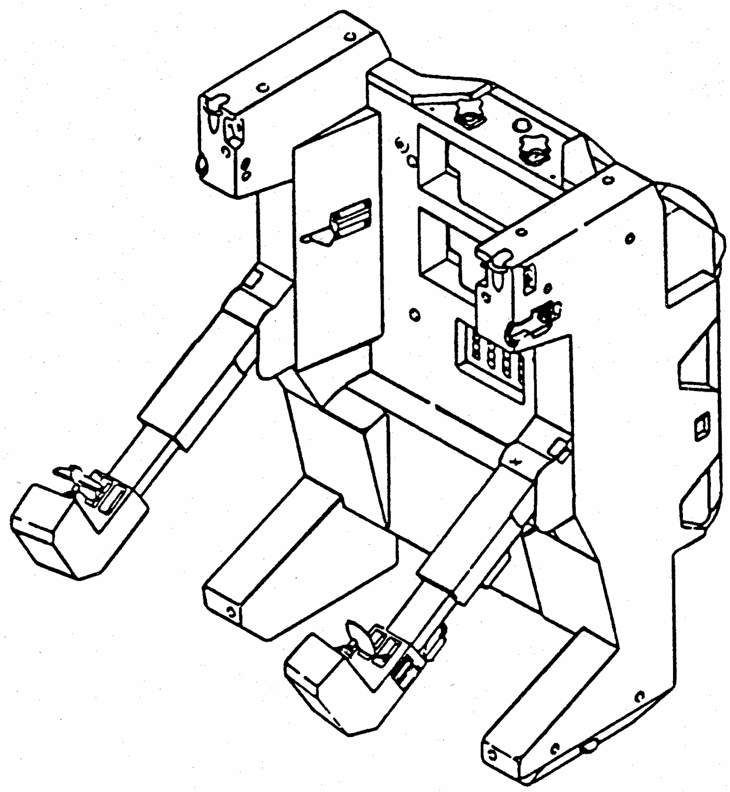
The MMU will have a 35 mm still photo camera operated by the astronaut during EVA/MMU operations.

The two MMUs are located in the forward section of the orbiter payload bay.

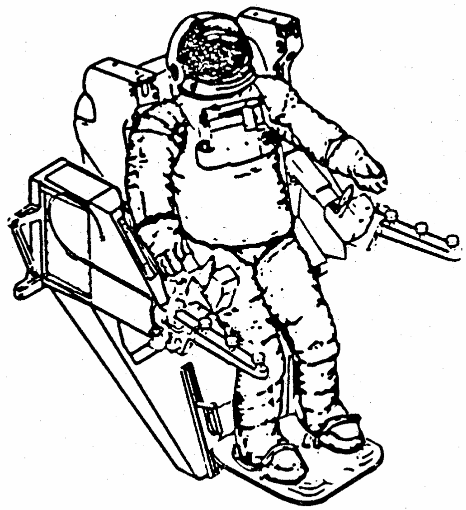
Built by Martin Marietta, Denver, Colo., the MMU is 1.2 m (49.4 in.) high, 81 cm (32.5 in.) wide, and 1.1 m (44.2 in.) deep with control arms extended. The MMU weighs 136 kg (300 lb.) when charged with nitrogen. With a space suited crewman and consumables added, on-orbit mass is about 335 kg (740 lb.).

Helmet Camera

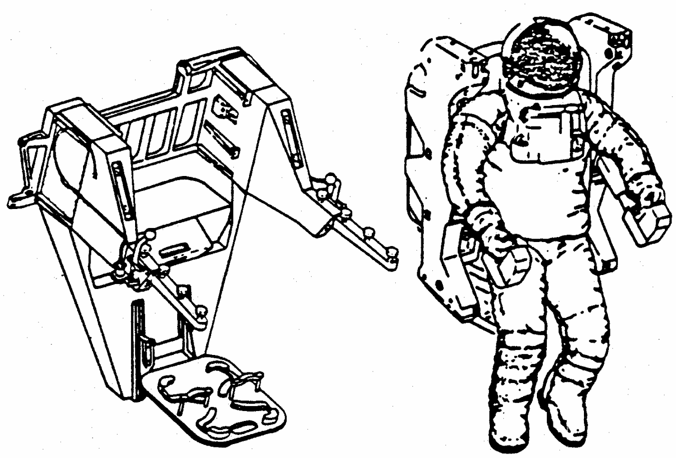
Each space suit will carry a small color TV camera attached to the EMU helmet. The hand-sized camera is solid state and housed above the helmet visor. It was developed for NASA by Fairchild Weston Systems Inc., of Syosset, N.Y.



MANNED MANEUVERING UNIT



Donning configuration



Egress/ingress

MANNED MANEUVERING UNIT/FLIGHT SUPPORT STATION INTERFACE

SOLAR MAXIMUM REPAIR MISSION

Background

The Solar Maximum Mission (SMM) observatory was launched on A Delta launch vehicle from Cape Canaveral on Feb. 14, 1980.

During its tenth month of operation and following extensive collection of data on solar flares and other solar activity, the spacecraft "blew" three hermetically sealed fuses in its attitude control system, forcing engineers at NASA's Goddard Space Flight Center, Greenbelt, Md., to develop a new attitude program.

Using torquer bars on board and taking advantage of the Earth's magnetic influence, they established the spacecraft in a sun-pointing mode that still permitted three of the seven instruments on board to collect data. Those three instruments are the Gamma Ray Spectrometer, the Hard X-Ray Burst Spectrometer and the Active Cavity Radiometer/Polarimeter.

The other four instruments are the Coronagraph/Polarimeter, which the astronauts hope to repair on Mission 41-C; the Ultraviolet Spectrometer and Polarimeter; the X-Ray Polychrometer; and the Hard X-Ray Spectrometer.

All four of those instruments require pointing accuracy from the spacecraft and could not function effectively with the spacecraft spinning through space with its longitudinal axis pointed toward the sun, as it has since the attitude control system failure.

Repairs to be made during the mission include replacing the attitude control system module, replacing the main electronics box on the Polarimeter/Polarimeter, and placing a cover over the gas vent of the X-Ray Polychrometer. Scientists are hopeful all seven instruments will regain their capability to collect data. However, because of electronics problems that had developed in the Hard X-Ray Imaging Spectrometer before the loss of the fuses, scientists feel they have only a 20 percent chance of obtaining 90 percent use of that instrument.

Repairs to the satellite will be conducted on flight days three and five. On flight day three, mission specialist George Nelson will fly out to the Solar Max satellite and stabilize it. Astronaut Terry Hart in the aft flight deck then can maneuver the orbiter's Remote Manipulator System (RMS) arm to grapple the ailing spacecraft and bring it into the Shuttle's payload bay. Nelson will fly out to the SMM using the Martin Marietta Manned Maneuvering Unit (MMU). The MMU's is a jetpowered backpack which proved so successful on the previous Shuttle mission (41-B) when operated by Bruce McCandless II and Robert L. Stewart.

Scenario for Repair

To conduct the repair mission, the Shuttle will have made a direct ascent to 260 nautical miles (299 statute miles). Following the deployment of the Long-Duration Exposure Facility on flight day two, commander Robert L. Crippen and pilot Dick Scobee will maneuver the Shuttle higher by another 4 to 10 miles, or to the altitude of the SMM, parking approximately 91 m (300 ft.) away from the Solar Max.

Before Nelson attempts to capture the spacecraft, engineers in the Payload Operations Control Center (POCC) at Goddard will deactivate the attitude control system on the spacecraft. The spacecraft will continue to spin; however, with the attitude control system deactivated, Nelson will have an easier time stabilizing the spacecraft.

When Nelson has stopped the spacecraft from spinning, Crippen and Scobee will move the Shuttle close (about 9 m or 30 ft.) to the Solar Max so Hart can reach out with the remote arm, grapple the satellite and maneuver it into the Flight Support System's cradle in the payload bay.

Solar Max is locked onto the cradle remotely by astronaut Hart, who will engage two umbilicals which provide electrical Power from the Shuttle to the Solar Max.

In the meantime, Nelson will remove the 153 kg (338 lb.) MMU and join astronaut James van Hoften, who also is conducting an Extravehicular Activity (EVA) and who has remained tethered to the Shuttle during Nelson's excursion out to the Solar Max.

In the cradle, the SMM will be tilted forward 25 degrees so its solar arrays will clear the orbiter tail as it is rotated and will provide better access to the attitude control system module.

Nelson and van Hoften then will position themselves to begin replacement of the faulty control system module.

To keep from floating away, van Hoften will secure his feet on a platform called a Manipulator Foot Restraint (MFR) attached to the end of the orbiter's mechanical arm. Nelson will be secured below on a Portable Foot Restraint (PFR).

Using a device known as the Module Service Tool (MST), van Hoften will unscrew two retention bolts, remove the module, and replace it with a spare module, which will have been fastened to the lower portion of the Flight Support System. Replacing the module is expected to take 45 minutes.

Then, the more difficult task of replacing the Main Electronics Box (MEB) on the Polarimeter/Polarimeter will begin. It is more difficult because the spacesuit gloves are bulky, and the exchange requires working with scissors and small screws.

During this EVA, van Hoften will pull back some thermal protection and install a hinge so that panel on the MEB can be opened like a door.

He is expected to remove all but four of the six screws which hold the panel closed, using an electric screwdriver. That activity will conclude the EVA for flight day three.

On flight day four, Challenger will be flown to 285 nautical miles (328 statute miles), an orbital altitude which is expected to give Solar Max two additional years of effective operations.

After receiving safety clearance from the Goddard Payload Operations Control Center, Nelson and van Hoften will make another EVA on flight day five. Van Hoften will unfold and tape back the protective thermal blanket, remove the remaining screws on the panel and secure it open with a special bracket. Van Hoften must now unscrew 22 screws, each with a head no bigger than one-eighth of an inch while wearing gloves that one might compare with boxing gloves. The screws hold 11 electrical connectors. Van Hoften will then have to cut some additional wiring before he can remove the electronics box.

The electronics box is removed and stowed in the FSS locker. A replacement unit will be moved into position, at which time Nelson and van Hoften will exchange roles. Nelson will remate the MEB's 11 electrical connectors with clips, eliminating the need to reinstall the previously removed screws. He then will remove the panel support bracket, close the panel door, secure the six panel screws, and reinstall the thermal protection.

Hart then will pick up Solar Max on the remote arm and hold it off to the side of the Shuttle, where engineers at Goddard will deploy the high-gain Tracking and Data Relay Satellite System (TDRSS) 1.27 m (50 in.) antenna on Solar Max and conduct some tests with the spacecraft's new attitude control system.
The

onboard computer system will have been reprogrammed completely between EVAs, with Goddard engineers having sent up and checked out 44,000 words of the spacecraft's 48,000-word memory.

The EVA astronauts will be able to witness movements of the spacecraft and of the antenna before they return to the Shuttle airlock.

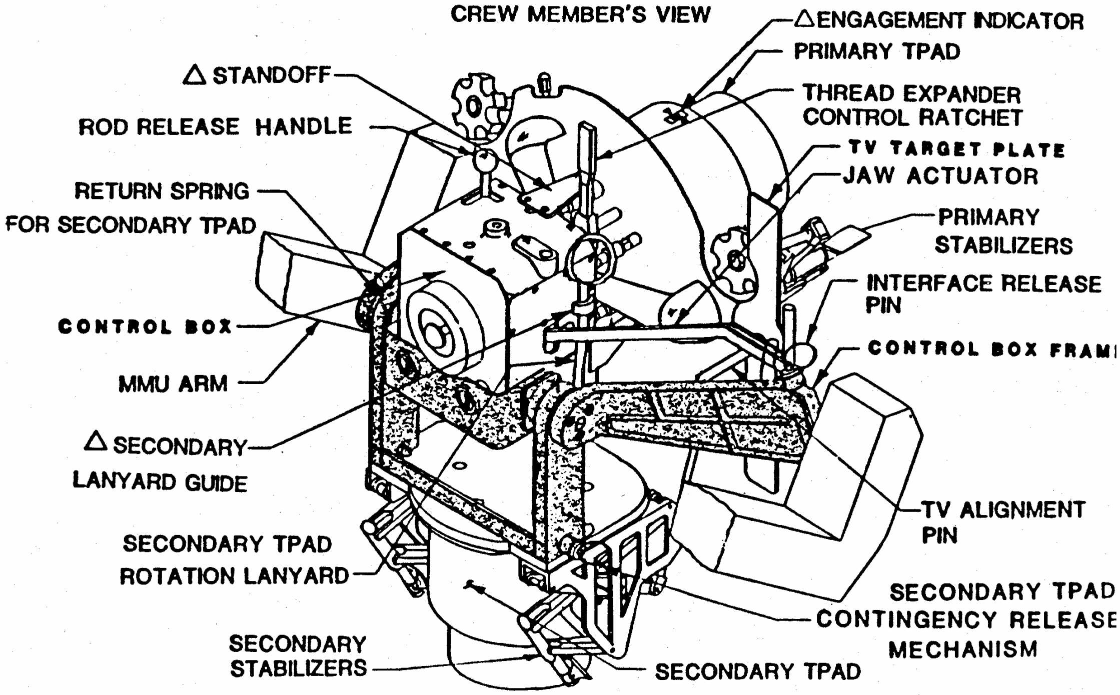
Re-Deploy

The Solar Max will remain on the arm outside the Shuttle payload bay throughout the night. The next day, Hart will position the spacecraft above the Shuttle, and -- after receiving word from Goddard that the spacecraft is "go" for release -- will gently drop it from the arm's grasp, placing it back in orbit. The Shuttle will station keep about 61 to 91 m (200 to 300 ft.) away for approximately two hours and will remain in relatively close proximity for a total of eight hours before the astronauts have to start preparations for reentry.

The spacecraft will undergo a checkout period of approximately 30 days before becoming operational again.

Cost of the repair mission has been estimated at about $48 million. The cost of a replacement satellite, including launch costs, would have amounted to an estimated $235 million.

TPAD ASSEMBLY



THE TPAD IS A T- SHAPED ASSEMBLY MEASURING APPROXIMATELY 20 INCHES BY 20 INCHES AT ITS GREATEST HEIGHT AND DEPTH.

TPAD ASSEMBLY MOUNTED ON MMU

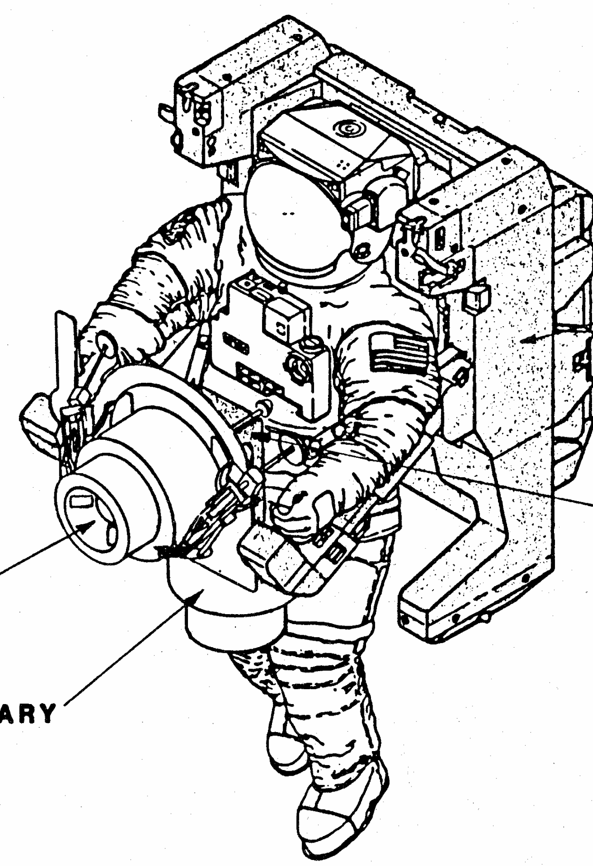
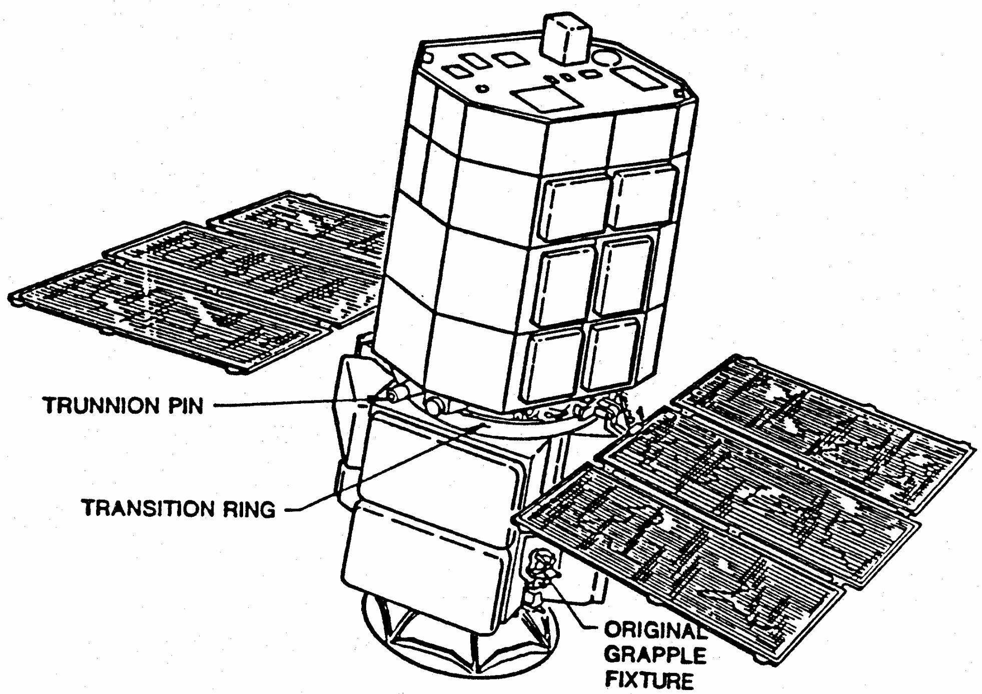


FIGURE 1 - SPACE SUITED EVA ASTRONAUT WITH TPAD AND MMU

SOLAR MAXIMUM MISSION SATELLITE (SMM)



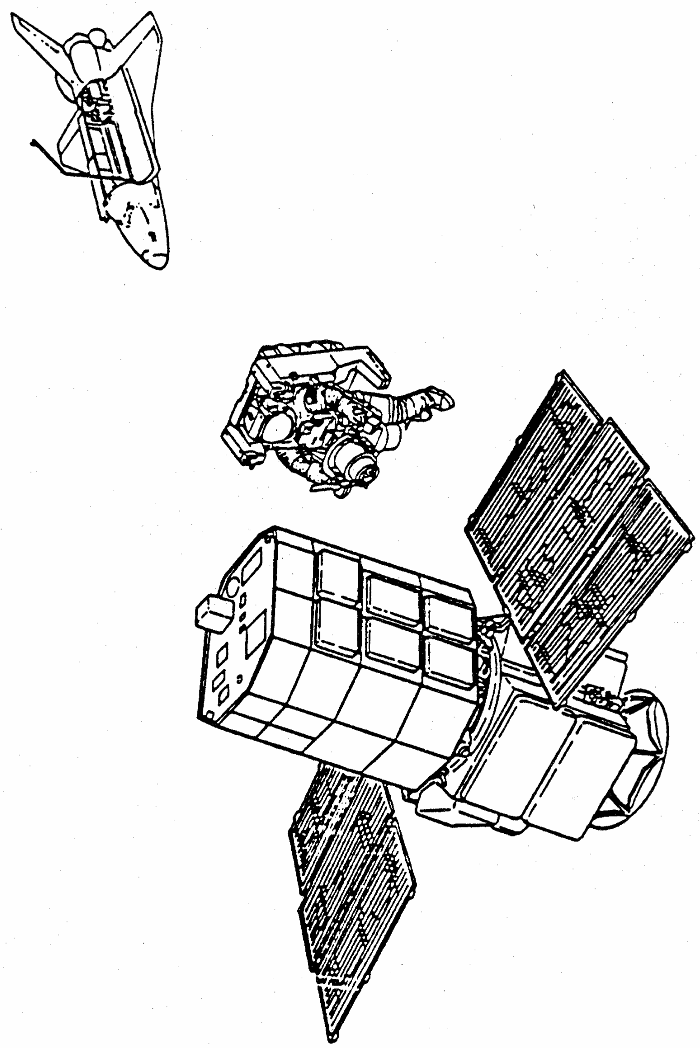
THE SMM TRUNNION PIN IS LOCATED IN A TRANSITION RING AT THE APPROXIMATE MID-POINT OF THE SATELLITE JUST BELOW THE SOLAR ARRAY PANELS AND EXTENDS APPROXIMATELY 4 INCHES BEYOND THE THERMAL INSULATION COVERING THE SATELLITE.

EVA-1 TIMELINE (Flight Day 3)

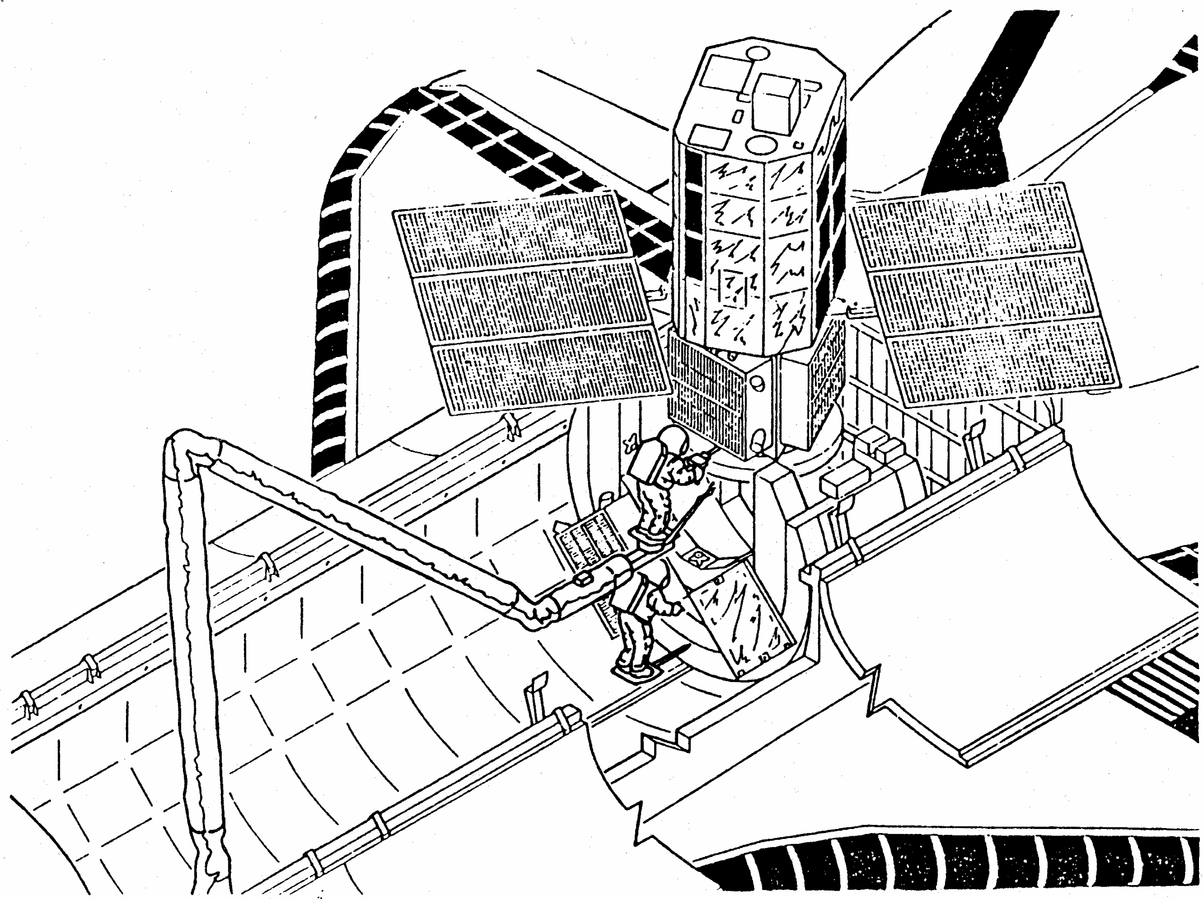
Time	EV-1 (Nelson)	EV-2 (van Hoften)
0:00	Airlock Egress (approx. MET 002:00:15)	Airlock Egress (approx. MET 002:00:15)
	MMU Prep and Checkout	TPAD Prep
1:00	Don T-Pad	
@ Orbital Sunrise	Translate to SMM Dock/Stabilize	Setup Equipment for ACS Module Replacement
	(RMS Grapple/Berth)	
2:00	Doff TPAD, MMU	Grapple MFR/Ingress
	Assist EV-2	ACS Module Replacement
3:00		
4:00		Begin MEB Replacement
	Stow Equipment	Stow Equipment
5:15	Ingress	Ingress

EVA-2 TIMELINE (Flight Day 5)

Time	EV-1 (Nelson)	EV-2 (van Hoften)
0:00	Airlock Egress (approx. MET 003:22:10)	Airlock Egress (approx. MET 003:22:10)
	Set up Tools on MFR	Grapple MFR/Ingress
l:00	Assist EV-2	Start MEB Replacement
2:00		
	Install new MEB	Remove old MEB
	(RMS Unberth SMM)	(RMS Unberth SMM)
4:00	Stow Equipment	MMU Test Flight
5:25	Ingress	Ingress

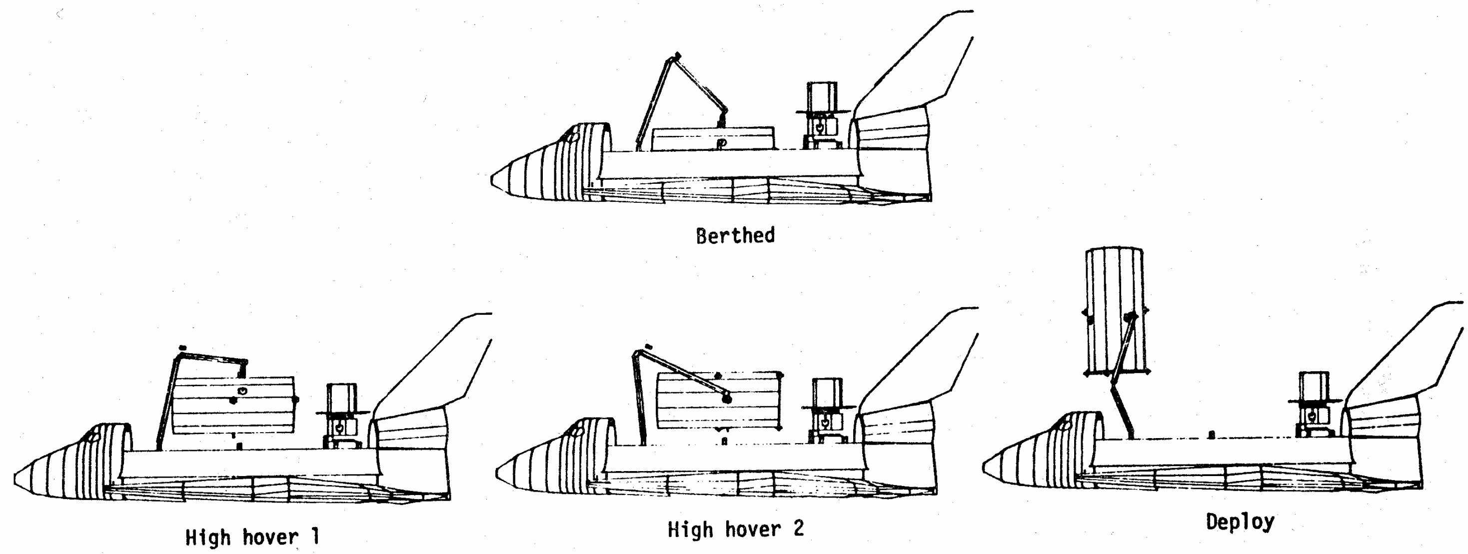


FLIGHT TO SMM

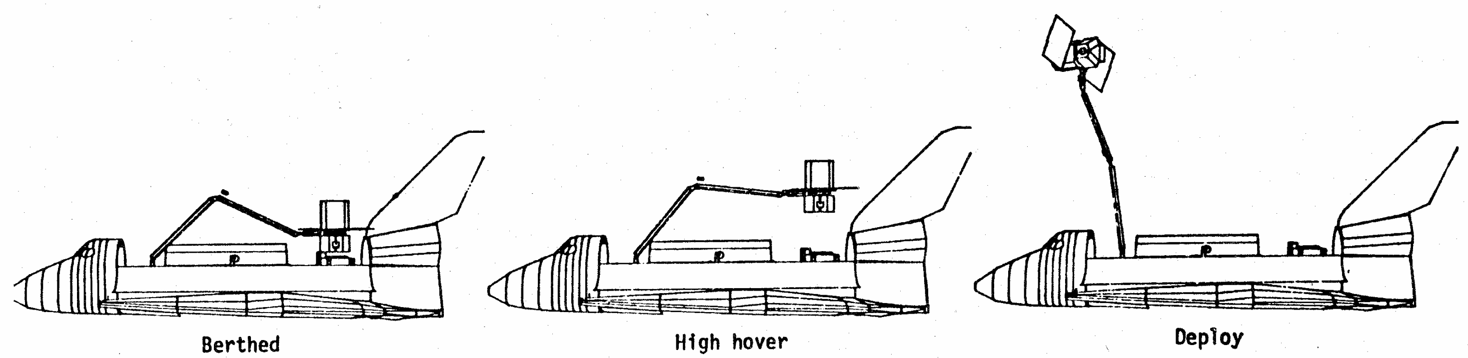


MODULE REPLACEMENT USING MANIPULATOR FOOT RESTRAINT

SMM DEPLOYMENT



LDEF deployment



SOLAR MAXIMUM MISSION
PAYLOAD OPERATIONS CONTROL CENTER (POCC)

When Shuttle 41-C crewmen repair the malfunctioning Solar Maximum Mission (SMM) satellite, the satellite's ground control center at the Goddard Space Flight Center in Greenbelt, Md., will play a major role in advising the astronauts about their mission.

The Shuttle flight will be the first to link a NASA remote control center to the Shuttle. As such, it becomes a milestone: the first expansion of NASA's satellite control capabilities to include servicing satellites in orbit.

The Solar Maximum Mission Control Room at Goddard has directed the SMM satellite since its launch in February 1980. Following the usual NASA pattern of one satellite-one control room, the facility is the only control room for the satellite and provides its entire ground support. This support ranges from directing its scientific observations to monitoring the health of its onboard systems.

So long as a satellite functions properly in orbit, these ground control capabilities are sufficient to insure years of successful operation. Ground controllers frequently solve minor systems problems afflicting satellites. However, the SMM has suffered major systems failures which, until the Shuttle, would have left it permanently crippled.

41-C requires a series of complex commands to the satellite synchronizing its activities with the astronauts' work. Thus, operations throughout the mission will be closely linked between the SMM control room at Goddard and Shuttle mission control at Johnson Space Center in Houston.

To support the Shuttle repair, the SMM control center has expanded from one to five rooms, and multiplied its capabilities accordingly. Together, the five rooms comprise the Solar Maximum Retrieval Mission's Payload operations Control Center (POCC). The center of POCC activity is the First Mission operations Room (MOR-A), which is the prime control room for coordinating satellite and crew activities.

Prior to astronaut retrieval of the SMM satellite, the MOR-A will disarm the satellite's pyrotechnics and command shut-down of its remaining attitude control system. These steps will make astronaut George Nelson's effort to stabilize the satellite before pick-up by the Shuttle's Remote Manipulator System safer and easier.

Before repairs begin in the Shuttle's cargo bay, ground controllers will shut down electrical power aboard the satellite. Following repair, they will verify the satellite's pointing accuracy.

Additionally, through the repair sequence, controllers will monitor the thermal condition of the satellite to insure it remains within tolerable limits.

Activities in the MOR-A will be directed by the Solar Maximum Repair Mission operations Manager, the POCC director and the POCC controller. Its staff includes three attitude control system engineers and a specialist for the main electronic box of the SMM's Polarimeter/Polarimeter instrument; a specialist for the SMM 's High-gain Antenna, which will be deployed to return future SMM scientific observations through the Tracking and Data Relay Satellite (TDRS); a communications and data handling engineer; a power system engineer; an onboard computer software engineer; and planning staff.

The MOR-A is linked to Johnson through Goddard's NASCOM (NASA Communications Network) utilizing commercial communications satellites. The control room can communicate directly with the SMM satellite both through Goddard's tracking network (including ground stations and the Tracking and Data Relay Satellite) and a Payload Interrogator (similar to a ground station) carried in the Shuttle's cargo bay.

The Shuttle POCC Interface (SPIF) via Houston receives such ancillary data from the orbiter as thermal and attitude data, which can be compared with similar values being reported by the SMM satellite. This redundancy provides a check, for example, against a misleading report of the satellite's temperature in the cargo bay, which would endanger its systems. The SPIF converts the Shuttle data to computer displays throughout the Payload operations Control Center for controllers monitoring the mission.

A Launch Control Room is responsible for monitoring the performance of the Flight Support System (FSS) in the Shuttle's cargo bay. The FSS will serve as the astronauts' workbase for SMM repairs, providing power and other services to the satellite while it sits passively aboard the Shuttle. Up to 12 people in the Launch Control Room monitor the FSS, ready to do structural analysis and find solutions if the FSS should fail.

The final room in the Payload operations Control Center for the Solar Maximum Retrieval Mission is the Launch Support Room -- a facility for updating continually the mission timetable. The Launch Support Room, staffed by two people, replans the satellite's activity timetable in 12-hour cycles according to mission progress.

Following the 41-C mission, the POCC will check out the performance of the repaired SMM satellite for approximately 30 days.

SHUTTLE STUDENT INVOLVEMENT PROGRAM

A colony of honey bees, about 3,300 in all, will be aboard the orbiter Challenger on flight 41-C. The purpose of the experiment is to compare quantitatively the size, shape, volume and wall structure of the honeycomb structures. The experiment will attempt to determine the characteristics of the hive construction of Apis mellifera honey bees in a zero-gravity environment.

Dan Poskevich, a student at Tennessee Technological Institute, Cooksville, Tenn., devised the experiment. He theorized that by comparing the structures built by a colony of honey bees in zero gravity and normal gravity environments generalizations may be formed for applications involving other populations of the order hymenoptra, bees, wasps, ants and related forms.

Honey bees have long been lauded for their selection of a six-sided - hexagon - cylinder as the structural unit that composes the honeycomb. Not only does the hexagon shape cell hold more honey than a triangular or square one, but it is also strengthened by its contact with adjacent cells. Two frames will be enclosed in a box measuring 22.84 by 22.84 by 22.84 cm (8.9 by 8.9 by 8.9 in.). Two cameras will be used to photograph each honeycomb frame continuously during construction. The environment will be controlled using timer-controlled lighting and temperature to simulate Earth conditions. A food supply will be located outside the hive section to supply water, pollen and nectar.

An Earth-bound control hive will be used for comparisons after the return of the zero-g hive from orbit.

Honeywell Inc., Minneapolis, Minn., is sponsoring the project and is providing technical support.

IMAX

On mission 41-C, one IMAX camera will be carried aboard the Challenger.

The IMAX camera is part of a joint project among NASA, the National Air and Space Museum, IMAX Systems Corp. of Toronto, Canada, and the Lockheed Corp. to produce a color motion picture of Shuttle flight operations from launch to landing. One 70 mm motion picture camera will be stowed in the middeck with several lenses, two loaded film magazines, and five rolls of reload film.

CINEMA 360

A Cinema 360 camera will be carried aboard the Challenger to provide motion picture photography for a unique format designed especially for planetarium viewing. The camera will be located in a canister in the Payload bay.

An Arriflex 35 mm Type 3 motion picture camera with an 8 mm/f2.8 "fisheye" lens will be used. The Cinema 360 camera, including an accessory handle and lens guard/support, weighs approximately 9.5 kg (21 lb.). A system power supply weighs an additional 7.7 kg (17 lb.).

The camera canister in the payload bay will provide film on exterior activities including EVA/ MMU operations, LDEF deployment or Remote Manipulator System operations. Lens focus, diaphragm setting and frame speed will be preset, thus requiring no light level readings or exposure calculations by the crew. The camera system will carry a 122-m (400-ft.) film magazine.

Filming done on this flight and 41-B and 41-D missions will be used in the production of a motion picture about the Space Shuttle program.

Cinema 360 is a consortium of four planetariums, located in Tucson, Ariz.; Jackson, Miss.; Reno, Nev.; and Chicago. The Gannett Foundation of Rochester, N.Y., has agreed to assume the costs of the film production.

STS-41C CREWMEMBERS

S83-46072 -- From left to right: Robert Crippen, crew commander; Terry Hart, mission specialist; James van Hoften, mission specialist; George Nelson, mission specialist; and Francis (Dick) Scobee, pilot.

BIOGRAPHICAL DATA

Commander: Captain Robert L. Crippen, USN

Crippen was selected as a NASA Astronaut in September 1969. He was the pilot on the first flight of the Space Shuttle (STS-1) on April 12-14, 1981 and commander of the STS-7 flight, June 18 - 24, 1983. He received his bachelor's degree in aerospace engineering from the University of Texas in 1960 and became a Naval Aviator in June 1962.

Pilot: Francis R. "Dick" Scobee

Scobee was selected as a NASA Astronaut in January 1978. He received his bachelor's degree in aerospace engineering from the University of Arizona in 1965. A U.S. Air Force pilot, he had a combat tour in Vietnam and graduated from the Air Force Test Pilot school in 1972. He has logged more than 5,300 flight hours in 40 types of aircraft.

Mission Specialist: Dr. George D. Nelson

Nelson was selected as a NASA Astronaut in January 1978. He received his bachelor's degree in physics from Harvey Mudd College, Claremont, Calif., in 1972 and a master's and a doctorate in astronomy from the University of Washington in 1974 and 1978, respectively.

Mission Specialist: Terry J. Hart

Hart was selected as a NASA Astronaut in January 1978. He received his bachelor's degree in mechanical engineering from Lehigh University, Bethlehem, Pa., in 1968, a master's degree in electrical engineering from Rutgers University, New Brunswick, N.J., in 1978. He was an Air Force pilot from 197O to 1973 and is currently flying with the Texas Air National Guard.

Mission Specialist: Dr. James D. Van Hoften

Van Hoften was selected as a NASA Astronaut in January 1978. He received his bachelor's degree in civil engineering from the University of California, Berkeley, in 1966, a master's degree in hydraulic engineering and a doctorate in fluid mechanics from Colorado State University in 1968 and 1971. He became a Naval aviator in 1970 and flew combat missions in Southeast Asia. He is a Naval Reserve pilot with more than 1,800 flight hours. He has published several papers on turbulence, waves and cardio-vascular flows.

SHUTTLE FLIGHTS AS OF MARCH 1984

10 TOTAL FLIGHTS OF THE SHUTTLE SYSTEM

STS-9 11/28/83 - 12/08/83	
STS-5 11/11/82 - 11/16/82	
STS-4 06/27/82 - 07/04/82	STS-41B 02/03/84 - 02/11/84
STS-3 03/22/82 - 03/30/82	STS-8 08/30/83 - 09/05/83
STS-2 11/12/81 - 11/14/81	STS-7 06/18/83 - 06/24/83
STS-1 04/12/81 - 04/14/81	STS-6 04/04/83 - 04/09/83
OV-102 **Columbia** **(6 flights)**	**OV-099** **Challenger** **(4 flights)**