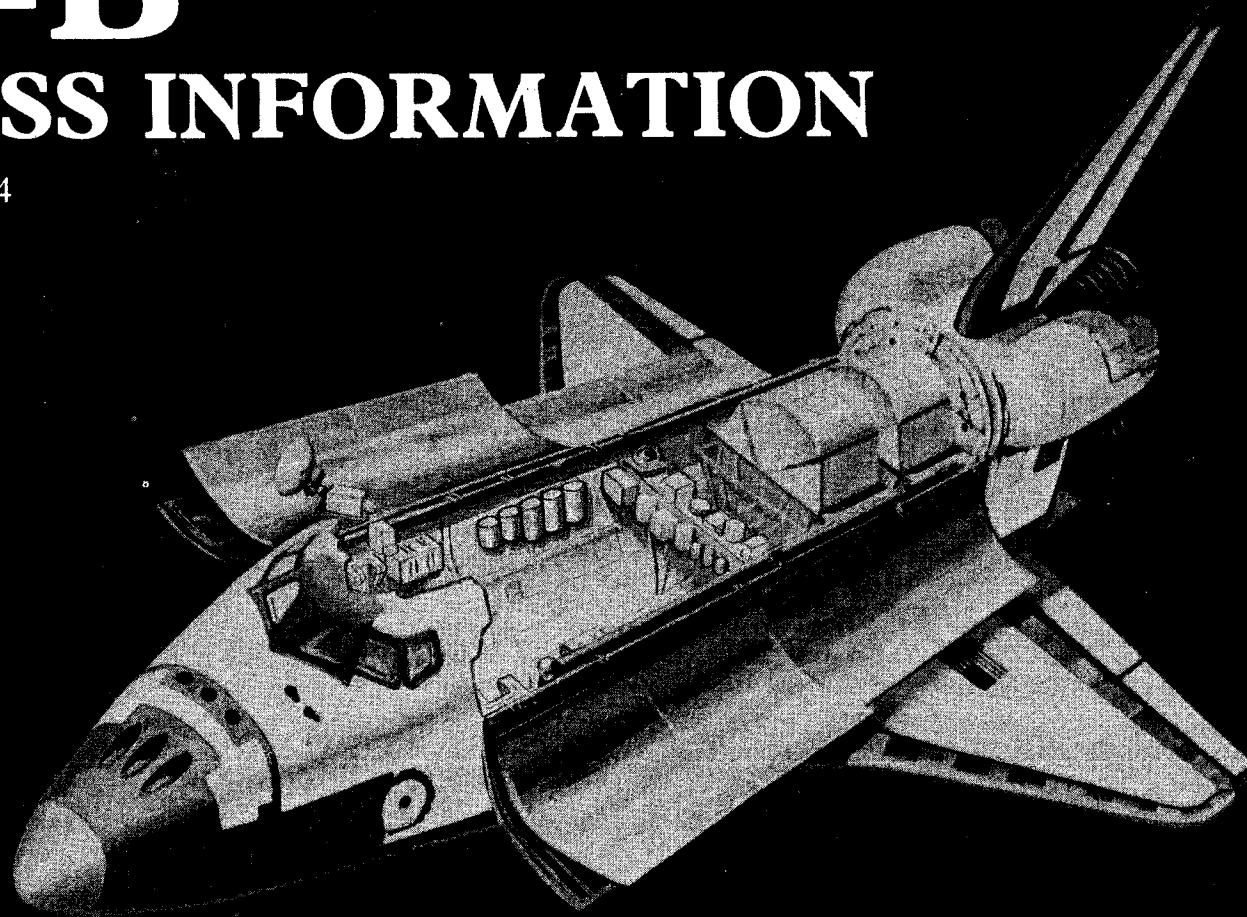


# 41-B

## PRESS INFORMATION

January 1984



*Office of Public Relations*



**Rockwell International**

Space Transportation &  
Systems Group



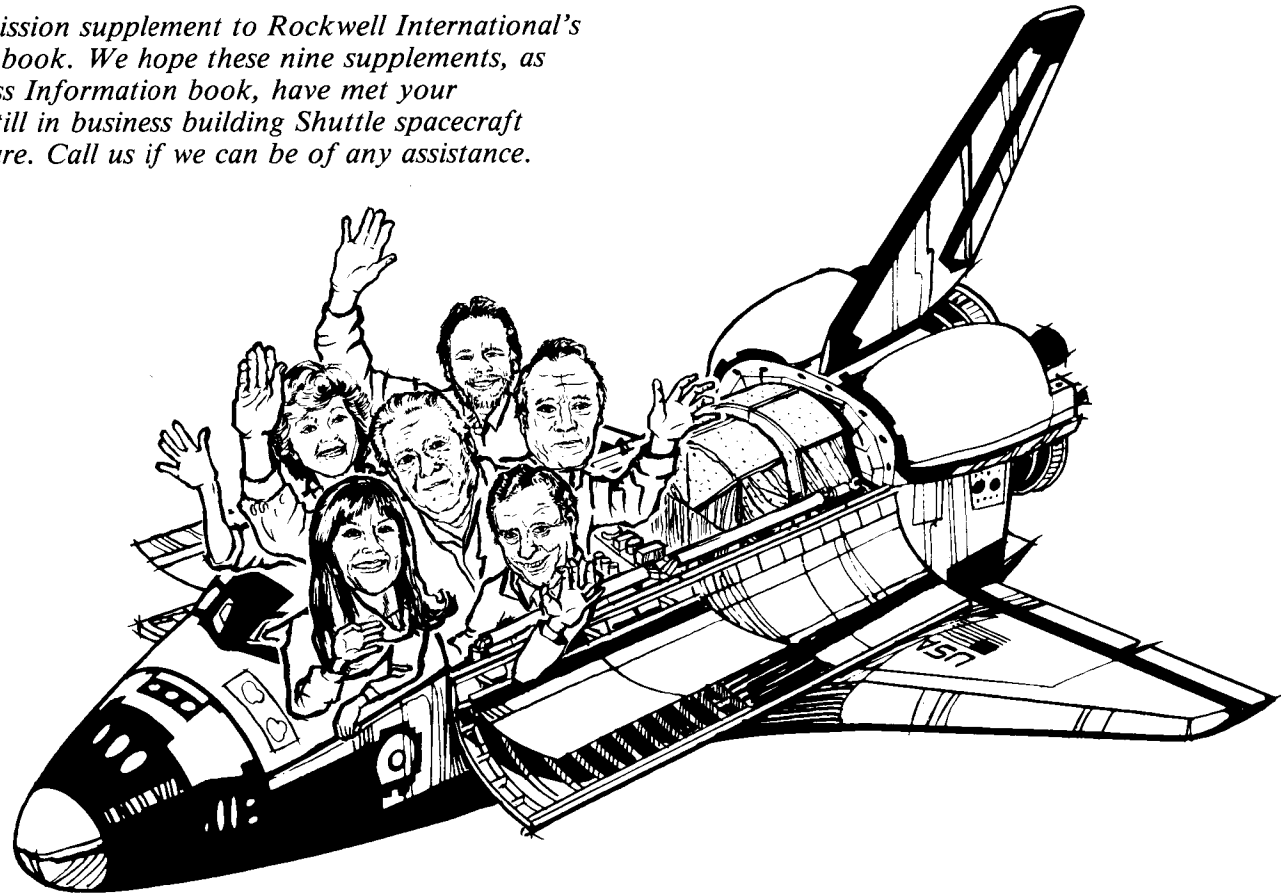
# 41-B

## PRESS INFORMATION

*This is our final STS mission supplement to Rockwell International's STS Press Information book. We hope these nine supplements, as well as the original Press Information book, have met your requirements. We are still in business building Shuttle spacecraft and other space hardware. Call us if we can be of any assistance.*

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## NEWS About Space Flight

...it comes from Rockwell International

Mission 41-B (STS-11), the tenth in America's Space Shuttle Transportation System program and the fourth flight into Earth orbit by the Rockwell International-built spaceship *Challenger*, further punctuates...with exclamation marks...what "man in a reusable spacecraft" really means.

This seven-day, 23-hour and 21-minute long mission with its astronaut crew of five, has a work schedule that calls for flexibility....flexibility in crew and spacecraft.

The first two days are STS operational—deployment of two communications satellites; one commercial, the other for a foreign government.

The WESTAR VI will be deployed from *Challenger's* cargo bay about eight hours after lift-off. With the WESTAR satellite is a PAM-D booster which, after deployment will be ignited sending the latest generation (Western Union) communication link into geosynchronous orbit (22,300 miles altitude).

On the second day, PALAPA-B2, for the government of Indonesia, will be deployed from *Challenger* and boosted into the higher circular orbit.

The third day and fourth are "flight test," primarily devoted to testing out the spacecraft's rendezvous radar system and star trackers. A balloon, called the Integrated Rendezvous

Target (IRT) will be inflated and deployed. Two separate tests will be made.

On the fifth and seventh days, it is "flight test" and "dress rehearsal." Astronaut mission specialists Bruce McCandless and Robert Stewart will make EVAs (extravehicular activity—space walk) testing the Manned Maneuvering Units (MMUs) which has gaseous nitrogen thrusters for controlling three axis attitudes and propulsion during non-tethered "free flight." During the seventh day, the MMU will be flown out to a distance of 300 hundred feet from the spacecraft.

The 41-B mission's sixth day will be primarily devoted to working with the Remote Manipulator System (RMS), its 50-foot-long arm and the SPAS-01A (Shuttle Pallet Satellite) which has previously flown on the STS-7 mission. SPAS-01A in "dress rehearsal" fashion, is a stand-in for the Solar Maximum Mission (SMM) satellite.

The Solar Max, designed to investigate the phenomenon of solar flares from near Earth orbit, was launched in February 1980 and late that year apparent blown fuses caused a failure of its attitude control module.

The next flight of *Challenger*, 41-C mission (STS-13), this spring is scheduled to rendezvous with the SMM at its 310-mile circular orbit, and a crew member will use the MMU to reach the satellite and attempt to stop its slow and wobbling spin so

that the spacecraft's RMS arm can attach itself to the 5,000-pound, 13-foot-long satellite. The Solar Max does have a grapple device located on its structure.

During the "dress rehearsal," the SPAS-01A will be spun by the rotating wrist of the RMS arm at a speed of about one degree a second, which is similar to the spin rate of the Solar Max. This will give the free flying crew member on this mission a test on rendezvous and docking procedures.

The Solar Max would be berthed in the *Challenger's* cargo bay, if all goes well during this spring's mission, a replacement attitude control module would be installed on the satellite along with an electronic box replacement. If all checks out, Solar Max would then be redeployed to do its job.

In this 41-B mission, in addition to the two communications satellite payloads, *Challenger's* cargo bay has five Get-Away Special canisters, a CINEMA 360-degree-wide field of

view camera, two MMUs (the EVA suits are in the airlock), and various assemblies and equipment used in the testing and dress rehearsal.

In the *Challenger's* crew compartment mid-deck are the Monodisperse Latex Reactor (MLR) and Isoelectric Focusing (IEF) experiments, a CINEMA 360-degree camera, an animal enclosure module (six rats) and an Acoustic Containerless Experiment System (ACES).

Vance Brand is the 41-B Mission spacecraft commander with Robert Gibson as pilot. Ronald McNair along with McCandless and Stewart, is the third mission specialist.

*Challenger* again is scheduled to be the first Shuttle spacecraft to land back at the Kennedy Space Center, Florida. On the STS-7 mission the KSC landing was programmed, but weather conditions redirected it to a landing at Edwards AFB, California.



# NEWS About Space Flight

...it comes from Rockwell International

## 41-B MISSION STATISTICS

Launch: Friday, February 3, 1984

8:00 A.M. E.S.T.  
7:00 A.M. C.S.T.  
5:00 A.M. P.S.T.

Payload Weight "Down": Approximately 6,662 kilograms  
(14,687 pounds)

Mission Duration: 168 hours (7 days), 23 hours, 21 minutes,  
35 seconds

Landing: Saturday, February 11, 1984,  
Orbit No. 128

7:21 A.M. E.S.T.  
6:21 A.M. C.S.T.  
4:21 A.M. P.S.T.

Payloads:

PAM-D/PALAPA B-2  
PAM-D/WESTAR VI  
SPAS-01A  
Getaway Specials (5)  
Integrated Rendezvous Target  
Acoustic Containerless Experiment System  
Manipulator Foot Restraint  
Isoelectric Focusing  
CINEMA 360 Cameras  
Monodisperse Latex  
Reactor  
Manned Maneuvering  
Unit (2)  
Animal Enclosure Module  
Cargo Bay Stowage Assembly  
Special Equipment Stowage  
Assembly

Inclination: 28.45 degrees

SSME Throttling: 104 to 75 to 104 to 3 "g" limit to  
65 percent

Spacecraft Altitude in Orbit: 165 nautical miles (189 statute  
miles), then to 170 by 165 nautical miles (195 by 189 statute  
miles), then to 176 by 165 nautical miles (202 by 189 statute  
miles), then by 155 nautical miles (202 by 178 statute miles),  
then to 155 by 155 nautical miles (178 by 178 statute miles),  
then to 152 by 152 nautical miles (174 by 174 statute miles)

Payload Weight "Up": Approximately 13,501 kilograms  
(29,766 pounds)

Entry Angle of Attack: 40 degrees

#### Crew Members:

Commander (CDR) Vance Brand  
Pilot (PLT) Robert Gibson  
Mission Specialist (MS)-3 Bruce McCandless  
Mission Specialist (MS)-2 Robert Stewart  
Mission Specialist (MS)-1 Donald McNair

#### Extravehicular Activity (EVA) Crew Members

EV-1 Bruce McCandless

EV-2 Robert Stewart

#### Crew Seating and Activities:

CDR — Left Seat — Mission success, vehicle and crew safety, data processing system, guidance navigation and control, environmental control life support system, rendezvous and intravehicular (IV)-1 crew member.

PLT — Right Seat — Payload deployment retrieval system (PDRS), SPAS (Shuttle Pallet Satellite)-01A systems, HP-41 programs, EVA communication, inflight maintenance and all *Challenger* systems except data process-

ing system, environmental control life support system and caution and warning.

MS-1 — middeck — ascent only — PAM-D/WESTAR IV, PDRS, all experiments (including SPAS-01A), closed circuit television/video tape recorder and all movies (including CINEMA 360) and integrated rendezvous target (IRT)

MS-2 — flightdeck — center seat — ascent and entry — PAM-D/PALAPA-B2, EV-2 and radiation monitoring equipment.

MS-3 — middeck — entry only — communication, caution and warning, EV-1 rendezvous, still photography, visual observations, grid, HP-41 loading and laser ranging.

Crossrange: 565 nautical miles (650 statute miles)

Entry: Will use automatic system until subsonic, then use Control Stick Steering

Runway: Runway 33, Kennedy Space Center, Florida

4

### FLIGHT TEST AND MISSION OBJECTIVES

#### FLIGHT TEST

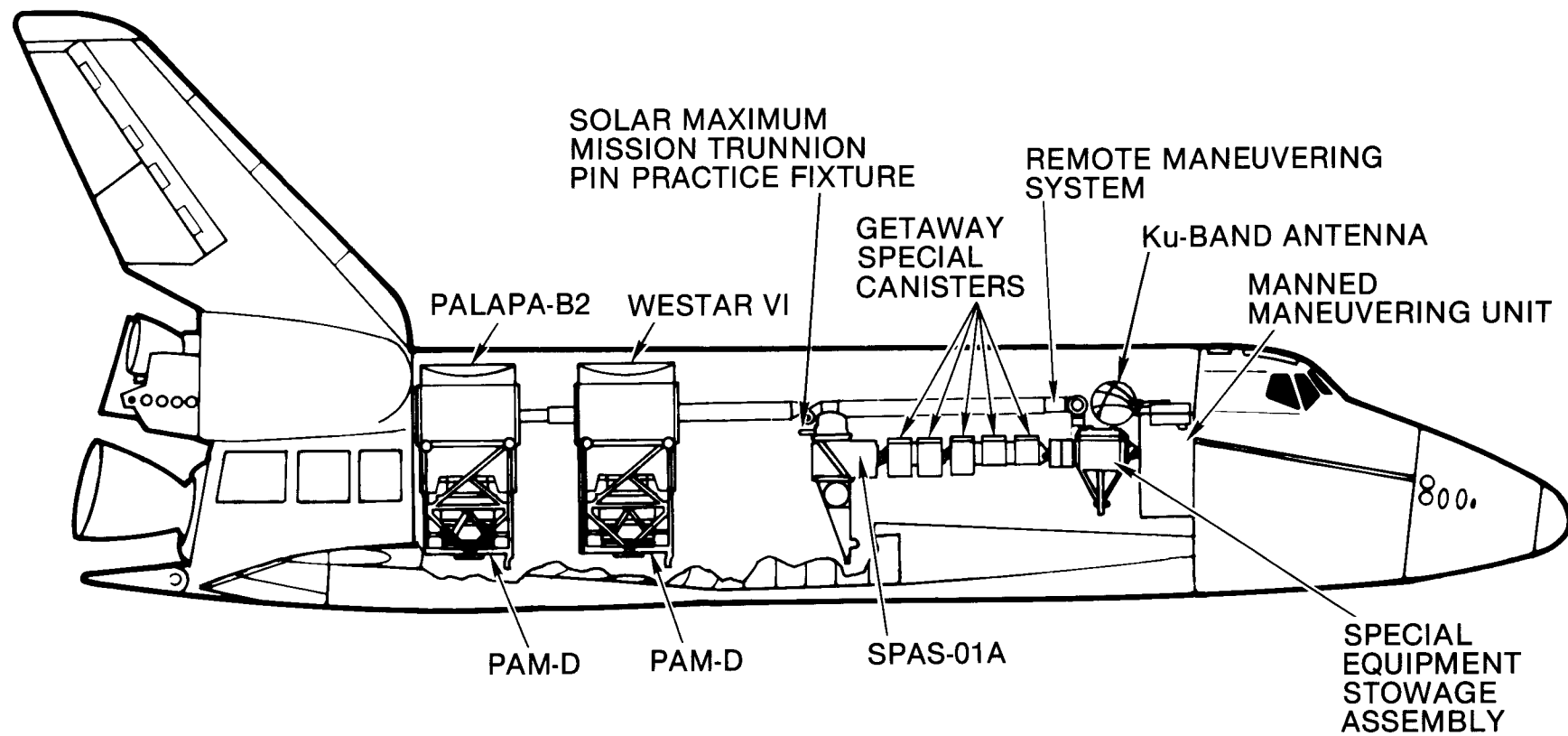
- External tank and solid rocket booster ascent performance
- External tank thermal protection system performance
- Solid rocket booster recovery
- Ascent structural capability evaluation
- Ascent compartment venting evaluation
- Crew module thermal evaluation
- POGO stability performance
- Crew compartment structural deflection test
- Shuttle payload low frequency model verification
- Orbital maneuvering system to reaction control system interconnect test
- Elevon trailing edge heating evaluation
- Entry programmed test inputs test No. 7
- Entry with lateral center of gravity offset test No. 4

- Descent compartment venting evaluation
- Reinforced carbon-carbon thermal protection system life evaluation

#### **MISSION OBJECTIVES**

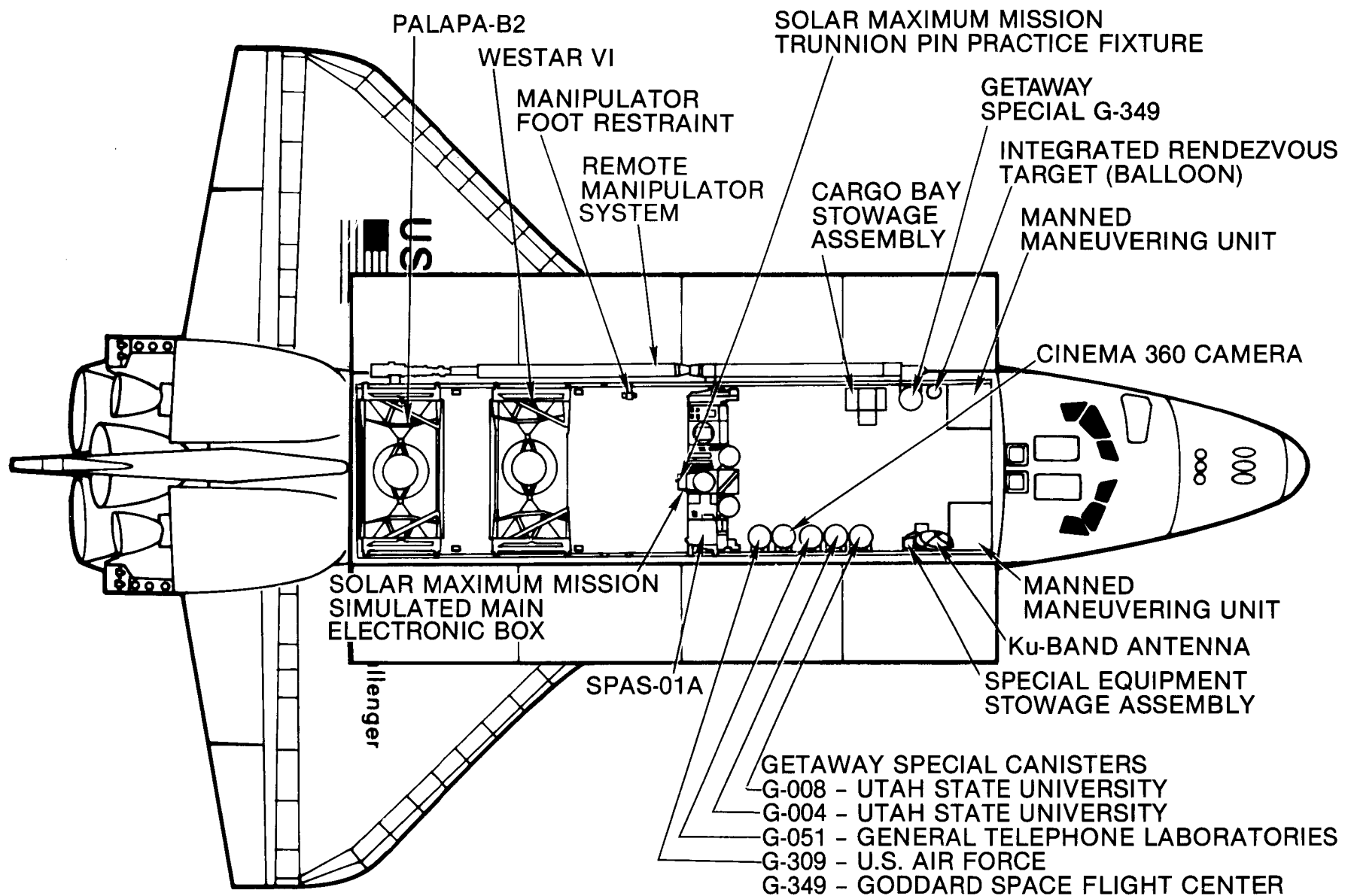
- Upper stage plume damage model verification
- Cabin atmosphere verification
- Manned maneuvering unit capability demonstration
- Manipulator foot restraint evaluation
- Extravehicular activity fluid transfer connector valve demonstration
- Rendezvous systems and sensors performance short range
- Rendezvous systems and sensors performance long range
- Atmosphere drag/density studies
- Cardiovascular deconditioning assessment
- Tracking and data relay satellite navigation test
- Radiation monitoring equipment (RME)
- Validation of predictive tests and countermeasures for motion sickness
- Closed circuit television laser ranging test
- Deployment of PALAPA B-2 satellite
- Deployment of WESTAR VI
- SPAS (Shuttle pallet satellite)-01A experiments
- Monodisperse latex reactor (MLR) experiment
- Isoelectric focusing (IEF) experiment
- Acoustic containerless experiment system (ACES)
- Cinema 360 Incorporated cameras
- Animal enclosure module
- Get-away-special (GAS) containers
- Integrated rendezvous target (IRT), first rendezvous conducted by Space Shuttle
- First landing at Kennedy Space Center, Florida

## 41-B PAYLOAD CONFIGURATION



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*41-B Payload  
Side View*



41-B Payload  
Top View

## MODIFICATIONS TO *CHALLENGER* FROM STS-8 TO 41-B

- Cryo heater control assembly box modification removes heater power from that cryo system in the event of a shorted heated circuit
- Installation of Special Equipment Stowage Assembly (SESA) at starboard bay 2 location in payload bay
- Payload structural support hardware in payload bays 6, 9, 10, 11, 12 and 13
- Modification of thermal control system blankets in payload bay longeron sill area to permit addition of stability links in bays 6, 9, 10, 11, 12 and 13 under longeron sill blankets
- Reconfigure hydraulic pressure line system No. 2 to eliminate interference with the body flap power drive unit insulation heater blanket
- Motor control assembly changes to improve electrical controls for the external tank umbilical doors and reaction control system crossfeed valves
- Improved water (H<sub>2</sub>O) isolation valve for vibration spectrum installed in environmental control life support system bay beneath crew module mid deck floor
- Addition of identification and clarifying nomenclature to T-0 umbilical connector panel
- Improves the orbiter landing capability by redesign of the main landing gear strut metering pin for the anticipated operational conditions
- Addition of wiring and two S-band power amplifier temperature measurements the operational instrumentation (OI) telemetry
- Removal of two substack fuel cell power plants and replace with three substack fuel cell power plants
- Lightning protection for the external tank umbilical area with replacement of aluminum plate in lieu of a titanium plate which will provide a good conductive path in external tank umbilical area and provided wire cables constructed of double shielded wire for the orbital maneuvering system/reaction control system pod “doghouse” area
- Modification of environmental control life support system freon to water (H<sub>2</sub>O) flow proportioning module
- Relocate overhead docking floodlight from the crew module overhead structure to the forward end of the payload bay at station X<sub>O</sub> 582
- Change screw in attitude direction indicators for inflight maintenance by flight crew
- Addition of heaters to main landing gear brake hydraulic lines
- Provide drainage of the wing glove area (both sides) into the mid fuselage at X<sub>O</sub> 807 bulkhead
- Modification of orbiter to support manned maneuvering unit (MMU) on orbiter port side in payload bay 1. Also provides electrical power for MMU heaters, gaseous nitrogen supply from orbiter gaseous nitrogen system for MMU recharging and display and downlink of seven temperature measurements. Addition of hand hold on orbiter X<sub>O</sub> 576 bulkhead
- Addition of second MMU accommodations on starboard side in payload bay 1. Also provides electrical power for second MMU heaters, gaseous nitrogen supply from orbiter gaseous nitrogen system for MMU recharging from port side and display and downlink of seven temperature measurements, addition of hand hold on orbiter X<sub>O</sub> 576 bulkhead

- Provide a bumper kit to the environmental control life support system freon loop/radiator interface area to prevent damage to extravehicular slidewire damage when payload bay doors are closed in a one “g” environment
- Install power reactant storage distribution cryo O<sub>2</sub> tanks with stronger fill tubes
- Addition of a different five volt excitation to the SRB (solid rocket booster) SEP (separation) switch for additional redundancy
- Replace all three side hatch window panes with optical quality glass for photographic purposes
- Provides accommodations for Ku-band to be hinged out and mount payload bay switch assembly on an indexing plate which mounts to a fixed plate on the bulkhead and allows full size payload installation
- Changes DP/DT sensor emergency Klaxon alarm limit from -0.05 PSI to -0.08 PSI to eliminate nuisance alarms
- Rework of motor control assemblies No. 2 and 4, addition of wiring, fuses and switch to display and control panel R13A2 to prevent damage during Ku-band antenna deployment and stowing
- Modify the main propulsion system gaseous oxygen flow control valve to incorporate ignition resistant Inconel 718 internal sleeve and seal/poppet assemblies
- Redesigned bracket and strap on crew module aft bulkhead to eliminate large openings between the on orbit console and A2 panel, prohibiting debris transit
- Closeout on upper sill longeron, angles and closeout panels at forward overhead commanders and pilots crew station in crew module
- Install RF switch, coax cables, harnesses and coax stowage device and new switch on panel A1A3 to route extravehicular mobility unit (EMU) TV system from S-band hemispheric antenna through S-band antenna switch to the government furnished equipment (GFE) video processor
- Replace modular auxiliary data system (MADS) pulse code modulation (PCM) multiplexer with upgraded design
- Rework crew module flight deck aft sidewall cover panels to preclude interference with wire harnesses
- Install closed circuit television cameras in payload per NASA manifest
- Addition of thermal control system blanket in the area of power reactant storage distribution system cryo tank set No. 3 to isolate the hydraulic and flash evaporator system water lines from the LO<sub>2</sub> and LH<sub>2</sub> cryo tanks
- Install fiberglass brackets on both left and right hand hydraulic brake lines
- Upgrade of star tracker light shade screw
- Remove and replace operations recorders and payload recorder
- Modification of tiles adjacent to reinforced carbon-carbon nose cap and install gap fillers and flow restrictors
- Remove and replace orbiter external tank ullage pressure signal conditioners with upgraded signal conditioners
- Install a resistor assembly box on each fuel cell power plant in order to monitor the end cell heater “on” measurements
- Upgrade of engine interface units (EIU’s)

- Inspection of four brazed sleeves in the forward reaction control system panel assembly
- Redesign of solenoid control valve on body flap power drive unit to eliminate braze joint
- Advanced flexible reusable surface insulation (AFRSI) test panels installed on upper forward fuselage, orbital maneuvering system/reaction control system pod sidewall left hand pod only, left hand side of vertical tail and left hand side of rudder/speed brake
- Beef-up of wet trash stowage volume F access door on crew compartment mid deck floor to support walk-on in one “g” environment (is not a problem on orbit or in one “g” environment when ground support equipment flooring is used)
- Relocate upper switch beam antenna, docking light and floodlight wiring below X<sub>O</sub> 576 bulkhead insulation to prevent potential damage during extravehicular activity
- Provide modification of water pump beam to water pump clearance in crew compartment below mid-deck floor
- Redesign of S-band switch beam antenna’s (4) internal mounting assemblies by adding higher tensile strength screws and bushings
- Installation of government furnished equipment galley, revise Volume “D” door (mid-deck floor) to allow on orbit access with only two stowage lockers removed, sleeping bags, shorten waste management curtain rods by two inches to allow proper positioning with galley installed
- Adds measurements from each of the three TACAN’s to the operational instrumentation telemetry
- Removal and replacement of hatch latch bearings on side hatch and airlock hatches
- Modification of forward orbiter external tank attach bolt
- Manipulator controller interface unit (MCIU) mounting bracket modification
- Deletion of Window 1 and Window 6 16mm camera brackets as cameras are in stowage locker for launch and entry
- Heads-up display improved symbology
- Redesign of aft Window 7 window fairing to accommodate water (H<sub>2</sub>O) coolant line and permit inflight maintenance (removal) of aft flight deck attitude direction indicator
- Modification of orbiter hatch “O” ring seals to preclude seal sticking to mating surface
- Addition of quick shoe camera mounts
- Modification on inboard edge tiles of right hand and left hand outboard elevons
- Changes in orifice control size for cabin air cooling system
- SPAS umbilical separation, retraction and retention system utility kit
- Mid fuselage barrel nut retention device
- Tack-welded in orifices in water spray boilers
- Replace four rudder/speed brake LI-900 tiles with FRCI-12 tiles
- Change out fastening device on EVA reel stowage container cover from snaps to turn buttons
- Upgrade and modification of aft power controller assemblies (PCA’s) 1, 2 and 3

- Authorize engineering effort on site at KSC for STS-11 and is closed after launch
- 37 wing strain gages with associated wiring and signal conditioning connected to modular auxiliary data system (MADS)
- Deletion of portable foot restraint booms
- Addition of electrical grounding to the galley
- Waste collection system insulation (accomplished at General Electric)

NOTES: The galley is installed in the crew compartment mid-deck

The remote manipulator system and Ku-band antenna are installed

A second hydrogen (H<sub>2</sub>) separator has been added in series to existing H<sub>2</sub> separator in the potable water line for removal of H<sub>2</sub> from potable water

A third extravehicular mobility unit (EMU) is stowed in the airlock

The text and graphics system is not installed. A

spare computer is carried in its place in avionics bay 3B

For the two scheduled extravehicular activities, the crew compartment depressurization and prebreathe sequence will be as follows:

The crew compartment cabin pressure is allowed to decrease from 14.7 PSIA to 12.5 PSIA through metabolic usage

One hour prior to depressurizing the crew compartment from 12.5 PSIA to 10.2 PSIA, mission specialists Bruce McCandless and Robert Stewart will don the launch and entry helmets and prebreathe 100 percent oxygen for one hour

The crew compartment cabin is then depressurized from 12.5 PSIA to 10.2 PSIA and will remain at this pressure for at least 12 hours minimum

Prior to the extravehicular activity by mission specialists Bruce McCandless and Robert Stewart, both will don the EMU's and prebreathe 100 percent oxygen in the EMU's in the airlock for 40 minutes prior to the EVA

## LINE REPLACEABLE UNITS (LRU'S) *CHALLENGER* FROM STS-8 TO 41-B

- Removal and replacement of:

Ascent thrust vector control No. 4

Gaseous oxygen ullage pressure transducer No. 3

Space Shuttle main engine No. 3

Aft left reaction control system thruster L3D

Forward reaction control system thruster R3D (required forward reaction control system removal)

Four quad S-band antennas

Nose landing gear thruster assembly

Hydraulic circulation pump No. 2

Starboard payload bay door limit switch within rotary actuator

Gaseous hydrogen pressurization outlet pressure sensor (main propulsion system)

Auxiliary power unit No. 3 gearbox lube oil outlet temperature sensor

Smoke detector B avionics bay 1

Remote manipulator system elbow television camera

Payload bay television camera D

Water spray boiler controller 3A

Waste collection system

General purpose computer No. 1

Main landing gear brakes

Motor controller assembly No. 2

Hydraulic accumulator No. 2

Auxiliary power units No. 1, No. 2, and No. 3

S-band power amplifier

Inertial measurement units (IMU's) navigation base position 1 and 2

All five general purpose computers (GPC's) were removed and replaced

## WESTAR VI

WESTAR VI is the third satellite of the latest generation of satellites purchased by Western Union from Hughes Aircraft Company's Space and Communications Group at El Segundo, California.

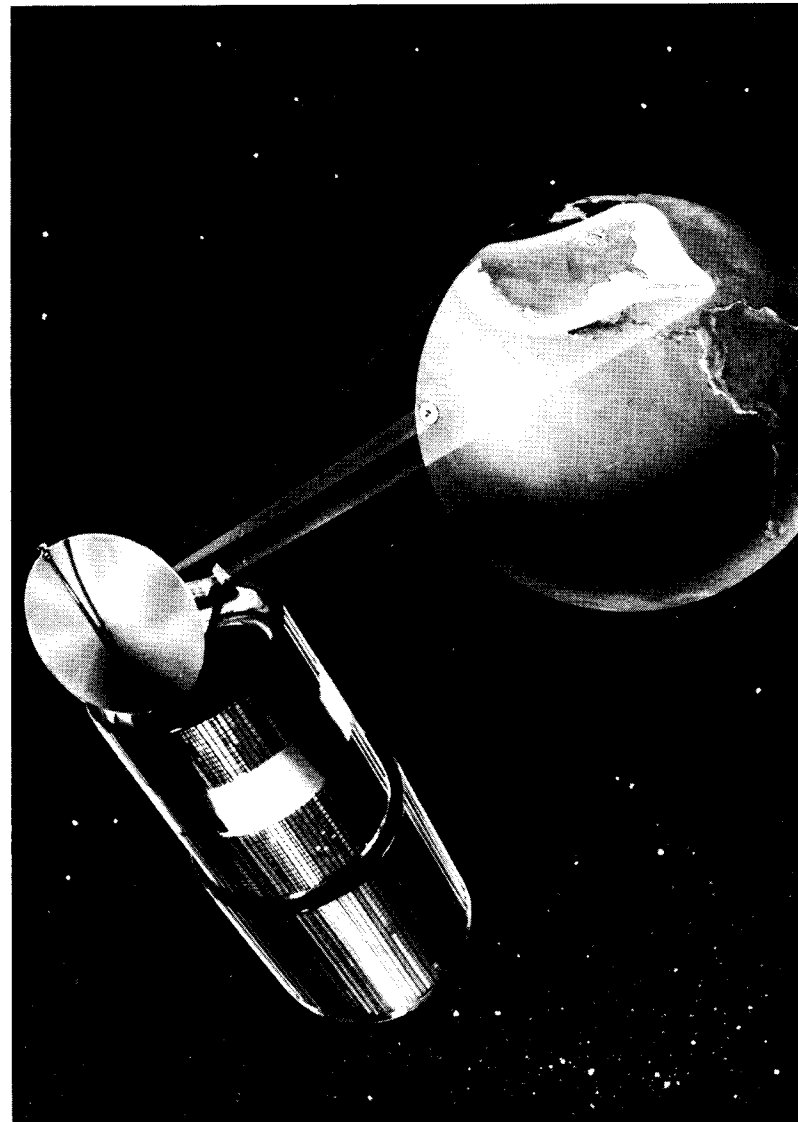
WESTAR IV was launched February 25, 1982 and WESTAR V was launched June 8, 1982 on McDonnell Douglas Delta boosters. WESTAR VI as the first to be carried into earth orbit aboard the Space Shuttle.

WESTAR IV and V carry 24 transponders, each capable of handling 2,400 one-way voice circuits or a color television transmission, twice the capability of earlier WESTAR satellites. WESTAR VI will have an additional six spare transponders to its regular 24.

The five-satellite WESTAR system provides continuous video, facsimile, data, and voice communications service throughout the continental United States, Alaska, Hawaii, Puerto Rico, and the Virgin Islands.

The WESTAR control station is located in Glenwood, New Jersey. The system includes seven major earth stations and is integrated with Western Union's 10,000 mile terrestrial microwave network. The satellites are built for Western Union's principal subsidiary, the Western Union Telegraph Company, and are partially owned by American Satellite Company. The network management center is at Upper Saddle River, New Jersey.

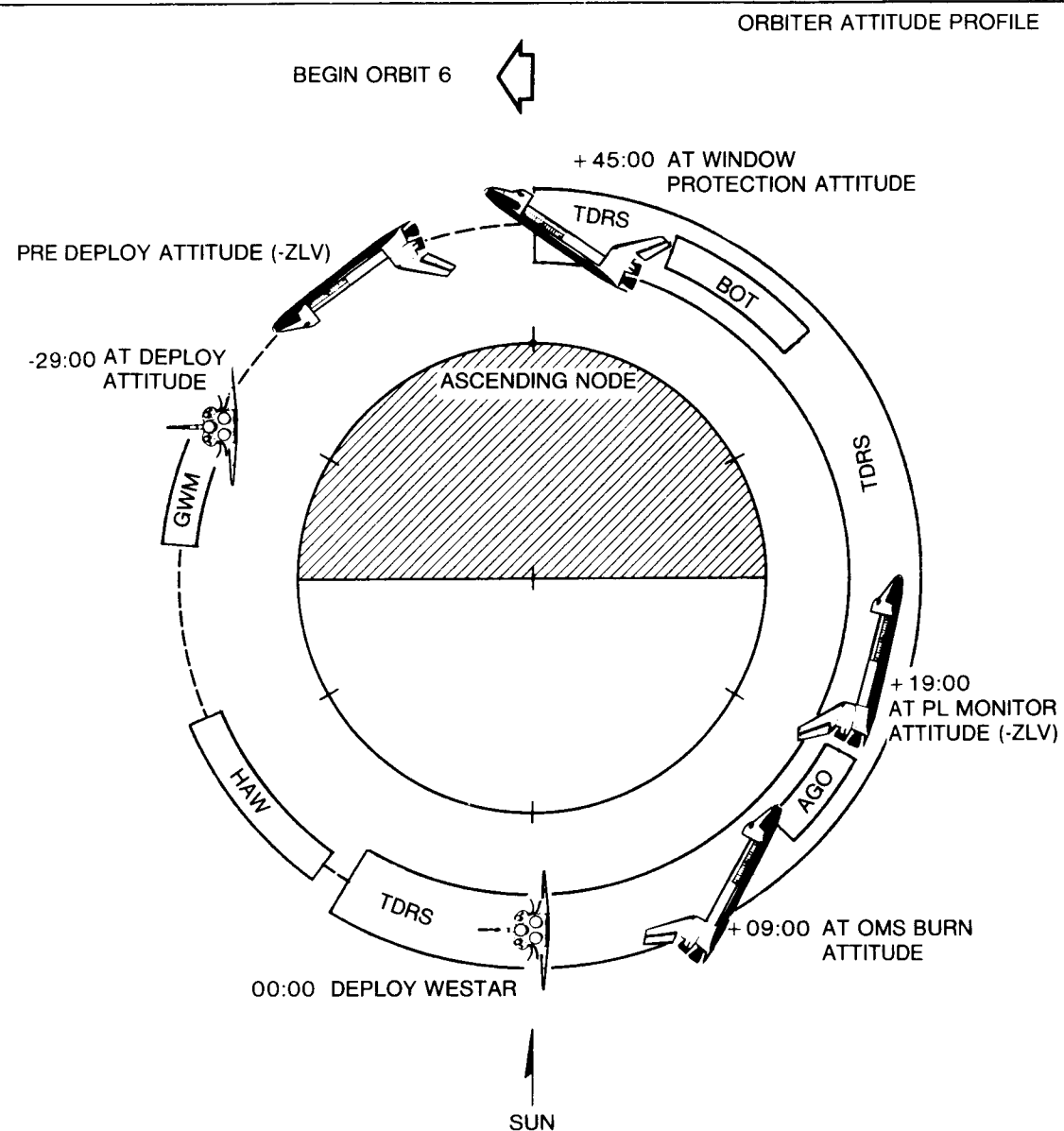
The new WESTAR's are 2 meters (7.1 feet) wide, 2.7 meters (9.1 feet) high in the stowed position. With the 1.8 meter (6 foot) wide antenna erect and the aft solar panel deployed, the satellite is 6.5 meters (21.6 feet) high. It weighs 580 kilograms (1,280 pounds) at beginning of life in orbit. On-orbit station keeping is provided by four thrusters using 141 kilograms (313 pounds) of hydrazine propellant. The solar cells generate 935



WESTAR VI

## ORBIT 6 EVENTS

- 45:00 BEGIN ORBIT 6  
-40:00 INITIATE MANEUVER TO DEPLOY ATTITUDE  
-29:00 SUNRISE  
-29:00 AT DEPLOY ATTITUDE  
-29:00 TO -24:00 GUAM CONTACT  
-17:00 TO -09:00 HAWAII CONTACT  
-15:00 MECHANICAL SEQUENCE START  
-08:00 TO +47:00 TDRS CONTACT  
-03:00 TERMINAL SEQUENCE START  
00:00 DEPLOY WESTAR  
+03:00 INITIATE MANEUVER TO OMS BURN ATTITUDE  
+11:00 TO +15:00 SANTIAGO CONTACT  
+15:00 OMS SEP BURN  
+18:00 INITIATE MANEUVER TO PAYLOAD MONITORING ATTITUDE  
+26:00 SUNSET  
+29:00 INITIATE MANEUVER TO WINDOW PROTECTION ATTITUDE  
+33:00 TO +39:00 BOTSWANA CONTACT  
+45:00 PAM PERIGEE MOTOR FIRING INITIATE INERTIAL ATTITUDE HOLD



watts at the beginning of life, and two nickel-cadmium batteries furnished full power during Earth's eclipse. The satellites has a design life of 10 years.

WESTAR I launched April, 1974 was replaced with WESTAR V. WESTAR I life time was seven years, however it was retired after nine years of service. WESTAR I was removed from its geosynchronous orbit of 22,300 miles and boosted to higher orbit by about 100 to 200 miles. WESTAR II launched in October, 1974 is to be retired at the end of 1984 and will also be removed to the higher orbit from the 22,300 mile geosynchronous orbit. The WESTAR's as they are retired will also be raised to the higher orbits.

WESTAR VI was originally scheduled to be launched on Ariane and due to significant delays, WESTAR VI was manifested on to this Space Shuttle flight with a McDonnell Douglas PAM-D which will boost it after deployment from *Challenger* to geosynchronous orbit.

WESTAR IV is located at 99 degrees west longitude and WESTAR V is located 123 degrees west longitude.

It is noted that *Challenger's* Ku-band antenna will be inhibited during WESTAR VI deployment until WESTAR VI/PAM-D are 91 meters (300 feet) from *Challenger*.

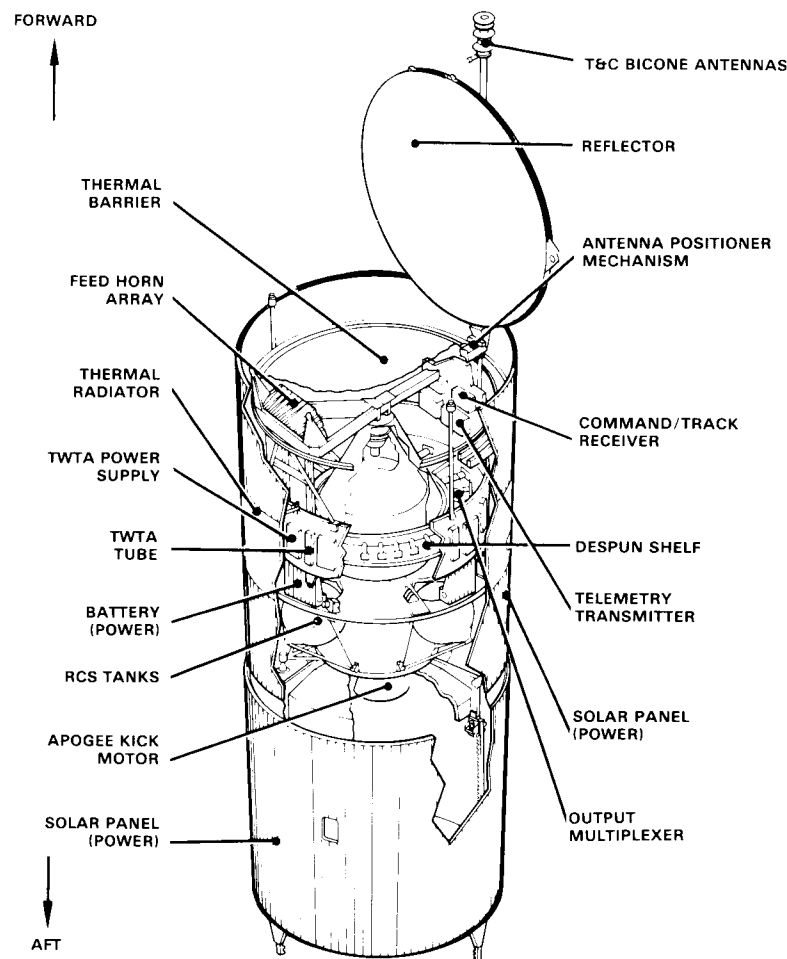
## PALAPA-B2

PALAPA-B2 is the second of a second generation communications satellite for Indonesia. PALAPA satellites have electronically linked Indonesia's 13,677 islands that curve along the equator for 5,100 kilometers (3,400 miles) and brought advanced telecommunications to the nation's 150 million inhabitants which speak over 250 languages besides the national language Bahasa Indonesia and encompasses a variety of cultures. The expression "PALAPA" denotes Indonesian national unity. The name derives from the historic amuktl palapa oath. Amuktl palapa in ancient Javanese means to relax after exertion.

The Indonesian government demonstrated foresight in recognizing early that communication satellites were the most economical and efficient way to handle geographic barriers and electronically link the people of Indonesia and other members of the Association of Southeast Asian Nations (ASEAN).

PALAPA-B satellites are built by Indonesia by Hughes Aircraft Company Space and Communications Group of El Segundo, California. The \$79 million fixed price contract calls for delivery of two spacecraft and their associated perigee stage vehicles under contract to PERUMTEL, Indonesia's state-owned telecommunications company. Approximately six percent of the total price is paid on an incentive basis, and is dependent on satisfactory communications performance over a full eight year mission life.

PERUMTEL records as an example, show that between 1976 and 1981, long-distance telephone traffic increased from 1.3 million to 4.2 billion pulses with PALAPA-A. The seven-year service of PALAPA-A is now drawing to a close and the launch of the second generation PALAPA-B satellites assure continuity of communication services and supply expanded capacity to accommodate future growth. The PALAPA system has contributed to government goals for national betterment. Television and radio broadcasts disseminate government policies and information, educational programs, and entertain-

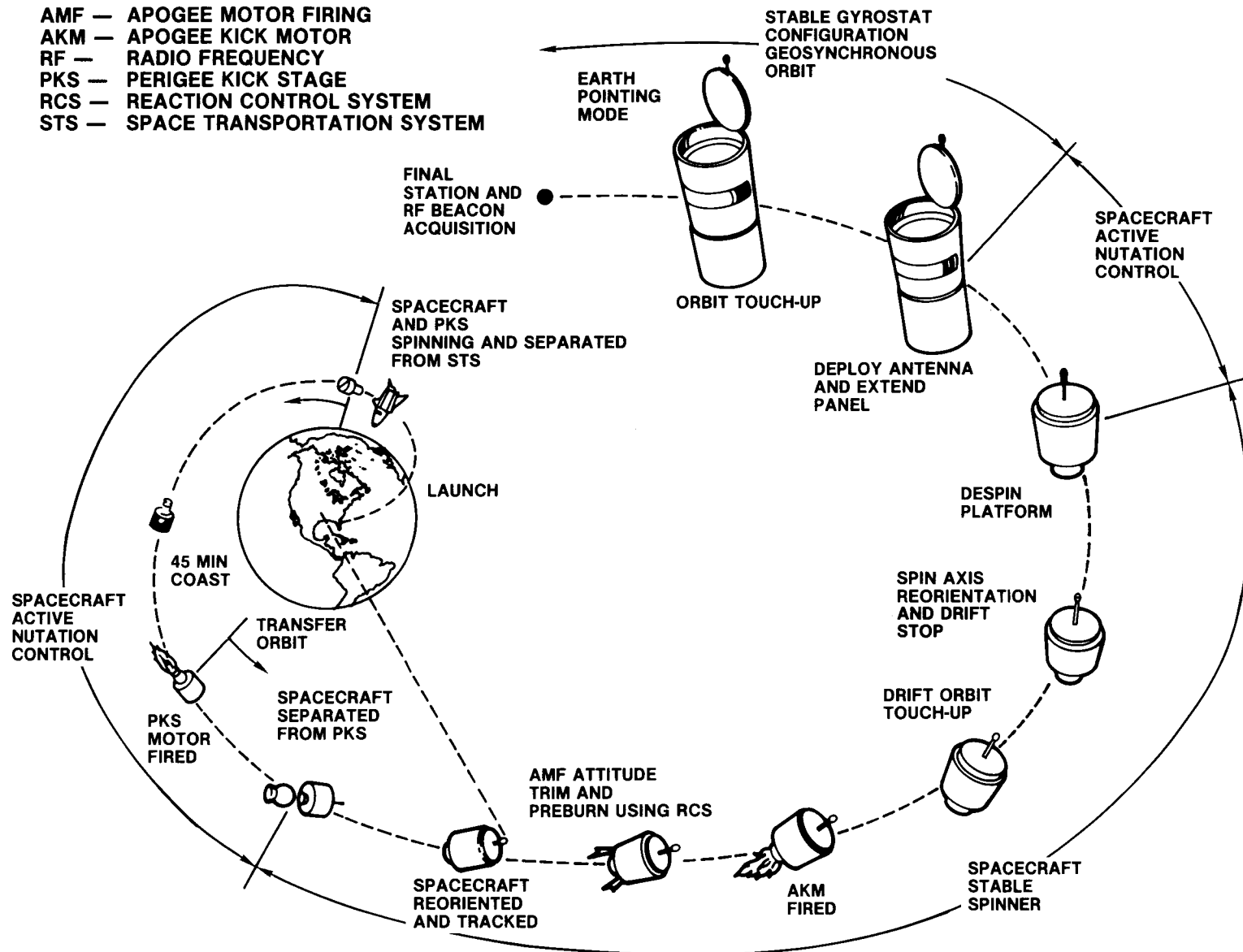


*PALAPA-B2 Deployed*

ment. Instantaneous communications and satellite-related job opportunities, direct and indirect, stimulate regional, national, and international economic activity. In addition, PALAPA system assists on the vigilant defense of Indonesia's national security.

**ABBREVIATIONS:**

AMF — APOGEE MOTOR FIRING  
 AKM — APOGEE KICK MOTOR  
 RF — RADIO FREQUENCY  
 PKS — PERIGEE KICK STAGE  
 RCS — REACTION CONTROL SYSTEM  
 STS — SPACE TRANSPORTATION SYSTEM



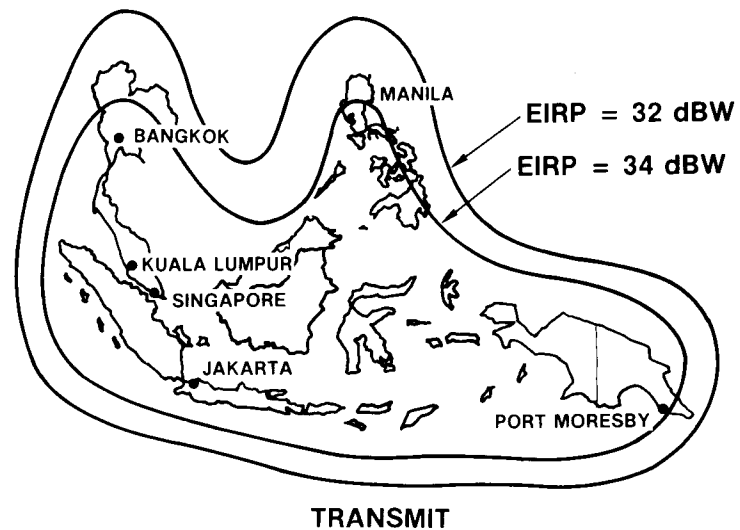
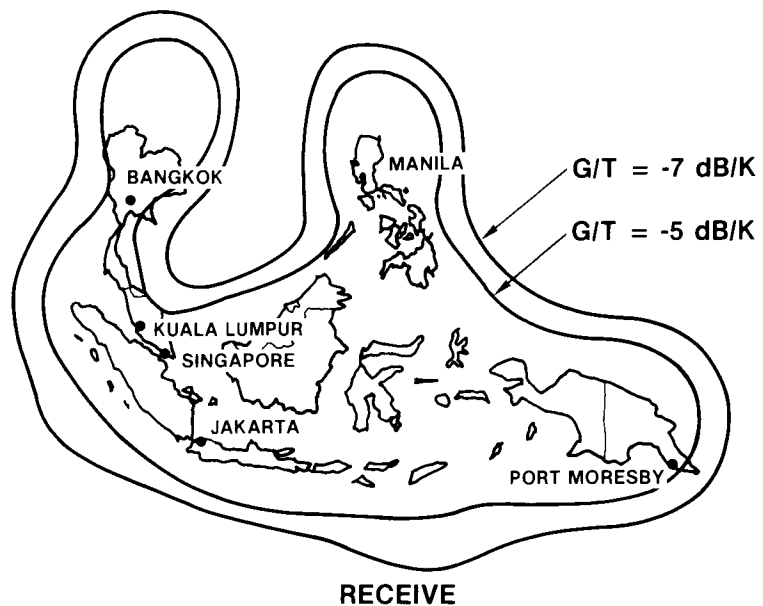
*PALAPA-B2 Mission Scenario*

A separate \$5.4 million contract between PERUMTEL and Hughes Aircraft Systems International provides for ground equipment, services, and training. The master control station in Cibinong near Jakarta, functions as the center of the system and will be expanded and necessary modifications will also be made at Banduring and Cilacap ground stations. The master control station tracks and sends commands to the satellites and controls the telephone and television networks. New radio, control, and computer equipment has been added to the master control station for the expansion to the second generation PALAPA-B satellites. PERUMTEL staff will continue to be entirely responsible for operation and maintenance of the PALAPA system.

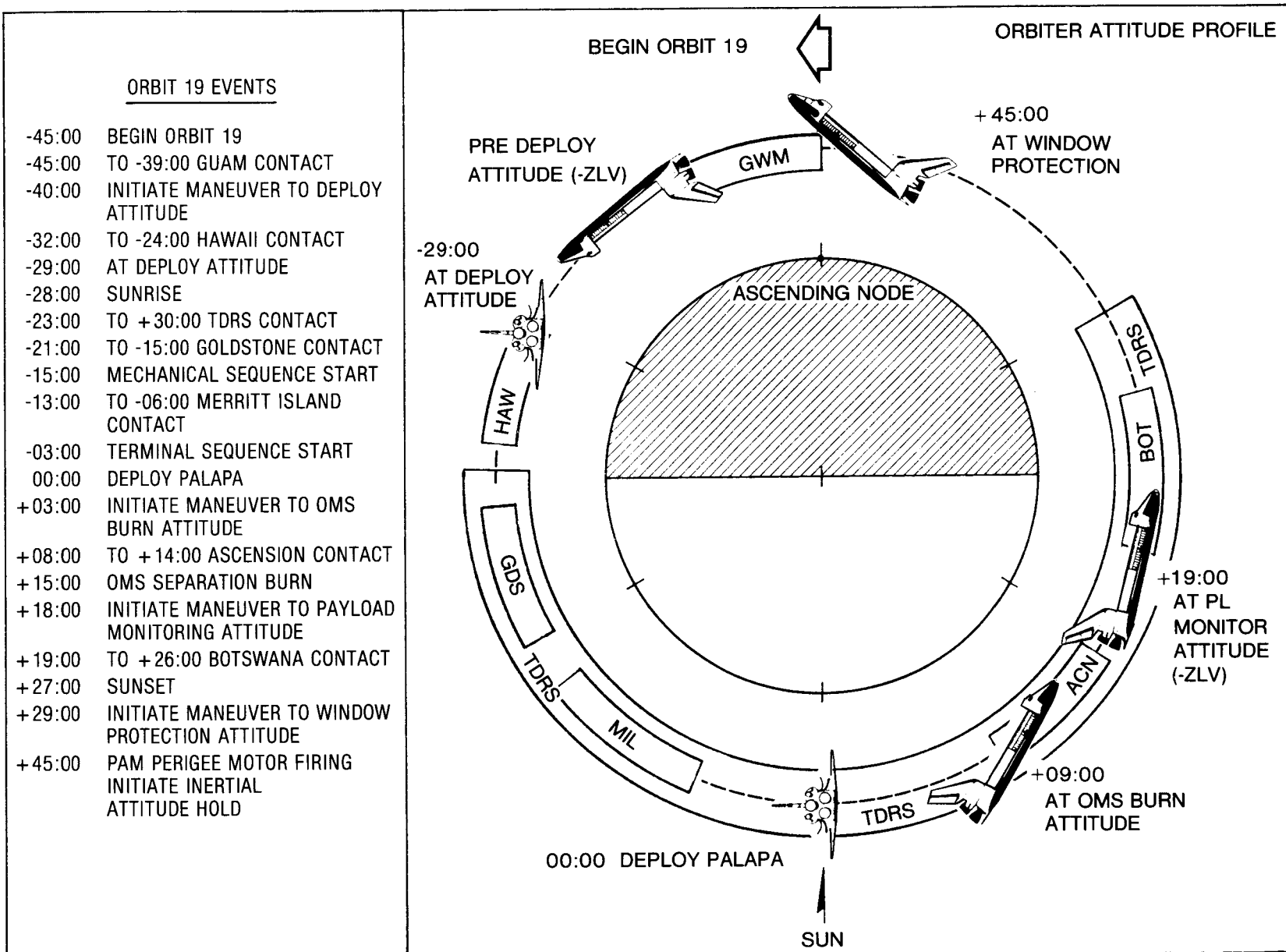
PALAPA-A was inaugurated with 40 ground stations to meet the expanding requirements of PERUMTEL and other users, a network of 125 earth stations are now in operation. The increased power of PALAPA-B makes it possible to utilize stations with antennas 3 to 4.5 meters (9 to 14 feet) in diameter, as opposed to the 10 meter (32 feet) antennas at the original stations.



*PALAPA-B2 On Station at Geosynchronous Orbit*



*PALAPA-B Coverage*



*PAM-D/Palapa-B2 Deployment Sequence*

The two new PALAPA satellites are twice as big and have twice the capacity and four times the electrical power of the earlier built PALAPA-A satellites built by Hughes: The new satellites provide 24 transponders, twice the number of PALAPA-A. The 24 transponders provide 12,000 two-way telephone calls or 24 color television programs or combinations thereof. A conservative estimate as the transponder capacity required up through 1990 is 12 for Indonesia and nine for other ASEAN members. Thailand, Malaysia, the Philippines, and Singapore, a total of 21. The PALAPA-B satellites will bring improved quality and efficiency to the systems television, telephone, telegraph/telex, and data transmission services to Indonesia and the ASEAN members in addition to expanded coverage in remote and rural areas and to Papu, New Guinea either of the two PALAPA-B satellites could satisfy these requirements with three transponders to spare for evolving needs; two satellites in orbit afford the safeguard of a complete backup or redundancy of the space system.

PALAPA-B1 became operational on 30 July 1983.

PALAPA-B satellites are 2 meters 25 millimeters (7 feet one inch) wide, 2.7 meters (9 feet) high in the stowed position. With the 1.8 meter (6 foot) wide antenna erected and the outer solar panel extended, the spacecraft is 6.7 meters 127 millimeters (22 feet 5 inches) high. It weighs 651 kilograms (1,437) pounds at beginning of orbit. Four thrusters using hydrazine propellant provide stationkeeping and attitude control during the satellite's

design life of more than eight years. Two panels of the solar cells generate 1,062 watts of electrical power at beginning of life in orbit. Two nickel-cadmium batteries provide full power during eclipse when the spacecraft passes through earth's shadow.

PALAPA-B2 is mated with the McDonnell Douglas PAM-D and carried into earth orbit by *Challenger*. When deployed from *Challenger*, the PAM-D is used to provide the boost of PALAPA-B2 to geosynchronous orbit.

It is noted that *Challenger's* Ku-band antenna will be inhibited during PALAPA-B2/PAM-D deployment until PALAPA-B2/PAM-D are 91 meters (300 feet) from *Challenger*.

The satellites will be placed in geosynchronous orbit, PALAPA-B1 is at 108 degrees east longitude and PALAPA-B2 will be at 113 degrees east longitude.

The PALAPA-B2 satellite in the 41-B mission will nominally be deployed on the ascending node of orbit 19 over the Atlantic ocean, mission elapsed time of day one at approximately two hours and three minutes. The predeploy, ejection and sequence of events for placement at geosynchronous orbit are similar to the WESTAR VI sequences.

Financing for the PALAPA-B satellites is provided by Eximbank in cooperation with major U.S. commercial banks.

## SPAS (SHUTTLE PALLET SATELLITE)-01A

SPAS-01A is the first satellite to be refurbished from a previous flight (STS-7) and be flown again (41-B).

In the 41-B mission SPAS-01A will be used in several different activities. It will not be released as a free flyer in this mission.

SPAS-01A will be used for gathering science data with the different experiments mounted on it while it is berthed in *Challenger's* payload bay.

A trunnion pin on SPAS-01A will be used as a docking point by an extravehicular activity (EVA) astronaut in a Manned Maneuvering Unit (MMU) with a Trunnion Pin Acquisition Device (TPAD) while berthed in *Challenger's* payload bay.

SPAS-01A provides mounting for a simulated Solar Maximum Mission (SMM) spacecraft Main Electronics Box (MEB) which will be used by an EVA astronaut in a Manipulator Foot Restraint (MFR) attached to the Remote Manipulator System (RMS) arm to simulate removal and replacement of SMM MEB while on the RMS arm and in MFR while SPAS-01A remains berthed in *Challenger's* payload bay.

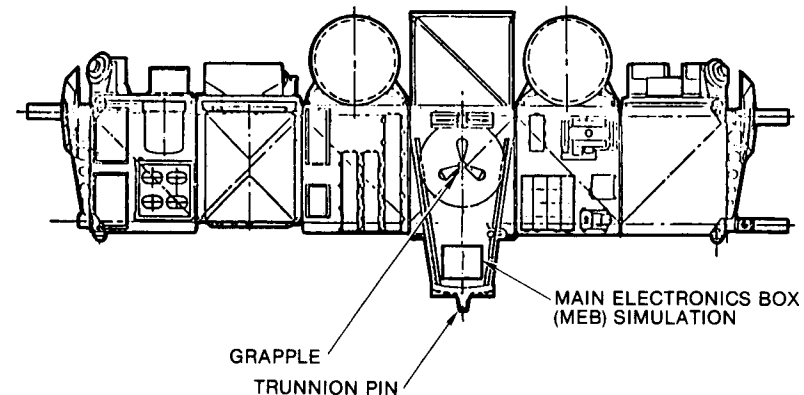
SPAS-01A will be unberthed from *Challenger's* payload bay through use of the RMS arm and payload retention mechanisms. SPAS-01A will be deployed above *Challenger's* payload but remain attached to the RMS arm and rotated about one degree per second. (simulates rotation of SMM spacecraft) It is noted the RMS wrist roll is capable of plus or minus 447 degrees roll capability. Thus, it would take about 15 minutes to reach the RMS wrist roll stops at one degree per second rotation rate. EVA astronauts in an MMU with TPAD will rendezvous and dock with the trunnion pin on SPAS-01A by matching SPAS-01A rotation rate (will not stop rotating SPAS-01A), then undock. SPAS-01A will then be berthed in *Challenger's* payload bay.

NASA has equipped SPAS-01A with a 70mm Hasselblad photo camera and a 16mm film camera and two color television cameras. Both television cameras cannot operate at the same time. The cameras are utilized to monitor the two extravehicular activities associated with this flight.

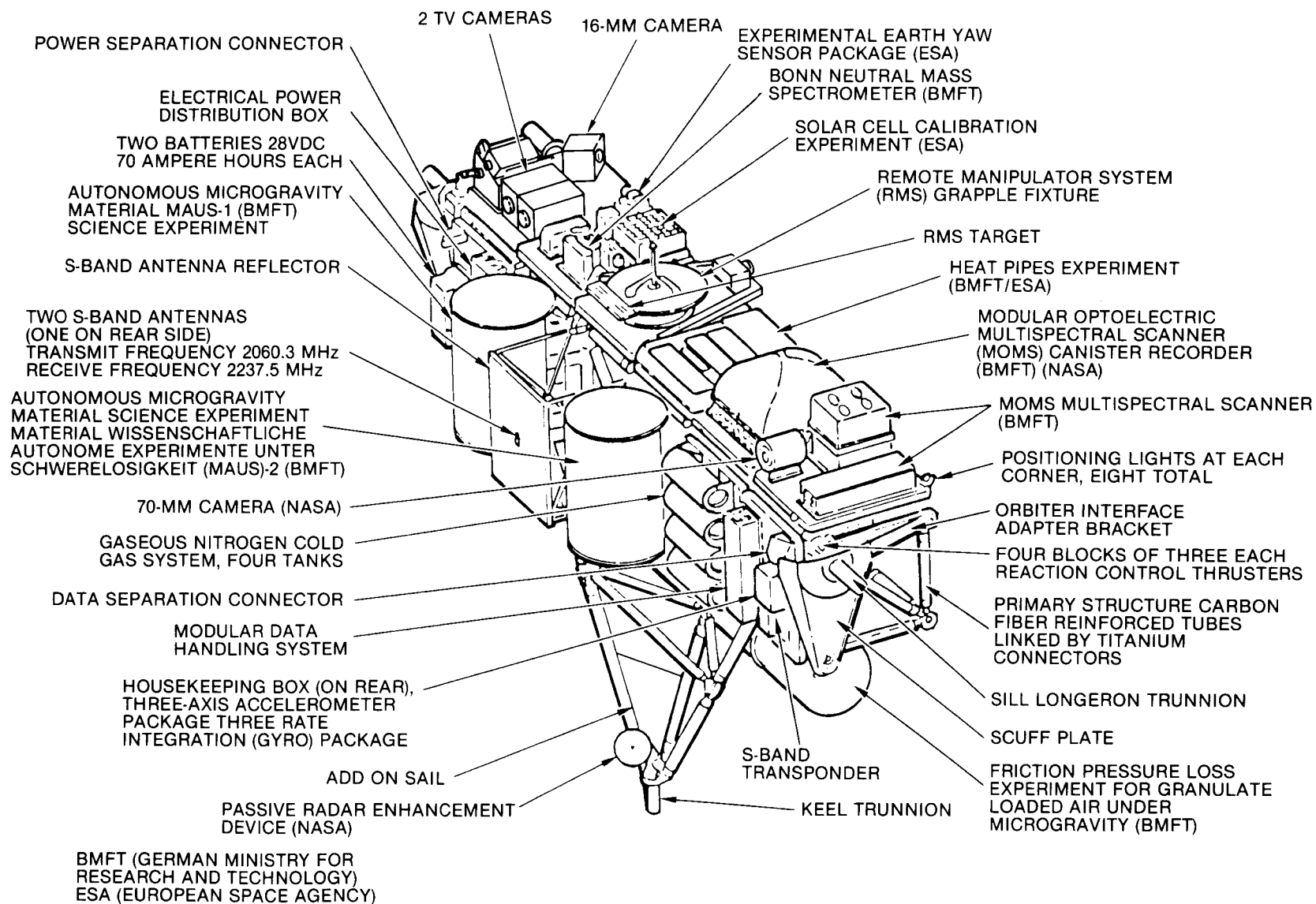
SPAS-01 was developed by the West German firm Messerschmitt-Boelkow-Blohm GmbH (MBB). NASA and MBB signed an agreement in June 1981 at MBB Space Division Headquarters in Bremen; Federal Republic of Germany for launch services to be provided by NASA. The German Federal Ministry of Research and Technology (BMFT) has promoted the SPAS-01 pilot project and contributed substantially to the funding.

Six scientific experiments from BMFT, the main customer and two from the European Space Agency (ESA), are the first European "passengers" on SPAS-01.

SPAS-01 structure is 4.2 meters (13.7 feet) long and 0.7 meters (2.2 feet) wide. Fully equipped SPAS-01 weighs approximately 1,500 kilograms (3,307 pounds) and is 1.5 meters (5 feet). SPAS-01 payload is 900 kilograms (1,984 pounds). The structure is constructed of carbon fiber tubes 60 millimeters



SPAS-01A Top View



*Shuttle Pallet Satellite (SPAS) - 01A Configuration*

(2.3 inches) in diameter and 0.7 meter (2.2 feet) in length linked by titanium connectors. The tubes form a grid structure composed of segments each measuring 0.7 x 0.7 x 0.7 meter (2.2 x 2.2 x 2.2 feet). The basic measurement can be used in any way required. The SPAS-01 structure is statically attached by three trunnions in *Challenger's* payload bay. Two trunnions are attached to *Challenger's* payload bay port and starboard longeron sill and one trunnion to *Challenger's* keel fitting. Other subsystems are also modular, such as, power supply and data processing. The data handling system is a multiredundant modular digital system (MODUS). This "brain" of the system covers telemetry, encoding and decoding. SPAS-01A has 28 vdc battery power.

### SPAS-01A EXPERIMENTS

The Materialwissenschaftliche Autonome Experimente unter Schwerelosigkeit (MAUS) 1 and 2 sponsored by the German Federal Ministry for Research and Technology (BMFT) utilize Getaway Special (GAS) type systems with their own internal batteries and microprocessors. MAUS 1 will test microgravity processing of a new permanent magnet alloy using the properties of two metals (bismuth and manganese) that are difficult to mix on earth. MAUS 2 will measure oscillatory Rayleigh convection in fusion processes under micro-gravity conditions, a basic experiment concerned with crystal growing in space.

The friction loss experiment sponsored by BMFT is an autonomous experiment designed to determine effects of gravity on ground-based pneumatic conveyor systems by studying such systems in a nongravity environment.

Modular Optoelectronic Multispectral Scanner (MOMS) sponsored by BMFT is an electronic remote sensing camera. MOMS will be used to scan the greatest land mass and since the camera operating time is limited and the imaging will not penetrate cloud cover, scientists will use images from the Meteosat as a real-time indicator to determine when the SPAS-01 based camera should operate. MOMS was developed by MBB as a candidate for European remote sensing program.

The Bonn Neutral Mass Spectrometer experiment is a double-focusing magnetic mass spectrometer designed to measure the intensity and composition of gaseous contaminants in the *Challenger* payload bay and vicinity. The experiment is prepared by University of Bonn with support from BMFT.

Heat pipe experiment sponsored by BMFT tests heat pipes with capillary feed under microgravity conditions to improve design basis for such systems for terrestrial and space applications.

Yaw earth sensor package sponsored by ESA is a demonstration model of a sensor capable of measuring the yaw angle of a spacecraft that is stabilized in two axis for later use in operational systems. The system would allow reductions in the complexity of attitude control systems.

Solar cell calibration experiment sponsored by ESA is to measure various solar cells in the sun's direct, undisturbed rays as calibration standards for solar simulation systems on earth.

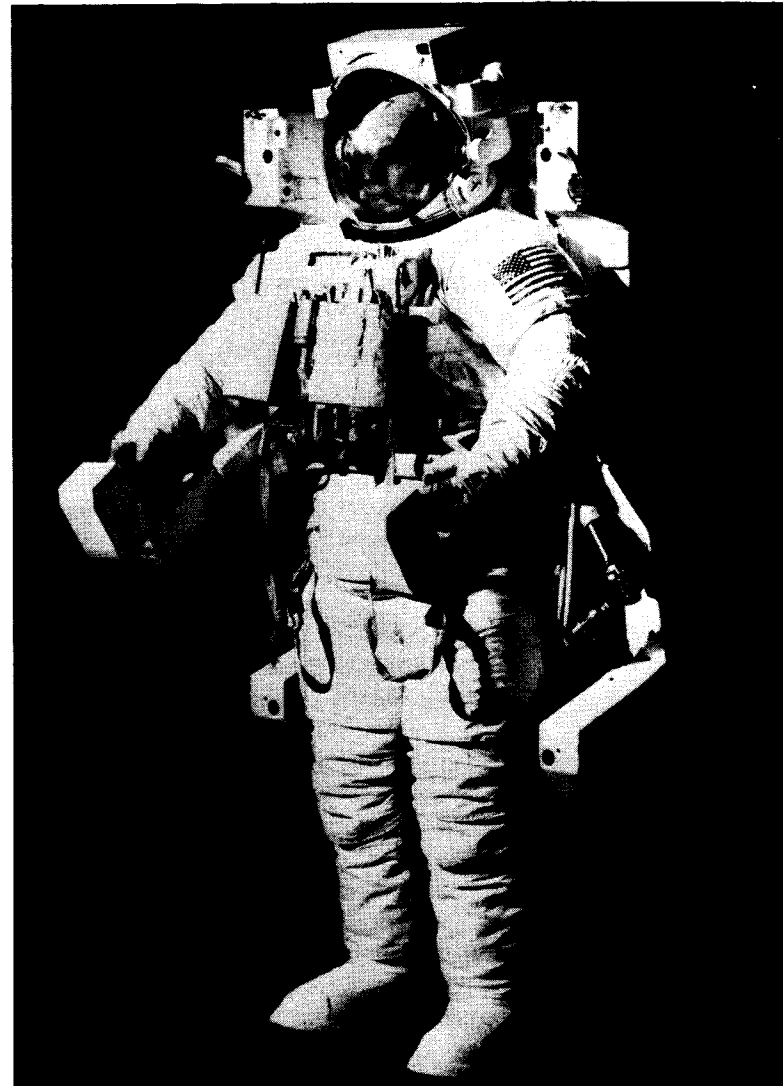
## MANNED MANEUVERING UNIT

The Manned Maneuvering Unit (MMU) is a self contained astronaut backpack propulsion device designed to permit astronaut(s) to maneuver untethered outside the orbiting spacecraft. The MMU(s) enable the astronaut to perform a variety of extravehicular activities (EVA's) such as, satellite retrieval, satellite repair, satellite deployment, satellite maintenance, science investigations and observations, in space assembly and rescue operations.

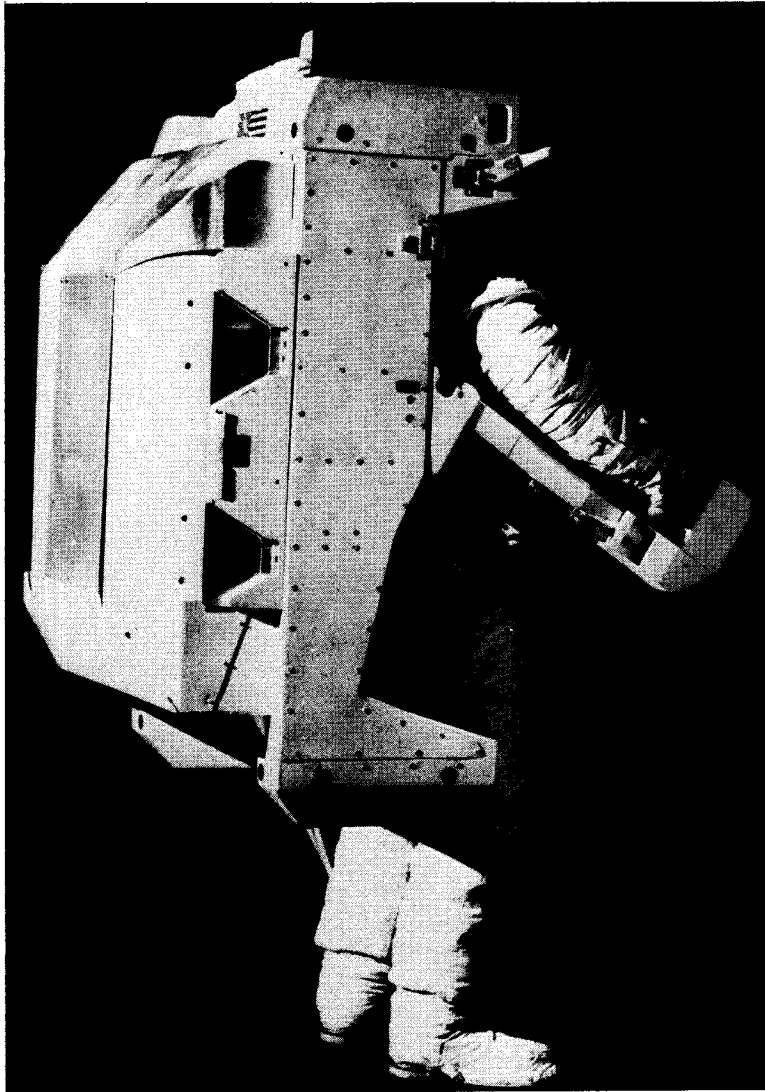
The MMU's are designed, built and tested by Martin Marietta Aerospace, Denver Division, Denver, Colorado under contract from NASA's Johnson Space Center, Houston, Texas. Two flight units were accepted by NASA and delivered to Johnson Space Center in September 1983. Installation of the two MMU flight units in *Challenger's* payload bay for this mission began in November 1983 at the Orbiter Processing Facility (OPF) at Kennedy Space Center, Florida. A third MMU used for qualification testing at Martin Marietta's Denver Aerospace Division is in standby at Johnson Space Center for the 41-B mission and after this mission, it will be used as a breadboard for systems upgrade.

The MMU is part of the complement of EVA provisions that include the Extravehicular Mobility Unit (EMU), the orbiter airlock and support equipment. Flight provisions can be made on each orbiter flight for three, two flight crew member EVA operations lasting up to six hours. Two are available for planned or unscheduled payload operations. The third is reserved for orbiter contingency EVA only.

The two MMU's in the 41-B mission are stowed in separate Flight Support Stations (FSS's) located in *Challenger's* payload bay. One MMU/FSS is installed on the forward port side of the payload bay and is referred to as MMU-1. The other MMU/FSS is installed on the forward starboard side of the payload bay and is referred to as MMU-2. The FSS provides the storage of the MMU during launch and during non MMU activity on orbit and during entry. Only one MMU is used in free flight at a time.



*Extravehicular Mobility Unit With Manned  
Maneuvering Unit*



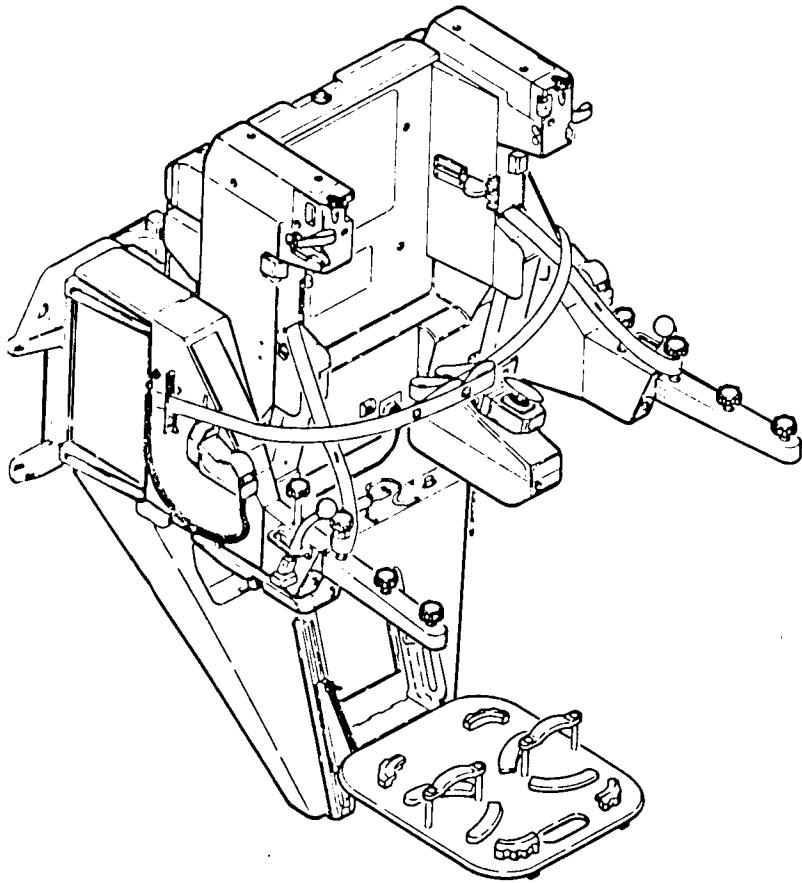
*Extravehicular Mobility Unit and Manned  
Maneuvering Unit*

The FSS also provides for servicing of the MMU. Each MMU has two battery systems which are charged from the orbiter's electrical power and distribution electrical power and distribution system through an umbilical. In addition each of the two batteries in each MMU have two heater systems, one for EVA free flight which is powered by the MMU and one for orbital mission phases which is powered by the orbiters electrical power and distribution system through the same umbilical. The orbiters Environmental Control and Life Support Support Support (ECLSS) Atmospheric Revitalization and Control System (ARCS) gaseous nitrogen supply system is also used to provide the recharging of the two gaseous nitrogen propellant tanks on each MMU through a service connection. The FSS provides an adjustable foot restraint that provides the EVA flight crew member with the proper height for donning and doffing the MMU. The FSS is an aluminum structure.

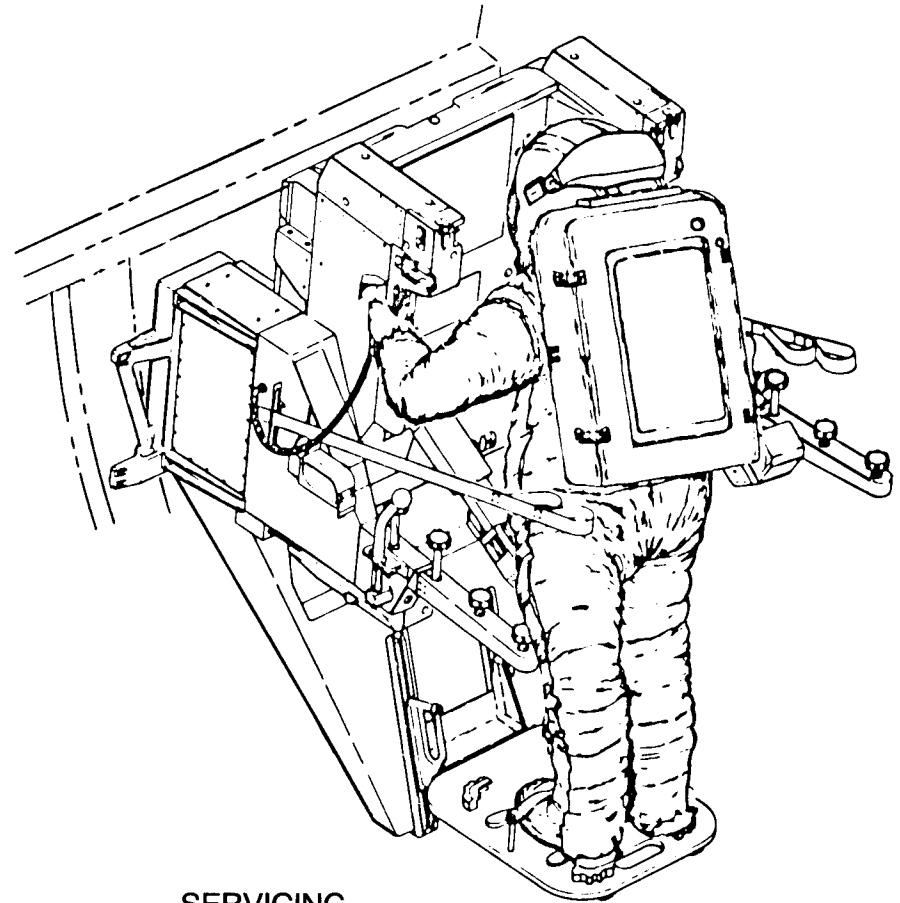
Each MMU consists of two side towers and arms connected by the center structure. Its main structure is aluminum. The towers support some of the propulsion thrusters, EVA flight crew members and displays and contain the MMU retention latches. The center structure supports two batteries, circuit breakers, control electronics assembly and associated circuitry, two gaseous nitrogen propulsion storage tanks and propulsion lines and fittings. The inboard surfaces of the towers support the EMU retention system consisting of two independent, manually activated latches, guide ramps and EMU Portable Life Support Systems (PLSS) contact points.

Each MMU is 1,253 millimeters (49.36 inches) high, 827 millimeters (32.56 inches) wide and 1,209 millimeters (47.6 inches) deep with the two hand controller (arms) fully extended. Each MMU weighs approximately 154 kilograms (340 pounds). Operational weight of the MMU, EMU, and EVA flight crew member is between 290 and 346 kilograms (640 and 763 pounds), depending on the weight of the EVA flight crew member.

Exterior surfaces of the MMU are painted while except where surface wear and closely controlled thermal properties are

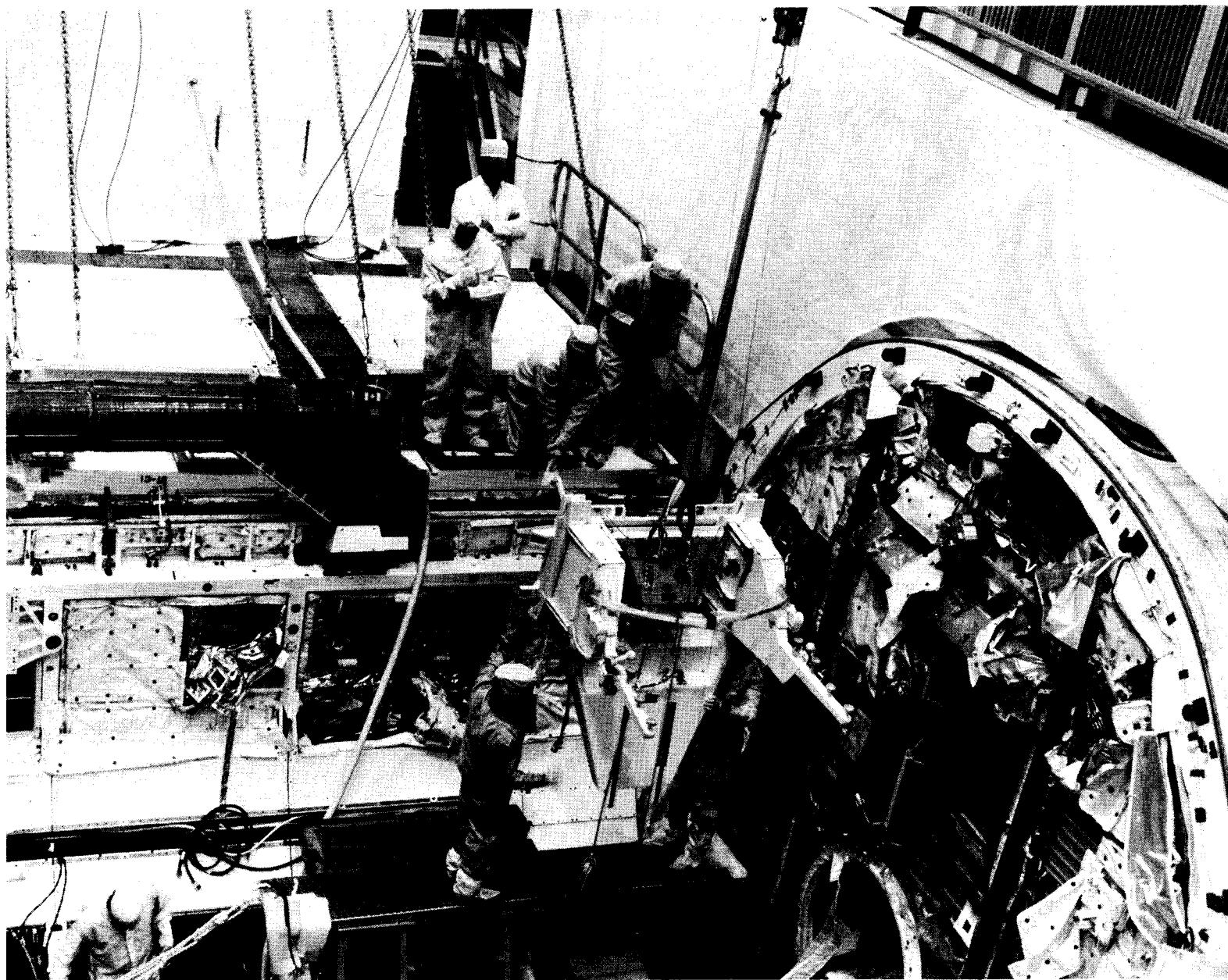


LAUNCH, ENTRY  
AND ON-ORBIT STOWAGE

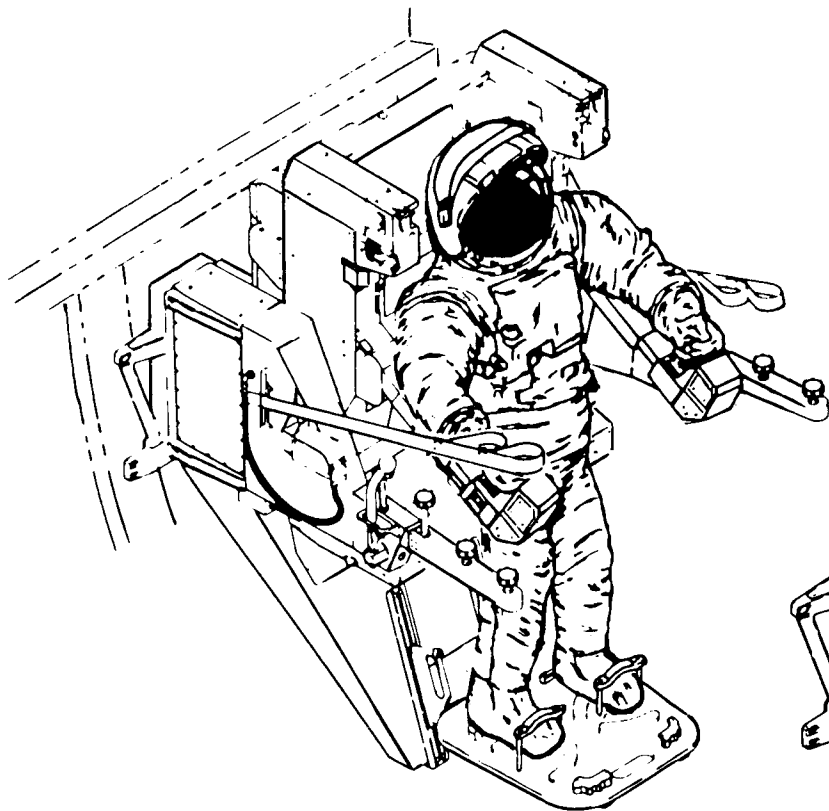


SERVICING  
(PROPELLANT CHARGE,  
BATTERY CHANGE)

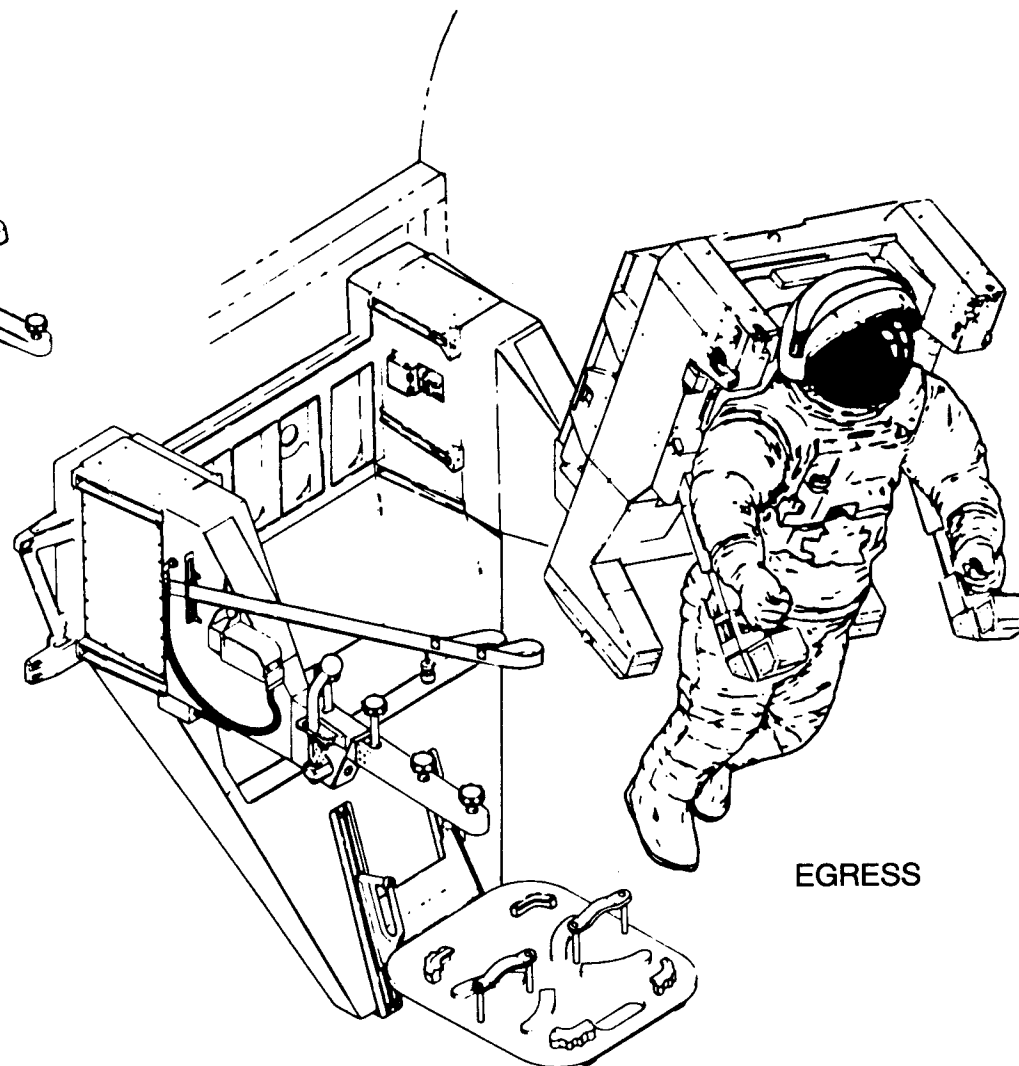
*Manned Maneuvering Unit (MMU)  
Flight Support Station (FSS)*



*Flight Support Structure Being Lowered and Installed in  
Challenger's Payload Bay Port (Left) Side*



DONNING CONFIGURATION

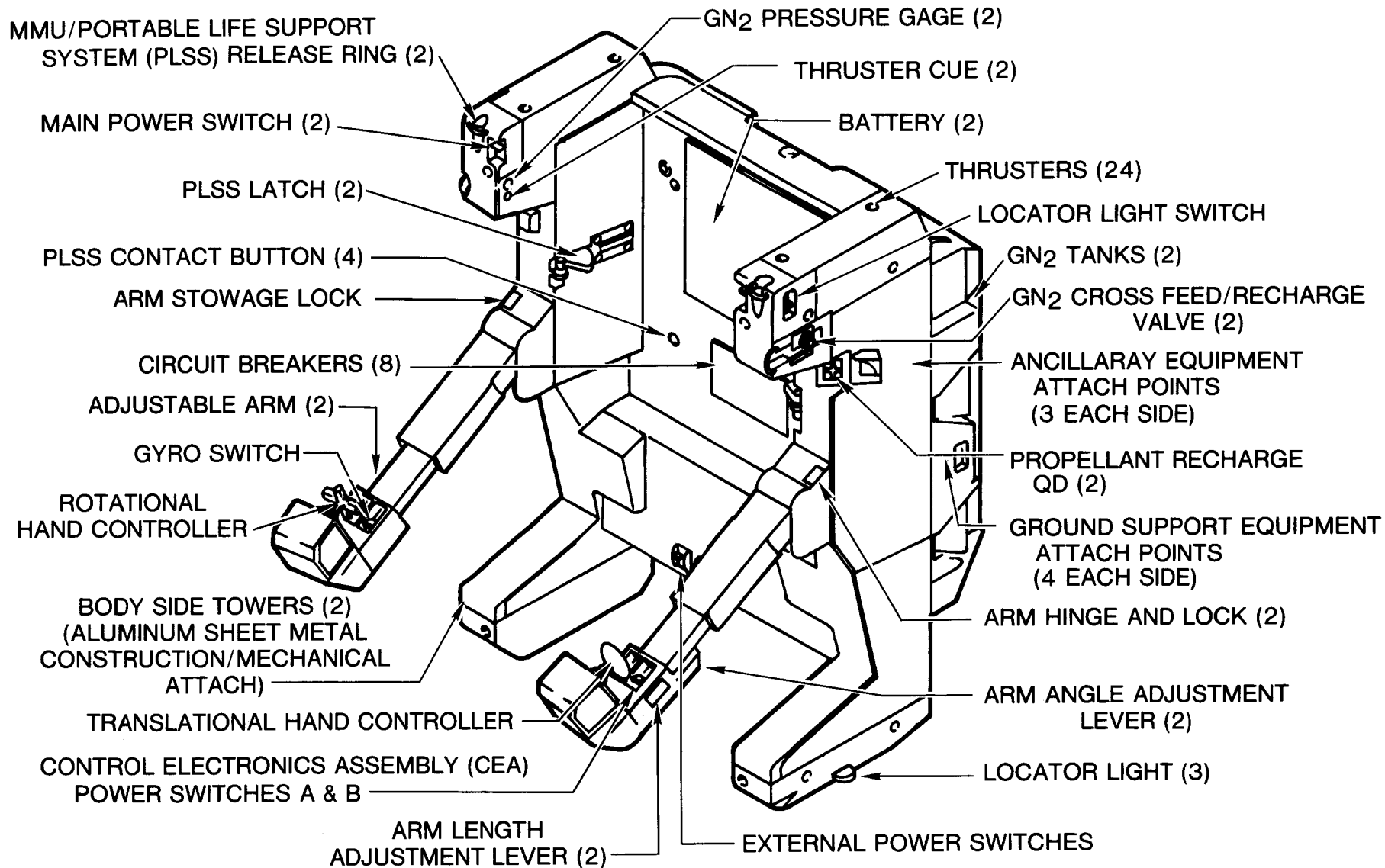


EGRESS

*Manned Maneuvering Unit (MMU)*



*Manned Maneuvering Unit in Flight Support Structure in  
Challenger's Payload Bay Port (Left) Side*



*Manned Maneuvering Unit (MMU)*

required. The MMU rear panel and upper pressure vessel shroud are covered with silvered Teflon to provide radiator surfaces for control electronics heat rejection. The inboard sides of the MMU rear panel and the battery box which enclose the control electronics assembly (CEA), are painted white. The CEA, batteries and other components are specially coated (high emissivity surfaces) to reject heat by radiation. The majority of the propulsion system components are constructed of stainless steel or aluminum with low-emissivity surfaces.

Heaters are required for both orbital storage and EVA operations. MMU surface temperatures in cold storage environments approach minus 118°C (minus 180°F) while allowable temperatures as high as minus 23°C (minus 10°F) are required for component storage. During EVA, surface temperatures can be as low as minus 84°C (minus 120°F), although most components must be above minus 51°C (minus 60°F) for operation. Heater components are thermally insulated from the structure where feasible, with heaters bonded directly to the components. Only battery storage heaters are mounted on the component.

Prior to the first scheduled EVA, *Challenger's* crew compartment cabin pressure is allowed to decrease from 760mm Hg (14.7 PSIA) to 646mm Hg (12.5 PSIA) through metabolic usage. One hour prior to depressurizing the crew compartment from 646mm Hg (12.5 PSIA) to 527mm Hg (10.2 PSIA), mission specialists Bruce McCandless and Robert Stewart will don the Launch and Entry Helmets (LEH's) and prebreathe 100 percent oxygen for one hour. The crew compartment is then depressurized from 646mm Hg (12.5 PSIA) to 527mm Hg (10.2 PSIA) and will remain at this pressure until Mission Elapsed Time (MET) of day 6, four hours and 30 minutes in the 41-B mission. Prior to the first scheduled EVA mission specialists Bruce McCandless and Robert Stewart enter the airlock and don the EMU's. After donning the EMU's, the EVA flight crew members will prebreathe 100 percent oxygen in the EMU's in the airlock for 40 minutes prior to the EVA. The airlock hatch on the mid-deck side of the crew cabin is closed and airlock depressurization is accomplished. The airlock hatch on the

payload bay side of the airlock is opened and the two EVA flight crew members prepare to egress the airlock.

EV-1 is the designation for mission specialist Bruce McCandless and EV-2 is the designation for mission specialist Robert Stewart.

EV-1 egresses the airlock tethered, as he approaches FSS/MMU-1 for MMU-1 preparation and checkout. EV-1 ingresses the port FSS foot restraints and checks MMU-1 and then moves backwards into MMU-1 for donning MMU-1 by latching the EMU PLSS into MMU-1. Mechanical latches located on the inside of each tower above the arm base spring into receptacles on the EMU PLSS and holds the astronaut in place in addition to a lap belt in front of the EVA flight crew member. The EVA flight crew member removes the tether. The MMU is released from the FSS by two levers. MMU checkout is then accomplished with the EVA flight crew member in the FSS foot restraint. EVA-1 positions the translation hand control and rotation hand controls to check the MMU redundant (A and B system) mode of operation and for any failed on or off redundant (A and B system) gaseous nitrogen thrusters which verifies the force sensed in addition to illumination of cue lights and expected consumption of gaseous nitrogen propellants as the EVA flight crew member cannot hear the thrusters, thrusting in space. The MMU attitude hold capability through the thrusting of the MMU thrusters is also verified by EVA flight crew member movement or by movement of *Challenger*.

EV-1 egresses the FSS foot restraints and translates untethered to approximately 45 meters (150 feet) above the plane of *Challenger's* wings and vertical tail, staying in view of *Challenger's* aft flight station crew compartment windows at all times. EV-1 returns to the payload bay and translates again in the same direction to approximately 91 meters (300 feet) and returns to the payload bay. EV-1 during the translations recognizes the size of *Challenger* as to distance from *Challenger* plus *Challenger's* Ku-band system and antenna are used in the rendezvous radar mode in this sequence.

To maneuver the MMU, the EVA flight crew member uses the rotation and translation hand controllers on the MMU to command the applicable gaseous nitrogen thrusters to thrust. The rotation and translation controllers provide a six-degree-of-freedom control, plus or minus pitch, roll, yaw (attitude control) and plus or minus x, y, z (translation control). The rotation hand controller is on the right arm of the MMU and commands the applicable thrusters to move the MMU in attitude control. The translation hand control is on the left arm of the MMU and commands the applicable thrusters to move the MMU in translation control. An automatic attitude hold for the three rotational axis is activated by a button on top of the rotation hand controller and may be used by the EVA flight crew member to maintain position relative to another object.

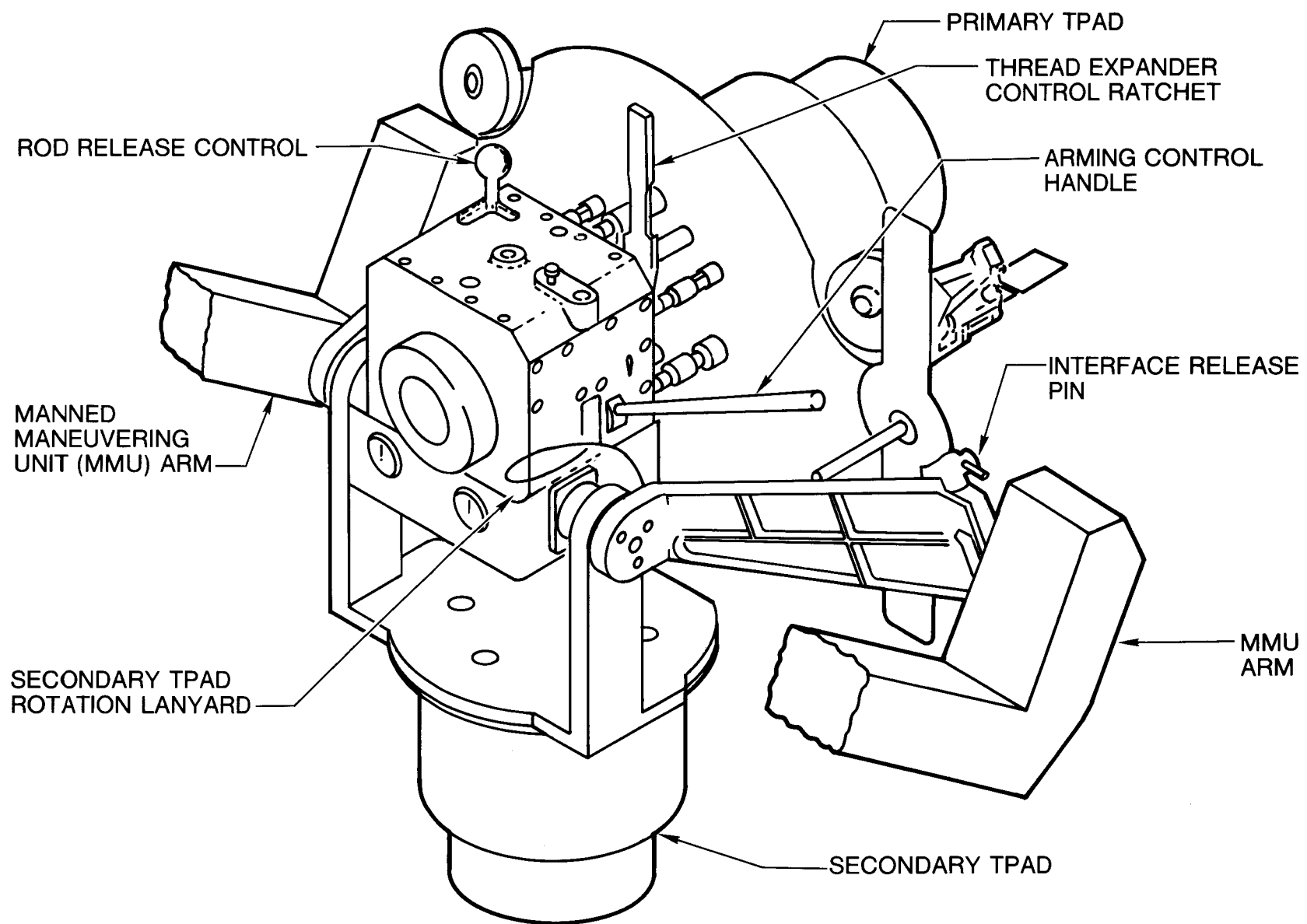
To achieve a fail-safe design, MMU control electronics and propulsion subsystems are arranged in redundant component sets. Normally both sets are used continuously. In the event of a failure, the failed set can be shut down, allowing the EVA flight crew member to continue to work and/or return to *Challenger* using the remaining set. The control electronics assembly (CEA) contains three gyros (one for each rotational axis), control logic, thruster-select logic, and motor-driven thruster valve drive amplifiers. The CEA accepts inputs from the rotation and translation hand controllers and during attitude hold, from the gyros.

Each MMU electrical power consists of two 16.8 vdc silver-zinc batteries and an electrical power distribution system that includes circuit breakers, switches, and relays. The batteries provide electrical power to the CEA, electrical power conditioners in the CEA and rotation and translation controllers. The two batteries provide sufficient power for a six hour EVA and can be recharged after each EVA from *Challenger's* electrical power and distribution system through an umbilical at each FSS. Three flashing locator lights on the MMU pinpoint the location of the EVA flight crew member from the *Challenger*. The lights flash for one-half second every two seconds and are visible up to one mile.

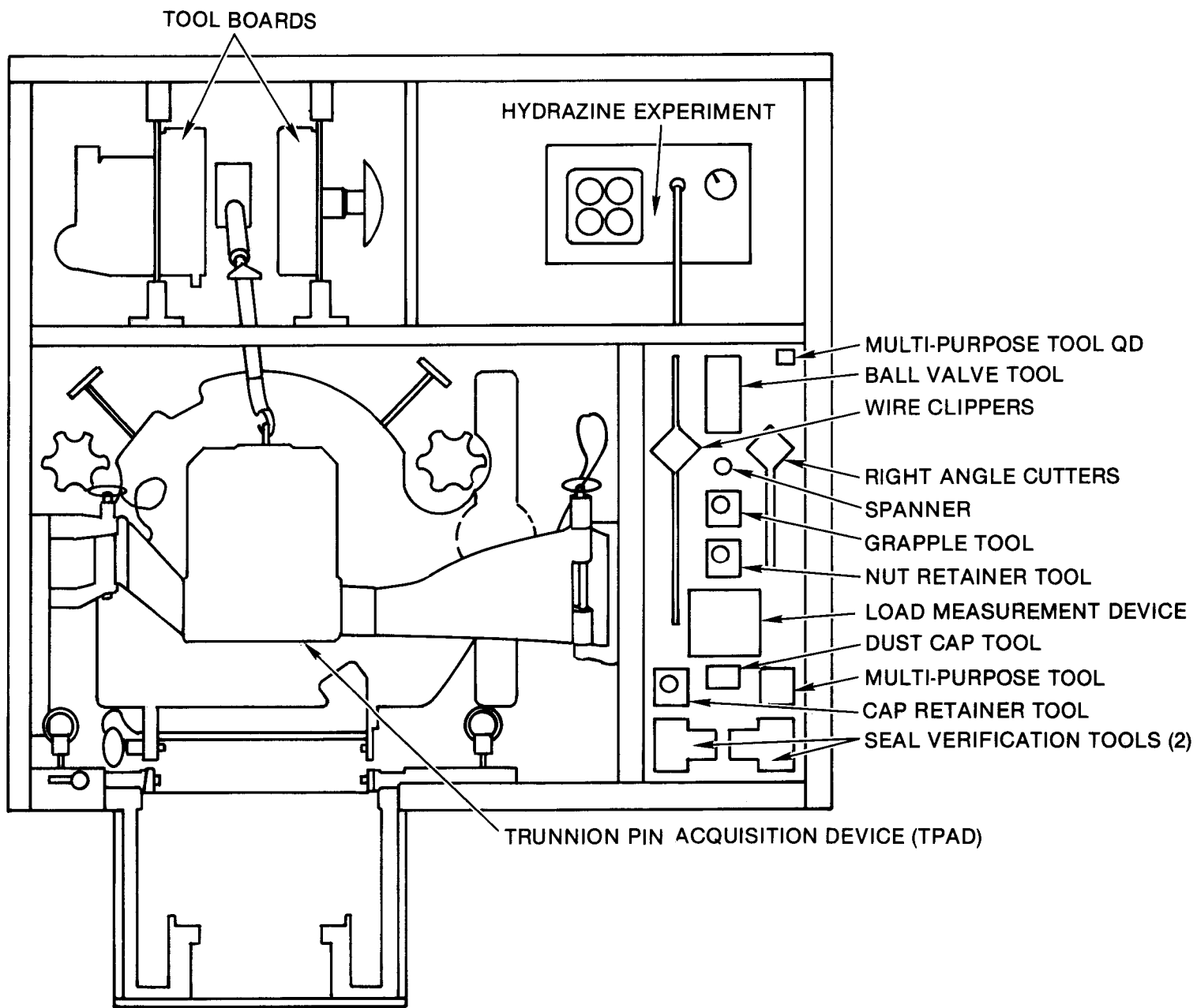
The MMU propulsion system consists of 24 gaseous nitrogen thrusters and two gaseous nitrogen supply tanks. The propulsion systems are divided into two systems, System A which consists of 12 gaseous nitrogen thrusters and one gaseous nitrogen supply tank and System B which consists of the remaining 12 thrusters and gaseous nitrogen supply tank. Gaseous nitrogen is utilized as it is a non-contamination gas. Crossfeed valves can be utilized to interconnect both gaseous nitrogen supply tanks for one system of 12 thrusters. The crossfeed valves are also utilized to recharge the MMU gaseous nitrogen supply tanks from *Challenger's* gaseous nitrogen system. The gaseous nitrogen supply tanks are 762 millimeters (30 inches) by 254 millimeters (10 inches) in diameter and are of aluminum with a Kevlar filament overwrap. Each tank holds 5.9 kilograms (13 pounds) of gaseous nitrogen pressurized to 155,250mm Hg (3,000 PSI). Two gaseous nitrogen pressure gauges read from 0 to 4,000 PSI on the right MMU tower which permits the EVA flight crew member to monitor the propellant supply during EVA activities and during recharge. Each of the 24 thrusters provide 7.6 Newtons (1.7 pounds) of thrust. The MMU gaseous nitrogen system will provide in one continuous  $\Delta V$  a total velocity of 20 meters per second (66 feet per second), however, the nominal  $\Delta V$  velocity is 0.6 meters per second (two feet per second). Gaseous nitrogen usage is dependent upon the total maneuvers during the six hour EVA which could require a recharge during the EVA. If a MMU gaseous nitrogen thruster stuck in the on position, the EVA flight crew member can respond in one to two seconds to shutdown the gaseous nitrogen system.

MMU dual electric and propulsion systems ensure that in case of a single operational failure, the EVA flight crew member would be able to complete a critical task and return to the orbiter using the remaining system. In case of a second failure, the EVA flight crew member could depend on rescue by the orbiter which would be able to overtake and capture the EVA crew member easily even if the MMU were operating at full thrust to gaseous nitrogen depletion.

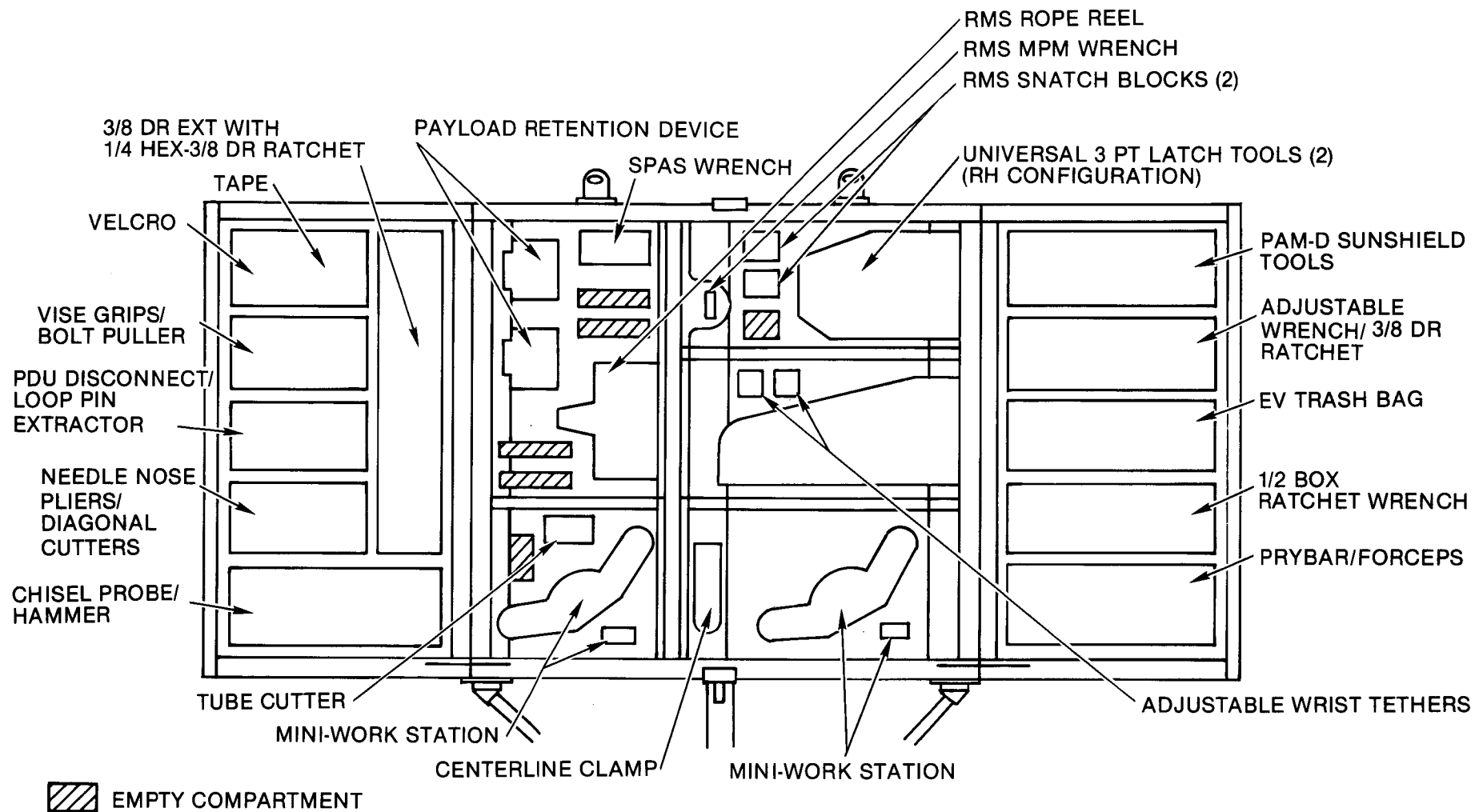




*Trunnion Pin Acquisition Device (TPAD)*



*Special Equipment Stowage Assembly (SESA)*



the aft flight station crew member monitors the RMS to determine that the RMS and RMS brakes provides the EV-2 flight crew member with a stable platform and no slippage of the RMS brakes.

EV-1 in MMU-1 upon completion of docking and undocking the TPAD on SESA, stows the TPAD on SESA. EV-1 in MMU-1 returns to the port FSS and stows MMU-1 in the FSS. EV-1 in MMU-1 moves backwards into the FSS to stow the MMU. To doff the MMU, EV-1 pulls the release rings on the front of both MMU towers, retracting latches, releasing EV-1 EMU from the MMU. EV-1 in the FSS foot restraints recharges MMU-1 gaseous nitrogen propulsion system from *Challenger's* gaseous nitrogen supply system and the batteries can be recharged through a trickle charge from *Challenger's* electrical power and distribution system overnight or the batteries can be removed and replaced. EV-2 in the MFR on the RMS returns to the proximity of the MFR stowage area on the port (left) side of *Challenger's* payload bay. EV-2 egresses the MFR foot restraints. EV-2, tethered, approaches MMU-1/FSS for MMU-1 preparation and checkout.

EV-2 ingresses the port FSS foot restraints and checks MMU-1 and moves backwards into MMU-1 for donning MMU-1 by latching the EMU PLSS into MMU-1. EV-2 proceeds to checkout MMU-1 by releasing MMU-1 from the FSS and will checkout the MMU in the foot restraints similar to EV-1 and then translates in a similar sequence to EVA-1 activities. EV-2 in MMU-1 dons the TPAD to the MMU arms and maneuvers to dock with the trunnion pin located on SPAS-01A in *Challenger's* payload bay. EV-2 in MMU-1 docks and undocks the TPAD on SPAS-01A. Upon completion of these activities EV-2 returns to the port FSS, stows MMU-1 in the FSS and doffs the MMU and progresses, tethered to the airlock for ingress.

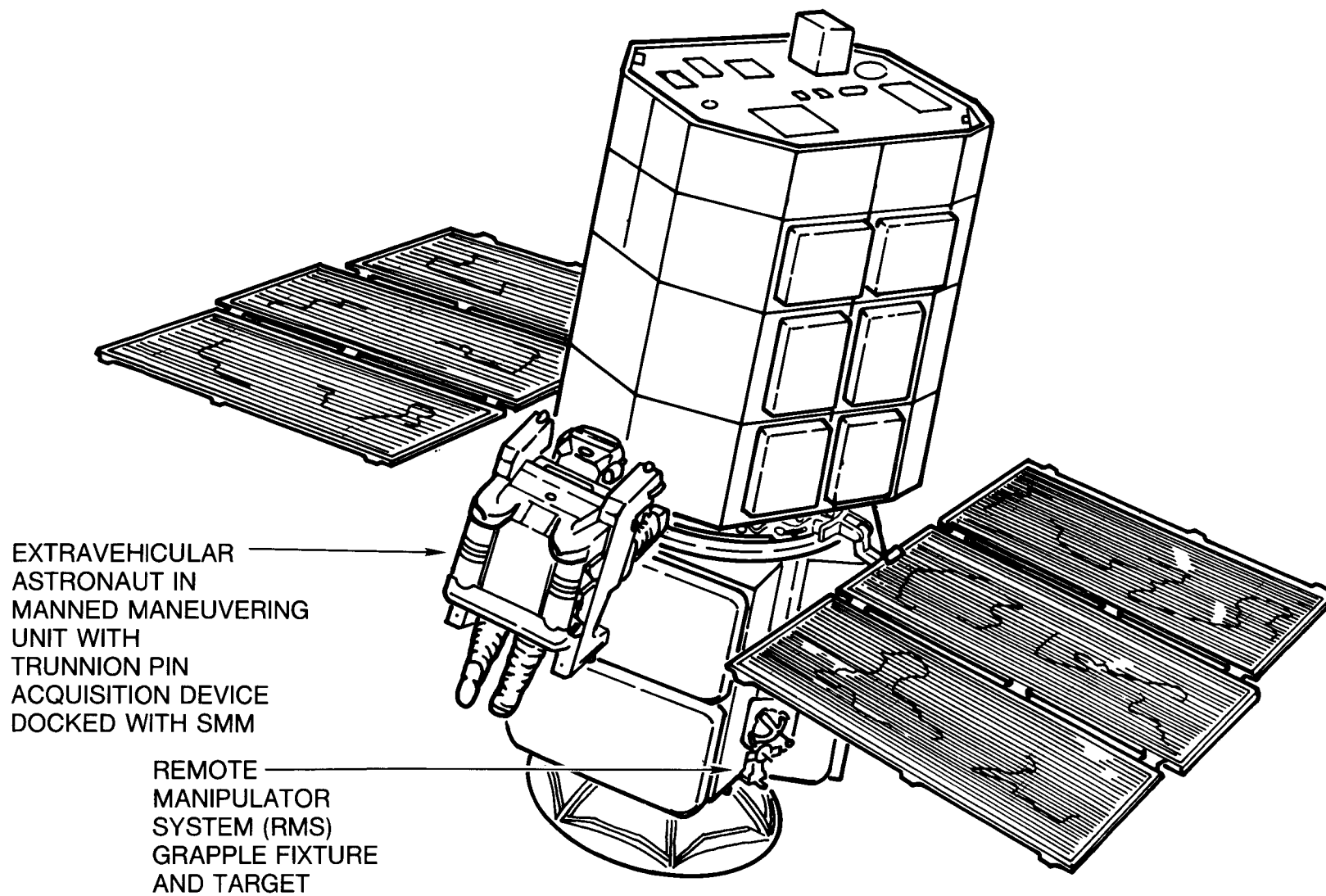
EV-1 ingresses the Manipulator Foot Restraint with tools and tethered on the RMS. The RMS positions EV-2 above the simulated SMM main electronics box (MEB) located on SPAS-01A. This simulates the work to be accomplished in the removal

and replacement of the MEB on SMM in the 41-C mission. Upon completion of these activities, EV-2 is maneuvered by the RMS to the stowage area of the MFR in *Challenger's* payload, egresses the MFR, stows the MFR and progresses, tethered for ingress to the airlock. EV-1 and EV-2 disconnect the tethers, close the airlock hatch on the payload bay side repressurize the airlock, open the hatch on the mid-deck side of the airlock and doff the EMU's.

The second EVA in the 41-B mission simulates the first EVA on the 41-C mission. The Ku-band antenna system in this second EVA will be used to transmit considerable real time television of this EVA.

EV-1 and EV-2 will prebreathe 100 percent oxygen in the EMU's in the airlock for 40 minutes prior to the EVA. The hatch on the mid-deck side of the airlock is closed and the airlock is depressurized. The hatch on the payload bay side of the airlock is opened and EV-1 and EV-2 egress the airlock.

EV-1, tethered, proceeds to the starboard (right) MMU-2/FSS and ingresses the FSS foot restraints and proceeds to checkout MMU-2 similar to what was previously accomplished during the first EVA on MMU-1. EV-2, tethered, proceeds to the port left side to SESA and prepare the TPAD for EV-2. Upon completion of EV-1 checkout of MMU-2, EV-1 will maneuver to the port side and attach the TPAD to the MMU arms. The flight crew member at *Challenger's* aft flight station positions the RMS arm to dock with SPAS-01A at its grapple fixture. SPAS-01 is unberthed from the *Challenger's* payload bay using the RMS and positions SPAS-01A above the payload bay. SPAS-01A remains attached to the RMS and the RMS rotates SPAS-01A at approximately one degree/second. EV-1 in MMU-2 with TPAD untethered, maneuvers from the payload bay to match SPAS-01A rotation rate on the RMS and will maneuver to dock with the rotating SPAS-01A using the TPAD on SPAS-01A trunnion pin. EV-1 will not try to stop SPAS-01A rotation rate, due to its rotation on the RMS. This sequence simulates the rendezvous and docking with SMM spacecraft in the mission. Upon completion of this sequence



*Solar Maximum Mission (SMM) Spacecraft*



*Extravehicular Astronaut in Manned Maneuvering Unit With Trunnion Pin  
Acquisition Device Approaching Solar Maximum Mission (SMM)  
Spacecraft for Rendezvous and Docking With Trunnion Pin*

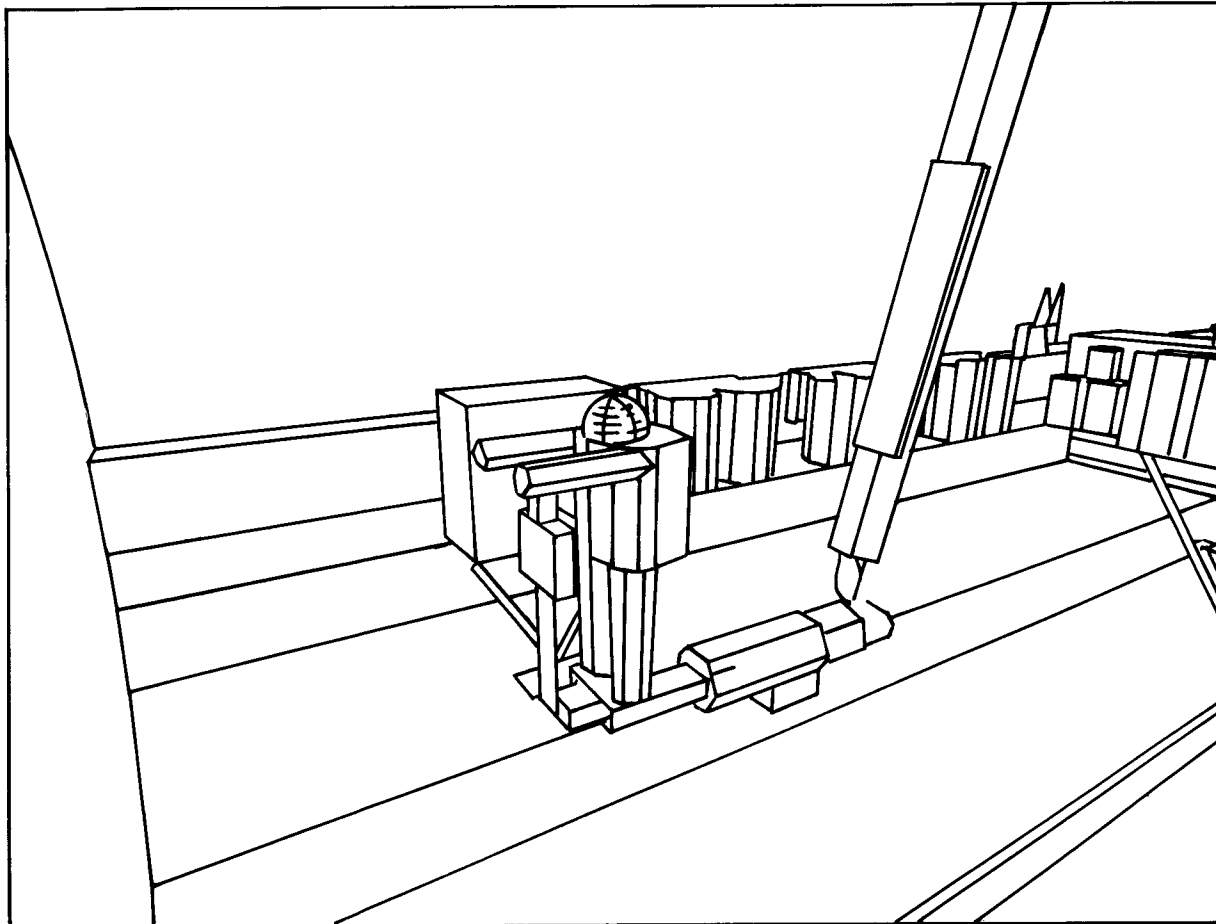
EV-1 in MMU-2 returns to the port side SESA and stows the TPAD, then progresses to the starboard FSS and stows MMU-2 in the FSS, doffs MMU-2 and recharges MMU-2 gaseous nitrogen propulsion system during the recharge of MMU-2 by EV-1, EV-2 is at the port (left) side MMU-1/FSS and recharges MMU-1.

EV-2 tethered progresses to the starboard MMU-2/FSS, and proceeds with the checkout of MMU-2 in the FSS foot restraints. Upon completion of MMU-2 checkout, EV-2 progresses to the port (left) side to SESA and attaches the TPAD to the MMU-2 arms. EV-2 in MMU-2 with TPAD untethered, maneuvers from the payload bay to rendezvous and dock with SPAS-01A similar to the EV-1 sequence. Upon completion of this sequence EV-2 in MMU-2 returns to the port side SESA and stows the TPAD, then progresses to the starboard FSS and stows MMU-2 in the FSS and doffs MMU-2.

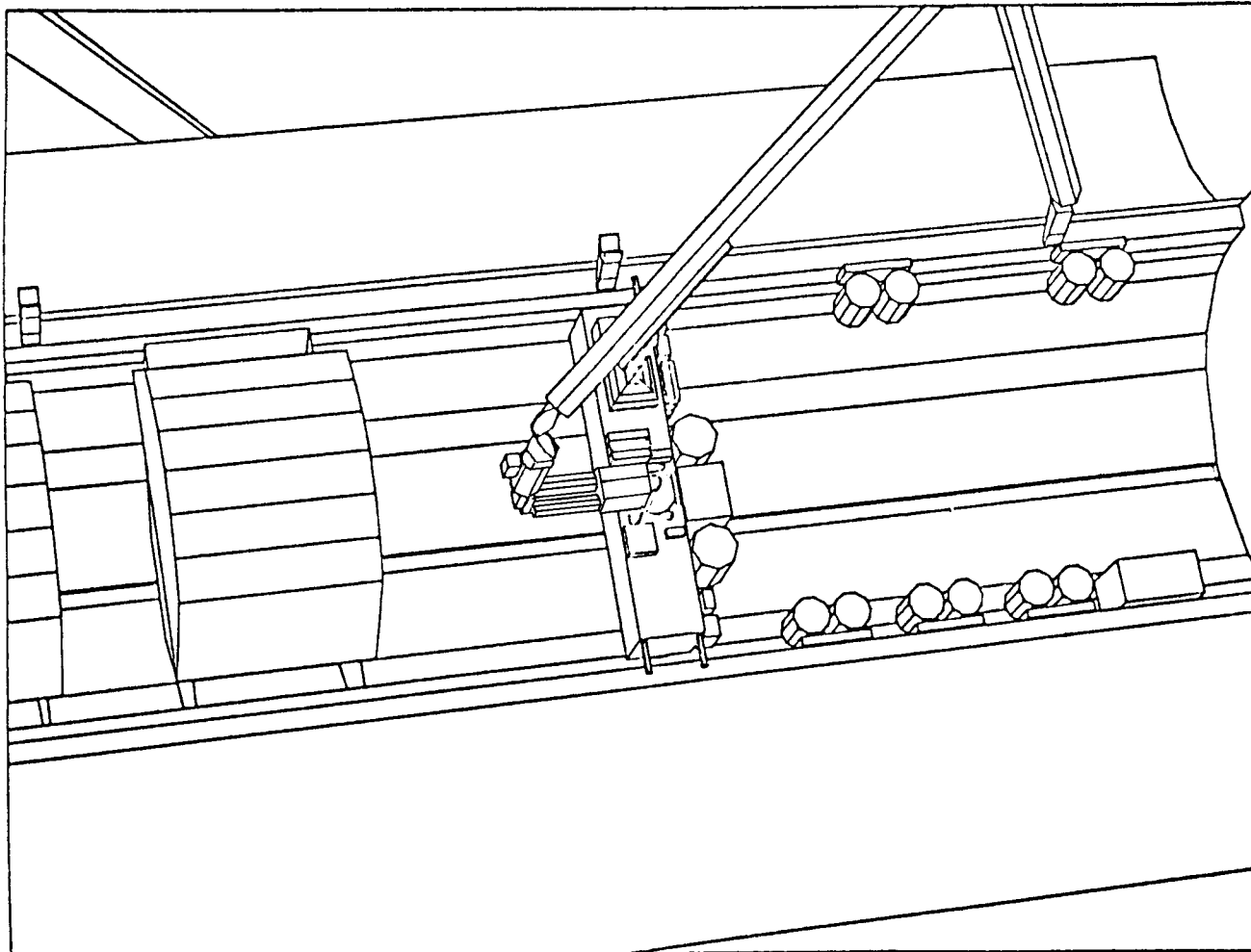
EV-1, ingresses the port (left) side MMU-1/FSS foot restraints and checks out MMU-1. EV-1 in MMU-1 will then proceed to accomplish a one hour engineering evaluation of MMU-1. EV-1 will then return MMU-1 to the port FSS, stow MMU-1 and doff MMU-1.

EV-2 tethered, during the EV-1, MMU-1 engineering evaluation progresses to the SESA and the hydrazine tool test equipment stowed in SESA. EV-2 will attach a tool to a representative valve module in SESA that would simulate the transfer of hydrazine in a space environment in a simulation of transferring hydrazine to a satellite. In this 41-B mission, a small container in SESA has Freon stored in it with a dye. EV-2 will position the valve module to permit the Freon to fill up a small line in SESA. The dye in the Freon would indicate any leakage in the valve module. In a later mission, an EVA flight crew member will transfer hydrazine. There will be two reservoirs of hydrazine and the EVA flight crew member will position a valve module permitting hydrazine to transfer from one reservoir to another, then back and forth as a demonstration of refueling a satellite.

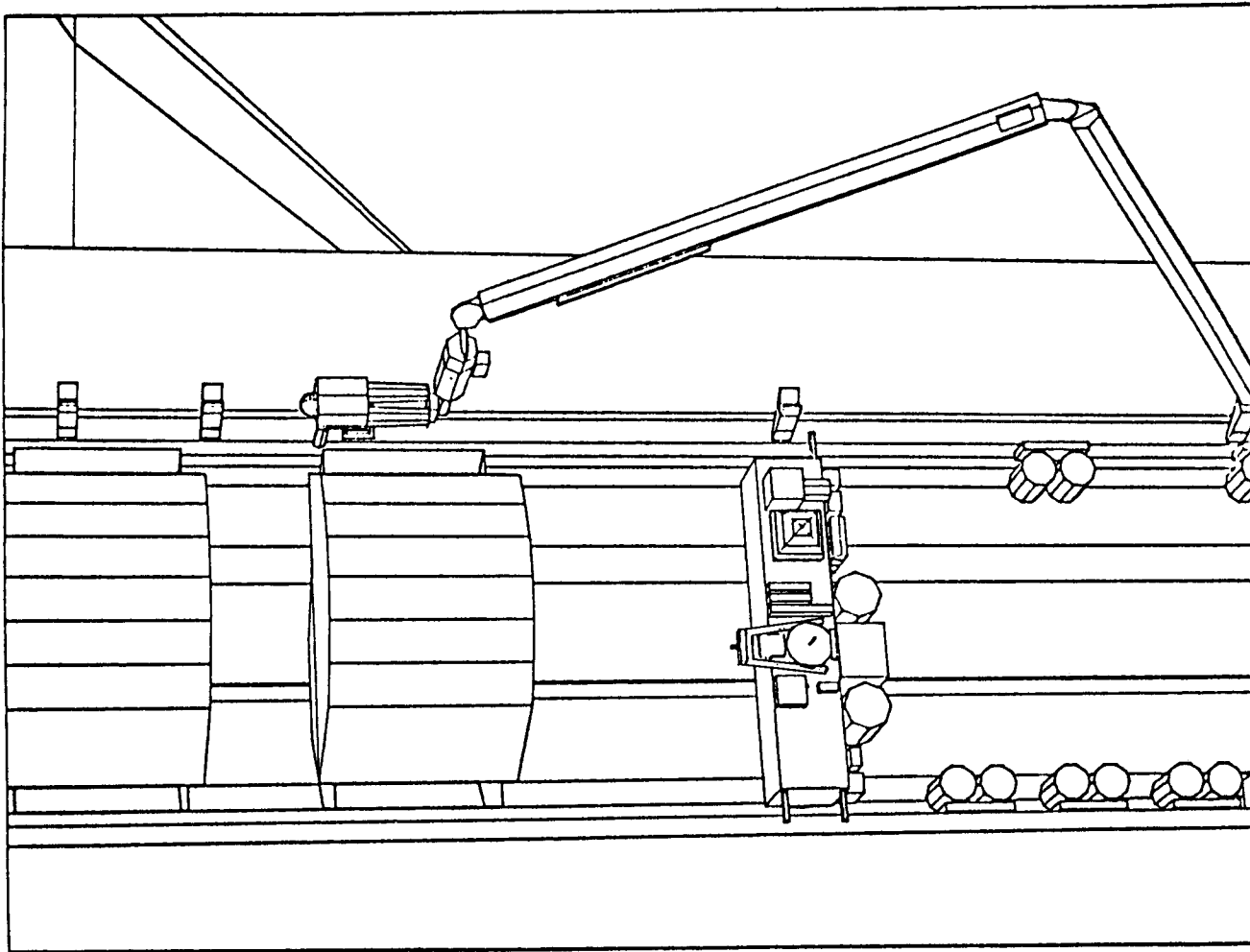
EV-1 and EV-2 will proceed after these sequences, tethered, to ingress the airlock, disconnect the tethers, close the airlock hatch on the payload bay side, repressurize the airlock, open the hatch on the mid-deck side of the airlock and proceed to doff the EMU's.



POSITIONING MANIPULATOR FOOT RESTRAINT ON REMOTE MANIPULATOR  
SYSTEM AT SPECIAL EQUIPMENT STOWAGE ASSEMBLY



EXTRAVEHICULAR ACTIVITY (EVA) EV-1 IN MANIPULATOR FOOT RESTRAINT  
(MFR) ON REMOTE MANIPULATOR SYSTEM (RMS) SIMULATING SOLAR  
MAXIMUM MISSION (SMM) MAIN ELECTRONIC BOX (MEB) REMOVAL, AND  
REPLACEMENT ON SPAS-01A DURING FIRST EVA



EXTRAVEHICULAR ACTIVITY (EVA) EV-2 IN MANIPULATOR FOOT RESTRAINT (MFR), ON REMOTE MANIPULATOR SYSTEM (RMS), PUSHING ON PORT (LEFT) LONGERON TO DETERMINE FORCE EVALUATIONS ON RMS AND DETERMINE THAT RMS PROVIDES A STABLE PLATFORM, DURING FIRST EVA

## INTEGRATED RENDEZVOUS TARGET

The Integrated Rendezvous Target (IRT) is a balloon that is stowed in a Get-Away Special canister on the port (left) side of *Challenger's* payload bay.

The balloon is jettisoned by springs from the Get-Away Special canister. Inside the jettison package is a gaseous nitrogen bottle which is used to inflate the balloon. When inflated, the balloon is two meters (6.6 feet) in diameter. The balloon is constructed of one mil thick mylar sheets. Also, inside the balloon is a 90 kilogram (200 pound) weight-mass.

When the IRT is jettisoned, the IRT will be utilized as a rendezvous target for the *Challenger*. The rendezvous of *Challenger* with the IRT evaluates the ability of *Challenger* to rendezvous with another orbiting body, such as with the Solar Maximum Mission (SMM) spacecraft in the 41-C mission. Two rendezvous maneuvers are scheduled to be accomplished with the IRT by *Challenger* in this mission.

In the STS-7 flight of *Challenger*, proximity operations were accomplished with SPAS-01. In this STS-11 mission, this will be the first rendezvous conducted in the Space Shuttle program.

When the IRT is jettisoned and inflated, the first rendezvous maneuver is conducted by *Challenger* with the IRT.

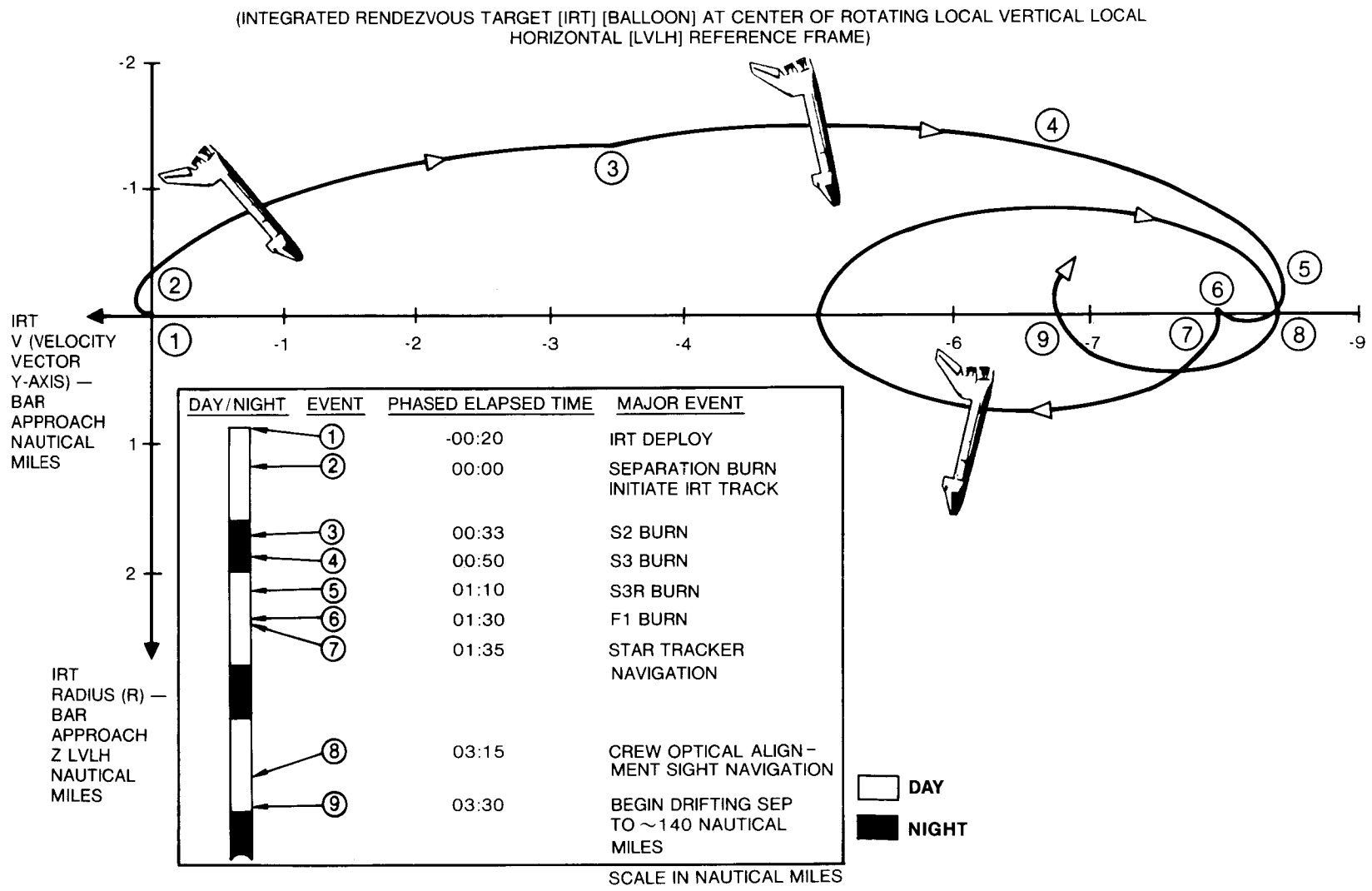
The IRT is deployed in a retrograde direction at approximately 0.4 meters per second (1.5 feet per second). Twenty minutes later, an 0.2 meters per second (0.8 feet per second) RCS maneuver is performed to ensure approximate separation for subsequent activities.

Approximately 33 minutes later a 0.8 meters per second (2.8 feet per second) maneuver is performed to position *Challenger* approximately eight nautical miles (nine statute miles) behind the IRT as the *Challenger* crosses the V-(velocity vector)-bar of the IRT. At that crossing a 2.3 meters per second (7.8 feet per

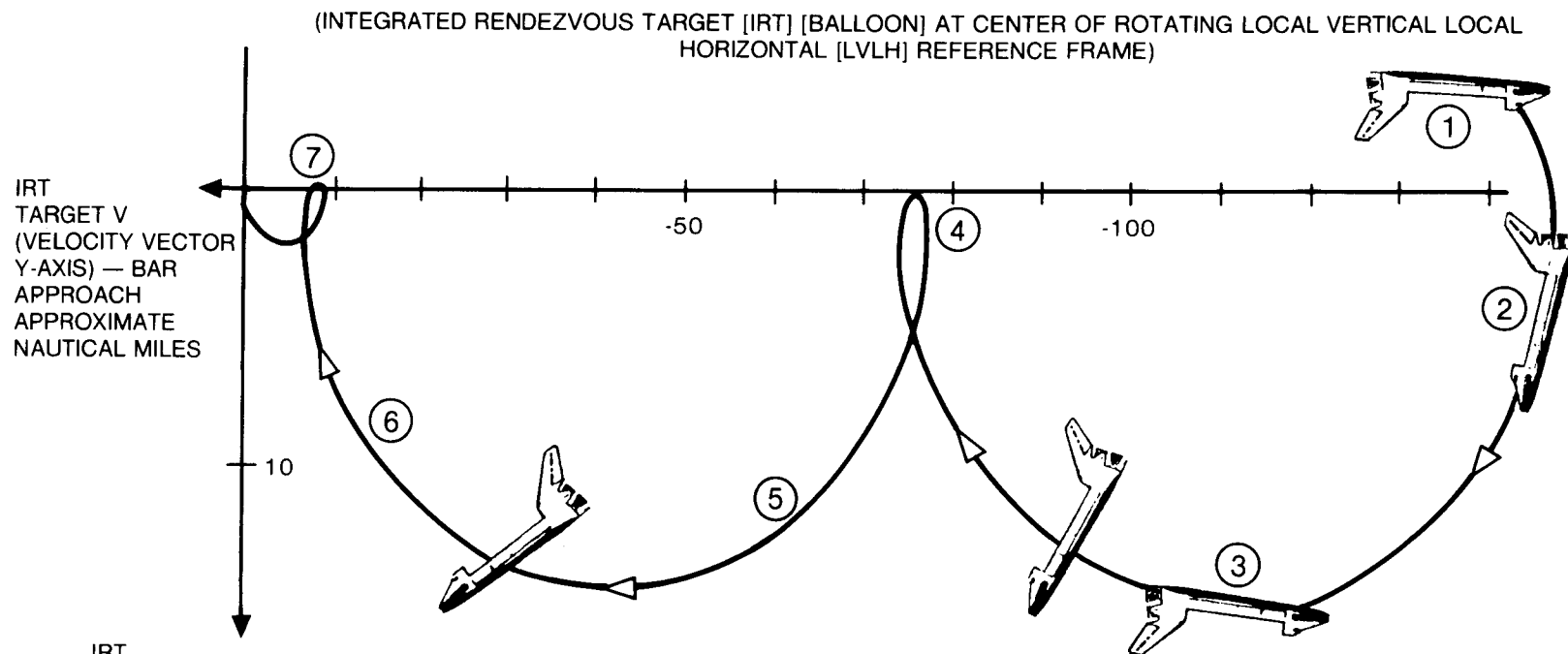
second) maneuver is performed to position *Challenger* into an orbit that positions it between five nautical miles (5.7 statute miles) and eight nautical miles (9 statute miles) behind the IRT. This portion of the test is designed to provide an opportunity to take rendezvous radar, COAS (crew optical alignment sight), and star tracker data required for rendezvous and to exercise the navigation and maneuver targeting capabilities of the onboard software and minimize the separation distance between *Challenger* and IRT for the second part of the rendezvous. After the first star tracker data take, a maneuver is targeted but not executed. The flight crew will then initiate their pre-sleep and eight hour sleep period.

The second part of the rendezvous activities occur on the subsequent day following the flight crew eight hour sleep period and post sleep activities. *Challenger* will be 140 to 150 nautical miles (161 to 172 statute miles) behind the IRT. This separation distance is due to differential drag effects on the IRT and *Challenger*. A 8.3 meter per second (27.4 feet per second) maneuver is performed to position *Challenger* eight nautical miles (9 statute miles) behind the IRT two orbits later. A star tracker opportunity occurs about eight minutes later. After this data take, a height adjustment maneuver of 1.2 meters per second (4.2 feet per second) is performed to place the apogee of *Challenger's* orbit 365 meters (1,200 feet) above the altitude of the IRT, 1.5 orbits later at the transition phases initiation point slightly less than an orbit later, following another star tracker data take, a corrective phasing maneuver of 0.1 meters per second (0.4 feet per second) is performed to ensure that *Challenger* will be eight nautical miles (nine statute miles) behind and 365 meters (1,200 feet) above the IRT at its next apogee.

When *Challenger* reaches apogee a 6.4 meters per second (21 feet per second) maneuver is performed to initiate the transition phase of the rendezvous. This portion of the rendezvous is designed to place *Challenger* 243 meters (800 feet) in front of the



*Rendezvous Profile — Phase I*



□ DAY  
■ NIGHT

DAY/NIGHT	EVENT	PHASED ELAPSED TIME	MAJOR EVENT
DAY	①	00:00	NORMAL CORRECTIVE (NC) BURN
	②	00:08	STAR TRACKER NAVIGATION
NIGHT	③	00:45	NORMAL HEIGHT (NH) BURN
DAY	④	01:35	STAR TRACKER NAVIGATION
NIGHT	⑤	02:03	NORMAL CORRECTIVE COMBINATION (NCC) BURN
DAY	⑥	02:30	RADAR NAVIGATION
DAY	⑦	03:00	TRANSITION INITIATION (TI) BURN

SCALE IN NAUTICAL MILES, DISTANCES ARE APPROXIMATE  
*Rendezvous Profile — Phase 2*

IRT one orbit later. The transition phase contains a star tracker opportunity early in orbit to provide correlative data for the rendezvous radar.

To maintain appropriate control of the trajectory, four mid course corrective maneuvers are planned. After the fourth mid

course, the flight crew will fly *Challenger* to the IRT orbit. After some proximity operations, a 1.2 meter per second (4 feet per second) maneuver is performed to establish final separation from the IRT.

## EXPERIMENTS

### MONODISPERSE LATEX REACTOR (MLR) EXPERIMENT

The monodisperse latex reactor experiment flown on *Columbia* in STS-3 produced tiny plastic spheres successfully as planned. The experiment was designed to study the feasibility of making monodisperse (identical size) polystyrene latex microspheres which may have major medical and industrial research applications.

In STS-3, the purpose of the experiment was to see whether near weightlessness in orbit would allow the polymerization reaction to continue without creaming, that is, to produce larger latex spheres without large, irregular masses of latex forming.

The examination of the product from the experiment in the STS-3 flight of *Columbia* showed that the theory was indeed correct and was 95 to 98 percent successful. Latex microspheres were made larger than scientists can produce on earth.

Some of the material produced in the STS-3 flight of *Columbia* were used as a seed in the STS-4 flight of *Columbia* to produce larger spheres.

Each of the four reactor chambers in the STS-3 mission experiment produced about 20 percent useable solids in the 100 millimeters (almost a half-cup) of raw material, each had at the start. One chamber produced spheres that were 0.2 - 0.3 microns wide as a control to be compared with ground-based spheres. The others produced spheres about 3.5 - 4.5 and 5.5 - 6.0 microns wide. Even at the largest size, it would take more than 4,200 spheres to span an inch. The largest that can be produced on the ground are 2-3 microns wide "using nonheroic measures."

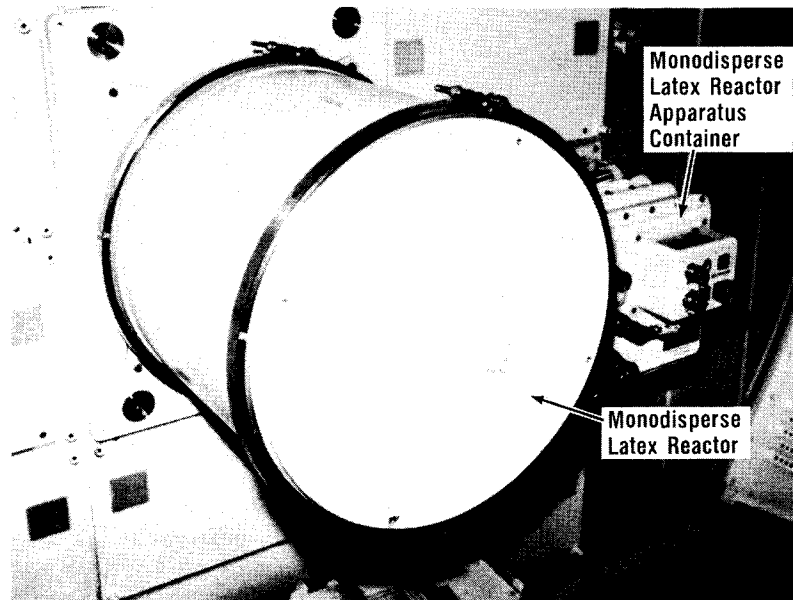
The monodisperse latex reactor (MLR) experiment on the STS-4 prevented the chemical process from taking place as planned due to a malfunction in the dc-dc converter during the

mission. Four batches of latex "seed" particles from the STS-3 flight were expected to grow in a range of sizes up to 10 microns. Due to the malfunction, the chemical process was only 55 percent completed.

During the STS-6 mission of *Challenger*, latex particles up to 20 micron diameter range were produced.

In the 41-B mission the second series of the MLR experiment is expected to produce latex particles in the 18 and 30 micron range.

Particles produced in the 10 micron range have been labeled by the National Bureau of Standards as the best example of the latex particles. The bureau is expected to place two sizes (10 and 30 microns) of the particles on the market by 1985 in the first commercial use of a product produced in space.



*MLR Experiment in Mid-Deck*

The experiment series is designed to determine whether beads up to 100 microns can be produced practically and economically in space.

This process was discovered more than 30 years ago when Dr. J.W. Vanderhoff of Lehigh University was with Dow Chemical Company. However, since Vanderhoff discovered the process, they have been limited to a maximum size of about five microns in size and still be monodisperse because gravity causes convection and other effects that limit the reaction to very small yields at great expense and effort. The experiment will help determine if much larger (perhaps as large as 40 microns) monodisperse beads can be produced practically and economically in space. One micron is a millionth of a meter. One inch is 25,400 microns long.

Possible applications for the spheres include measuring the size of pores in the wall of the human intestines in cancer research and measuring the size of pores in the human eye in glaucoma research and measuring blood flow in humans and as a carrier of drugs and radioactive isotopes for treatment of cancerous tumors.

If there is a major difference in pores within healthy and tumor cells, then the latex microspheres could become missiles that would stick inside tumors but not healthy tissues, thus carrying a higher drug dose in malignant tissue.

The experiment consists of four, 304 millimeter (12 inch) tall reactors, each containing a chemical latex forming recipe, housed in a 609 millimeter (24 inch) tall metal cylinder. The recipe is a suspension of very tiny (micron size) latex beads in water or another liquid which cause the beads to "grow" larger when the experiment is activated in space. In space, the latex mixture is heated to a constant 70 degrees Celsius (158 °F) which initiates a chemical reaction to form the larger plastic beads.

Prior to launch, each side of the reactors are loaded with 100-millimeters of the chemical latex-forming recipe. A small onboard computer will control the experiment after the flight

crew turns it on in orbit. A recorder will store all data produced during operation of the experiment. After 20 hours, the experiment turns itself off.

The reactor is removed from the *Challenger* spacecraft at the landing site and returned to the experimenters for sample and data analysis. After a cleanup and refurbishment of the experiment hardware, it will be ready for another flight.

The MLR experiment is located in the crew compartment mid-deck. It occupies the space of three mid-deck stowage lockers. It requires electrical power from the spacecraft to maintain timing and provide intermittent stowing operations in orbit.

The principal investigator on the experiment is Dr. John W. Vanderhoff of Lehigh University. The three co-investigators are Drs. Fortunato J. Micale and Mohamed S. El-Aasser, of Lehigh University, and Dale M. Kornfield of the Marshall Space Flight Center, Huntsville, Alabama.

Marshall Space Flight Center Payload Project Office, supported by the Center's Space Sciences Laboratory is responsible for producing and testing the experiment. The Spacelab Payload Project Office is also responsible for experiment safety and interfacing requirements for Space Shuttle flights.

Design support and integration of the experiment was provided by Rockwell International's Space Transportation and Systems Group, Downey, California. General Electric Company, Valley Forge, Pennsylvania built the reactors.

## **ISOELECTRIC FOCUSING (IEF) EXPERIMENT**

The isoelectric focusing experiment is a new type of electrophoresis experiment which separates proteins in an electric field according to their surface electrical charge.

The isoelectric focusing technique applies on electric field to a column of conducting liquid that contains certain molecules which carries a pH gradient in the column (alkalinity at one end,

acidity at the other end). This pH gradient causes the biological sample to move to a location in the column where it has a zero charge (its isoelectric point). The isoelectric system is capable of achieving a high resolution or purity in a sample separation.

The isoelectric focusing experiment consists of eight glass columns containing hemoglobin and blue dyed albumen. The columns are arranged in a row in the field of view of a 35mm camera.

The experiment is housed in a 228 millimeter (nine inch) high, 482 by 533 millimeter (19 by 21 inch) rectangular metal container in a mid-deck locker in *Challenger's* crew compartment.

A flight crew member will activate the equipment 23 hours into the mission and will operate for 90 minutes with 35mm pictures of the separation being taken every two to three minutes. The flight crew member will verify that the experiment has successfully turned itself off at the end of its running time.

The film from the experiment 35mm camera will be removed for processing after landing. The samples themselves are not required for post mission analysis.

Two other electrophoresis experiments, the McDonnell Douglas continuous Flow Electrophoresis System (CFES) and NASA's Electrophoresis Verification Test, have flown on previous Space Shuttle missions. The CFES demonstrated the capability of separating a large volume of biological materials. The electrophoresis verification test equipment was designed to separate high concentration of biological cells.

The isoelectric focusing experiment was developed by NASA's Marshall Space Flight Center in Huntsville, Alabama and the University of Arizona in Tucson, Arizona. The flight hardware was designed and built by laboratory personnel in Marshall's Center Science and Engineering Directorate. The protein samples are provided by the University of Arizona.

Principle investigated on the experiment is Professor Milan Bier of the University of Arizona in Tucson, Arizona. Co-investigator is Dr. Robert Snyder of the Separation Processes Branch of Marshall's Center Space Science Laboratory. Marshall's Spacelab Payload Project Office is responsible for managing the flight of the experiment.

## **ANIMAL ENCLOSURE MODULE (AEM)**

An animal enclosure module with six rats is carried into space in the mid-deck of the crew compartment and is mounted among the modular storage lockers.

The animal enclosure module with six rats was flown successfully in the STS-8 mission aboard *Challenger*.

This experiment is one of the first group of 10 high school student proposals chosen in 1981 by NASA as part of the Shuttle Student Involvement Program (SSIP). This experiment in the STS-11 mission will test the effects of weightlessness on the development of arthritis.

Dan Weber, now a student at Cornell University, designed the arthritis experiment while a student at Hunter College High School in New York City. For the past three years, he has been working closely with scientists at Pfizer Incorporated, Groton, Connecticut, at General Dynamics Convair Division, San Diego, California, and with NASA advisors. The animal enclosure module was developed by General Dynamics.

Weber's hypothesis—that arthritis may be affected by gravity—grew out of his relationship with his grandfather who suffers from rheumatoid arthritis. His grandfather's arthritis was relieved by swimming and hydrotherapy which seemed to work by reducing the inflammation and pressure on the joints. Weber learned that astronauts gained up to an inch in height in space because with no gravity the spine is not compressed as on Earth. He wondered if this lack of pressure would relieve some of the symptoms of arthritis.

In this flight, three rats will be injected with complete Freund's adjuvant, which causes symptoms similar to rheumatoid arthritis in humans. This technique is used by pharmaceutical companies to study arthritis and arthritic medications. The other three rats will be flown as normal healthy rats.

The animals will be measured at the Kennedy Space Center before the flight for weight, food and water consumption, raw volume and activity levels. A blood sample will be taken immediately after the flight to measure blood chemicals associated with arthritis. These same measurements will be made at Pfizer laboratories where Weber will work with his science advisor to determine the results of the experiment. X-rays will also be taken postflight to determine joint deterioration.

Over 15 million people suffer from arthritis.

The animal enclosure module provides the capabilities of supplying food and water as well as cycling lights on and off and is provided with the same atmosphere as that of the pressurized crew compartment. The animal enclosure module is 254 by 406 by 508 millimeters (10 by 16 by 20 inches).

#### **REMOTE MANIPULATOR SYSTEM WITNESS PLATE EXPERIMENT**

A witness plate is attached to the forearm of the remote manipulator system (RMS). The witness plate is to study oxygen interaction with materials prior the thrusting of the PAM-D perigee kick motor firing with PALAPA-B2.

The RMS is powered up to position the witness plate on the RMS forearm towards the impingement path of particle erosion from the PAM-D perigee kick motor thrusting with the PALAPA-B2 satellite.

This is to determine the effects or lack of effects of erosion particles associated with the PAM-D perigee kick motor. This is to determine if the orbiter attitude can be relaxed (orbiter spacecraft belly towards PAM-D perigee kick motor thrusting

for orbiter window protection attitude) in future Space Shuttle flights and PAM-D perigee kick motor thrusting periods.

#### **ACOUSTIC CONTAINERLESS EXPERIMENT SYSTEM (ACES)**

The ACES is a three-axis acoustic containment furnace experiment which when activated performs a preprogrammed sequence of operations on a material sample for a period of two hours and automatically shuts off. The experiment hardware is contained in two airtight canisters in the crew compartment mid-deck and operates off of orbiter 28 vdc power.

#### **CINEMA 360**

The CINEMA 360 is part of a joint endeavor agreement between NASA and CINEMA 360, Incorporated, a group of three planetariums, to produce color motion picture film of Space Shuttle operations from launch to landing. Two 35mm "Arriflex" motion picture cameras are carried aboard *Challenger* in this flight. One is in the crew compartment mid-deck with two extra film magazines and a second camera is in *Challenger's* payload bay. The camera in the payload bay is located on the starboard (right) side, mounted in a heated, pressurized Get-Away Special canister which has a lid that opens and closes and views through an optical dome using a "Fisheye" lens for photographing primarily during the EVA activities.

#### **RADIATION MONITORING EQUIPMENT (RME)**

The RME experiment is designed to measure radiation levels in *Challenger's* mid-decks at various times throughout the flight. Experiment equipment includes the Handheld Radiation Monitor (HRM-III), a gamma and electron dosimeter and the Pocket REM Meter (PRM), a neutron and proton dosimeter. The HRM-III will operate four times during the mission, while the PRM will operate twice.

## GET AWAY SPECIALS

There are five Get Away Special canister experiments in *Challenger's* payload bay. All five GAS payloads require flight crew member activation and deactivation of the experiments.

G051 is a General Telephone Laboratories, Inc., Waltham, Massachusetts, experiment which will pursue fundamental research of optical and electrical properties of an arc discharge lamp in gravity-free surroundings. Arc lamps are normally used for outdoor lighting of football fields and indoor lighting of arenas. Scientists hope the experiment will pave the way for the development of a more energy efficient light. The experiment requires three data takes during three Vernier Reaction Control System (VRCS) attitude control periods lasting less than one hour each. The experiment is in a 0.14 cubic meter (five cubic feet) canister.

G004 was purchased by L. R. Megill, a professor at Utah State University and donated to that institution. Experiments from two Utah State University students and students from the University of Aberdeen in Aberdeen, Scotland will be flown in the 0.07 cubic meter (2.5 cubic feet) canisters. The payloads are divided into three separate "space-paks," each of which is devoted to the experiment or experiments from a particular institution. This provides the experimenter with a volume approximately 101 millimeters (four inches) deep in a hexagon 482 millimeters (19 inches) between the corners. The space-paks themselves are built of foam and fiberglass and weigh approximately one kilogram (2.2 pounds) each. The three space-paks are held together with three graphite composite rods. A computer driven controller is supplied to each space-pak. Each experimenter is responsible for supplying their own battery power supply within the pak. The weight limit allotted for each experimenter is approximately 8 kilograms (17.6 pounds).

The first experiment was built by Taka Kitaura, a Utah State University student from Japan. His experiment is designed to study capillary waves in liquids. These waves are driven by surface tension forces, which are dominant in a gravity-free environment.

The second experiment was built by Scott Thomas, a Utah State University student. His experiment will study thermocapillarity, or the motion of liquids due to surface tension effects in which a temperature gradient has been established. These forces are dominant in a low gravity environment.

The third experiment contains three experiments developed by students from the University of Aberdeen in Aberdeen, Scotland. These experiments include a dimensional stability experiment, a light scattering experiment and the flight of some spores in space.

G008 was purchased by Utah Section of the American Institute of Aeronautics and Astronautics (AIAA) and donated to Utah State University for use in their Space Science program. The payloads are divided into three separate "space-paks" similar to the G-004 Get Away Special 0.07 cubic meter (2.5 cubic feet) canister. The payload was assembled at Utah State University with Dr. Rex Megill acting as payload coordinator, but it has experiments designed by students and faculty at Brighton High School, Salt Lake City, Utah and the University of Utah as well as University of Utah students.

The Brighton High School experiment was built by students from that institution under the direction of faculty members John Barainca and Leigh Gunnell. Students participating in the project include David Prince, Craig Peters and Janet Rollins. Seedlings or radishes will be sprouted in the zero-g environment. The presence of a light source will allow them to check the nature of the phototropic response under these conditions. A unique feature of this experiment is that about one-half of the seeds germinated in this experiment will be in space for the second time. They were flown aboard STS-5 *Columbia* by the Park Seed Company.

The university of Utah experiment was designed and constructed by students and faculty. Faculty advisors were Dr. George E. Gerpheide and Dr. Kathryn Ely. Students included in the project were Dave Beaufort, Hal Jackson, Bill Madsen and Ed Mathias. The experiment will involve an attempt to crystallize proteins under zero-g conditions. The

crystallization of proteins is necessary for X-ray crystallography, an important tool for biochemists. Crystal growth requires well controlled temperatures. An attempt will be made to control temperature using a thermal ballast composed of eutectic salt solution with a melting temperature near 25°C (77°F).

The third portion of the payload has two experiments constructed by two Utah State University students. The first is a reflight of the soldering experiment flown by Chris Alford on G-001 in the STS-4 mission aboard *Columbia*. This is the separation of flux from solder while soldering in microgravity. The second is a test of an experimental concept for the creation of a flow system for electrophoresis experiments. This system was designed by Von Walden. It is anticipated that the results will be of aid in the development of similar systems on later flights.

A computer driven controller is supplied to each space-pak, designed and built by Mr. Sawat Tantiphanwadi, a graduate student at Utah State University. Each experimenter is responsible for supplying their own battery supply within the space-pak.

G349 is a 8.14 cubic meter (5 cubic feet) canister by NASA's Goddard Space Flight Center. This is a reflight of a similar experiment flown on *Challenger* in the STS-8 mission, and one successfully flown on the OSS (Office of Space Science)-pallet in *Columbia* in the STS-3 mission. This Contamination Monitor Package (CMP) is mounted on the outside of the canister lid. The CMP experiment is to determine the effect of atomic oxygen within *Challenger's* environment. The experiment is built entirely with reusable or recycled parts.

The dramatic effect of atomic oxygen seen after most of the past Space Shuttle flights sparked interest in understanding the mechanisms and the orbital environment itself. The STS-8 attitudes provided an opportunity to look at these effects in an accelerated environment and provided an excellent calibration for the reaction efficiency for both the carbon and osmium films. However, it was unrealistic in terms of attitude and altitude and

provided relatively little information regarding scattering effects. This experiment has been designed to measure the atomic oxygen flux in two directions 90 degrees apart in a unique way. The experiment will measure the rate of mass loss of two materials known to readily oxidize, carbon and osmium. The information learned from this experiment will not only help future Space Shuttle missions, but also will provide insights to material behavior and environmental effects at higher altitudes for future missions like Space Telescope and Solar Maximum Mission.

Besides being the support structure, the GAS canister provides the electrical power (battery), storage of commands (in a read-only-memory) and data storage (tape recorder). As with the OSS-1 flight on STS-3 and on STS-8, the CMP contains four temperature-controlled quartz crystal microbalances (TQCMs) as its only sensors. TQCMs are very sensitive instruments which accurately measure mass changes of a crystal. TQCMs have traditionally been used to measure mass build ups of contamination of a crystal to determine molecular contamination levels. In this application, they will be used to measure the mass loss of a material (carbon and osmium) deliberately deposited before the flight. One sensor is left uncoated as a reference. The uncoated TQCM along with one coated carbon and another coated with osmium will face out of the bay, and the fourth TQCM with carbon will face aft. The mass loss of carbon and osmium will indicate the atomic oxygen flux as a function of time which can be correlated to altitude, attitude, and direction. Laboratory studies of reaction rates for these coatings will yield absolute rate determination. The sensors crystals for the 41-B mission have been replaced so that the STS-8 crystals could be analyzed and the top thermal blanket has been repaired. All other components are the same. The experiment is prepared by NASA's Goddard Space Flight Center and the co-investigators are Jack J. Triolo, Roy McIntosh, and Ray Kruger of Goddard Space Flight Center, Maryland.

GAS 349 is a reflight of the successful similar experiment flown on STS-8, *Challenger*. The experiment is a 0.14 cubic meter (5 cubic feet) canister. G349 is a cosmic ray upset experi-

ment (CRUX) to determine how charged particles might upset or change the logic state of a memory cell. This is the second flight of this experiment designed to resolve many of the questions concerning upsets caused by single particles. An upset or change in logic state, of a memory well can result from a single, highly energetic particle passing through a sensitive volume in a memory cell. In doing so, it deposits or loses energy, and if enough energy is deposited, the memory cell can change state. In some technologies, enough energy can be deposited to cause another effect, called "latchup," which can result in the device destroying itself by drawing excessive current.

Positive determination of the cause of an upset in flight is difficult because of other influences, such as electromagnetic interference (EMI), noise on power supply lines, or voltage dropouts, can result in the same device behavior as if induced by cosmic rays.

This experiment first flew on STS-8, and no upsets were experienced. However, since only four days of data were acquired during that mission, and since the predicted error rate for the entire memory was only one per day plus or minus a factor of about three, more flight time is needed in order to increase confidence that the final answer is statistically meaningful. That is, considering the predicted error rate, no errors in four days is quite possible, but no errors in a total of 10 or 11 days flight time (STS-8 plus STS-11) would be unlikely, and would indicate that prediction models are pessimistic and need to be refined. Thus, whether or not upsets occur, test results from CRUX will at least partially define the scope of the upset problem and therefore accomplish a goal of the experiment.

The experiment is prepared by the Goddard Space Flight Center and the principle investigator is John W. Adolphsen of Goddard Space Flight Center.

## KENNEDY SPACE CENTER SHUTTLE LANDING FACILITY

The runway at the Kennedy Space Center, Florida Shuttle landing facility is among the world's most impressive in terms of length and width. The runway is 4,572 meters (15,000 feet) in length plus a 304 meter (1,000 foot) overrun at each end. The width of the runway is 91 meters (300 feet). The concrete runway 22/04 at Edwards Air Force Base, Calif., matches the Kennedy Space Center runway in length and width with an overrun of eight kilometers (five miles) extending into the dry lake bed when landing on 04.

The Kennedy Space Center runway on a northwest-southeast alignment is designated runway 15 from the northwest to southeast and runway 33 from the southeast to the northwest. The runway is located approximately 3 kilometers (2 miles) northwest of the 160 meter (525 feet) tall Vehicle Assembly Building. The runway required approximately 546 hectares (1,350 acres) of land area, most of it high, dry land. Its use before the lands were purchased in the early 1960's was primarily agriculture. The runway is 406 millimeters (16 inches) thick in the center with thickness diminishing to 381 millimeters (15 inches) on the sides. Underlaying the concrete paving completed in late October 1975, is a 152 millimeter (6 inch) thick base of soil cement. The concrete used in paving the landing facility required about 1,000 carloads of cement and 10,000 carloads of crushed limestone and sand aggregate. 192,679 cubic meters (252,000 cubic yards) of concrete was used in paving the runway. The landing facility was built and outfitted at a cost of \$27.2 million.

The runway is grooved, together with the slope of the runway, 609 millimeters (24 inches) from centerline to edge, provides rapid drain off of any water from a heavy Florida rain, preventing hydroplaning.

From its inception, the Shuttle landing facility was designed as an ecological model for airfield construction and environmental impact was held to a minimum.

The orbiter navigation system acquires the Microwave Scan Beam Landing System (MSBLS) usually on or near the final leg of the heading alignment cylinder for the TAEM (Terminal Area Energy Management)/Autoland interface. The ground based MSBLS components are located in small shelters off the west side of the runway.

The two MSBLS azimuth/distance measuring equipment shelters at the far end of each runway is approximately 396 meters (1,300 feet) beyond the stop end of each end of the runway and 94 meters (308 feet) to the west of the runway's centerline. The MSBLS azimuth/distance measuring equipment shelter sends signals which sweep 15 degrees on each side of the landing path with directional and distance data.

The two MSBLS elevation stations are approximately



*Runway at KSC*

1,082 meters (3,500 feet) in from the runway threshold at each end of the runway. Signals from the MSBLS shelter near the spacecraft touchdown point sweep the landing path to provide elevation data up to 30 degrees. The three MSBLS system aboard the spacecraft receives these data and the spacecraft adjusts to the glide path. The two radar altimeters aboard the spacecraft provide altitude information in the spacecraft when it is below 1,524 meters (5,000 feet) altitude.

Approach lights point to the runway centerline and the threshold and edge lights outline the field similar to a commercial runway.

The tow way from the Shuttle Landing Facility to the Orbiter Processing Facility is approximately 3.2 kilometers (2 miles).

It is noted, that during the entry and landing phase planned for runway 15 at the Kennedy Space Center, Fla., C-band tracking stations at San Nicholas Island off the coast of California, Vandenberg Air Force Base, California, White Sands, New Mexico, Stallion Station, Arizona, Scotts Peak, Arizona and Mt. Lemmon, Arizona, will provide highly critical tracking data on the *Challenger* before it comes into view of the Eastern Test Range C-band stations at Merritt Island and Patrick Air Force Base, Florida. The Goddard Space Flight Center (GSFC) Merritt Island S-band station will provide highly critical telemetry, command and air-ground support as well as tracking data to the Johnson and Kennedy Control Centers.



## **NEWS About Space Flight**

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### **STS-1 MISSION FACTS (COLUMBIA) APRIL 12-14, 1981**

Commander: John W. Young  
Pilot: Robert L. Crippen  
Mission Duration—54 hours, 21 minutes, 57 seconds  
Miles Traveled—Approximately 933,757 nautical miles  
(1,074,567 statute miles)  
Orbits of Earth—36  
Orbital Attitude—145 nautical miles (166 statute miles)  
Landing Touchdown—853 meters (2,800 feet) beyond planned  
touchdown point

Landing Rollout—2,741 meters (8,993 feet) from main gear  
touchdown  
Orbiter Weight at Landing—Approximately 89,014 kilograms  
(196,500 pounds)  
Landing Speed at Main Gear Touchdown—180 to 185 knots  
(207 to 212 mph)  
STS-1 Liftoff Weight—Approximately 2,020,052 kilograms  
(4,453,379 pounds)  
Landed—Runway 23 dry lake bed at Edwards Air Force  
Base, Calif.

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### **STS-2 MISSION FACTS (COLUMBIA) NOVEMBER 12-14, 1981**

Commander: Joe Engle  
Pilot: Richard Truly  
Mission Duration—54 hour, 24 minutes, 4 seconds  
Miles Traveled—Approximately 933,757 nautical miles  
(1,074,567 statute miles)  
Orbits of Earth—36  
Orbital Altitude—137 nautical miles (157 statute miles)  
Landing Touchdown—Approximately 304 meters (1,000 feet)  
earlier than planned touchdown point  
Landing Rollout—Approximately 2,133 meters (7,000 feet)

from main gear touchdown  
Orbiter Weight at Landing—Approximately 92,534 kilograms  
(204,000 pounds)  
Landing Speed at Main Gear Touchdown—Approximately  
195 knots (224 miles per hour)  
STS-2 Liftoff Weight—Approximately 2,030,287 kilograms  
(4,475,943 pounds)  
STS-2 Cargo Weight—Approximately 8,771 kilograms  
(19,388 pounds)  
Landed—Runway 23 dry lake bed at Edwards Air Force  
Base, Calif.

**STS-3 MISSION FACTS**  
**(COLUMBIA)**  
**MARCH 22-30, 1982**

Commander: Jack Lousma  
Pilot: Gordon Fullerton  
Mission Duration—192 hours (8 days), 6 minutes, 9 seconds  
Miles Traveled—Approximately 3.9 million nautical miles  
(4.4 million miles)  
Orbits of Earth—130  
Orbital Altitude—128 nautical miles (147 statute miles)  
Landing Touchdown—Approximately 359 meters (1,180 feet)  
from threshold  
Landing Rollout—Approximately 4,185 meters (13,732 feet)  
from main gear touchdown

Orbiter Weight at Landing—Approximately 94,122 kilograms  
(207,500 pounds)  
Landing Speed at Main Gear Touchdown—Approximately  
220 knots (253 miles per hour)  
STS-3 Liftoff Weight—Approximately 2,031,653 kilograms  
(4,478,954 pounds)  
STS-3 Cargo Weight—Approximately 9,658 kilograms  
(21,293 pounds)  
Landed—Runway 17 lake bed at White Sands Missile Range,  
New Mexico

**STS-4 MISSION FACTS**  
**(COLUMBIA)**  
**JUNE 27-JULY 4, 1982**

Commander: Ken Mattingly  
Pilot: Henry Hartsfield  
Mission Duration—168 hours (7 days), 1 hour, 10 minutes,  
43 seconds  
Miles Traveled—Approximately 2.9 million nautical miles  
(3.3 million statute miles)  
Orbits of Earth—112 orbits  
Orbital Altitude—160 nautical miles (184 statute miles), then  
to 172 nautical miles (197 statute miles)  
Landing Touchdown—Approximately 288 meters (948 feet)  
from threshold

Landing Rollout—Approximately 2,924 meters (9,595 feet)  
from main gear touchdown  
Orbiter Weight at Landing—Approximately 95,029 kilograms  
(209,500 pounds)  
Landing Speed at Main Gear Touchdown—Approximately  
195 knots (224 miles per hour)  
STS-4 Liftoff Weight—Approximately 2,033,437 kilograms  
(4,482,888 pounds)  
Landed—Runway 22 concrete at Edwards Air Force Base,  
Calif.

**STS-5 MISSION FACTS**  
**(COLUMBIA)**  
**NOVEMBER 11-16, 1982**

Commander: Vance D. Brand  
Pilot: Robert F. Overmyer  
Mission Specialist: Joseph P. Allen  
Mission Specialist: William B. Lenoir  
Mission Duration—120 hours (5 days), 2 hours, 15 minutes,  
29 seconds  
Miles Traveled—1.5 million nautical miles  
(1.8 million statute miles)  
Orbits of Earth—81  
Orbital Altitude—160 nautical miles (184 statute miles)  
Landing Touchdown—Approximately 498 meters (1,637 feet)  
from threshold

Landing Rollout—Approximately 2,911 meters (9,553 feet)  
from main gear touchdown  
Orbiter Weight at Landing—Approximately 92,581 kilograms  
(204,103 pounds)  
Landing Speed at Main Gear Touchdown—Approximately  
198 knots (227 miles per hour)  
STS-5 Liftoff Weight—Approximately 2,036,010 kilograms  
(4,488,559 pounds)  
STS-5 Cargo Weight Up—Approximately 14,974 kilograms  
(33,013 pounds)  
Landed—Runway 22 concrete at Edwards Air Force Base,  
Calif.

**STS-6 MISSION FACTS**  
**(CHALLENGER)**  
**APRIL 4-9, 1983**

Commander: Paul Weitz  
Pilot: Karol Bobko  
Mission Specialist: Donald Peterson  
Mission Specialist: Story Musgrave  
Mission Duration—120 hours (5 days), 24 minutes,  
31 seconds  
Miles Traveled—1,819,859 nautical miles  
(2,092,838 statute miles)  
Orbits of Earth—80  
Orbital Altitude—153.5 nautical miles (176.6 statute miles)  
Landing Touchdown—Approximately 548 meters (1,800 feet)  
beyond threshold

Landing Rollout—Approximately 2,225 meters (7,300 feet)  
from main gear touchdown  
Orbiter Weight at Landing—Approximately 89,177 kilograms  
(196,600 pounds)  
Landing Speed at Main Gear Touchdown—Approximately  
195 knots (224 miles per hour)  
STS-6 Liftoff Weight—Approximately 2,036,889 kilograms  
(4,490,498 pounds)  
Cargo Weight Up—Approximately 20,658 kilograms  
(45,544 pounds)  
Landed—Runway 22 concrete at Edwards Air Force Base,  
Calif.

**STS-7 MISSION FACTS**  
**(CHALLENGER)**  
**JUNE 18-24, 1983**

Commander: Robert L. Crippen  
Pilot: Frederick H. Hauck  
Mission Specialist: Sally K. Ride  
Mission Specialist: John M. Fabian  
Mission Specialist: Norman E. Thagard  
Mission Duration—144 hours (6 days), 2 hours, 25 minutes, 41 seconds  
Miles Traveled—2,198,964 nautical miles (2,530,567 statute miles)  
Orbits of Earth—97  
Orbital Altitude—160 nautical miles (184 statute miles) to 160 x 165 nautical miles (184 x 189 statute miles) to 160 x 170 nautical miles (184 x 195 statute miles) to 157 x 170 nautical miles (180 x 195 statute miles) to 157 nautical miles (180 statute miles)

Landing Touchdown—Approximately 831 meters (2,727 feet) beyond threshold  
Landing Rollout—Approximately 3,185 meters (10,450 feet) from main gear touchdown  
Orbiter Weight at Landing—Approximately 92,069 kilograms (202,976 pounds)  
Landing Speed at Main Gear Touchdown—Approximately 205 knots (235 miles per hour)  
STS-7 Liftoff Weight—Approximately 2,034,666 kilograms (4,485,579 pounds)  
Cargo Weight Up—Approximately 14,553 kilograms (32,085 pounds)  
Landed—Runway 15 lake bed at Edwards Air Force Base, Calif.

**STS-8 MISSION FACTS**  
**(CHALLENGER)**  
**AUGUST 30 — SEPTEMBER 5, 1983**

Commander: Richard H. Truly  
Pilot: Daniel C. Brandenstein  
Mission Specialist: Guion S. Bluford, Jr.  
Mission Specialist: Dale A. Gardner  
Mission Specialist: William E. Thornton  
Mission Duration—144 hours (6 days), 1 hour, 9 minutes, 32 seconds  
Miles Traveled—2,184,983 nautical miles (2,514,478 statute miles)  
Orbits of Earth—97  
Orbital Altitude—160 nautical miles (184 statute miles) to 166 x 160 nautical miles (191 x 184 statute miles) to 166 x 121 nautical miles (191 x 139 statute miles) to 121 nautical miles (139 statute miles)

Landing Touchdown—Approximately 853 meters (2,800 feet) beyond threshold  
Landing Rollout—Approximately 2,804 meters (9,200 feet) from main gear touchdown  
Orbiter Weight at Landing—Approximately 92,657 kilograms (204,272 pounds)  
Landing Speed at Main Gear Touchdown—Approximately 195 knots (224 miles per hour)  
STS-8 Liftoff Weight—Approximately 2,038,027 kilograms (4,493,007 pounds)  
Cargo Weight Up—Approximately 10,255 kilograms (26,609 pounds)  
Landed—Runway 22 concrete at Edwards Air Force Base, Calif.  
First night launch and night landing

**STS-9 MISSION FACTS**  
**(COLUMBIA)**  
**NOVEMBER 28 — DECEMBER 8, 1983**

Commander: John Young  
Pilot: Brewster Shaw  
Mission Specialist: Robert Parker  
Mission Specialist: Owen Garriott  
Payload Specialist: Byron Lichtenberg  
Payload Specialist: Ulf Merbold  
Mission Duration: 240 hours (10 days), 7 hours, 48 minutes  
17 seconds  
Miles Traveled—3,732,928 nautical miles  
(4,295,853 statute miles)  
Orbits of Earth—166  
Orbital Altitude—135 nautical miles (155 statute miles)  
Landing Touchdown—Approximately 518 meters (1,700 feet)  
beyond planned touchdown point

Landing Rollout—Approximately 2,734 meters (8,970 feet)  
from main gear touchdown  
Orbiter Weight at Landing—Approximately 99,894 kilograms  
(220,225 pounds)  
Landing Speed at Main Gear Touchdown—Approximately  
183 knots (210 miles per hour)  
STS-9 Liftoff Weight—Approximately 2,044,123 kilograms  
(4,506,446 pounds)  
Cargo Weight Up and Down—Approximately 15,233 kilo-  
grams (33,584 pounds)  
Landed—Runway 17 dry lake bed at Edwards Air Force  
Base, Calif.



## NEWS About Space Flight

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### STS-9 SUMMARY

The STS-9 flight crew performed 206 attitude maneuvers and two orbital altitude change maneuvers in support of Spacelab-1 and its experiments during the STS-9 mission. Due to Spacelab-1 experiment power requirements being about 1.0 to 1.5 kilowatts below preflight predicted levels, adequate *Columbia* cryogenic oxygen and hydrogen consumables remained to extend the mission one day (from 9 to 10 days) and still have the necessary contingency reserves.

The primary objective of the flight was to successfully conduct verification flight tests (VFT's) of Spacelab as an operational element of the Space Transportation System and within remaining timeline constraints to conduct normal scientific Spacelab operations.

The STS-9 flight was launched on November 28, 1983, at 15:59:59.991 G.M.T. (10:59:59.991 a.m. E.S.T.) at Kennedy Space Center, Florida, and landed at Edwards AFB, California, on December 8, 1983 at 3:48 a.m. P.S.T. with the heaviest landing weight flown to date. This flight was launched on the most northern inclination (57.5 degrees) of any U.S. manned flight. The six man flight crew for this Spacelab mission, the largest ever flown, was composed of four astronauts and two non-astronaut payload specialists, one of the first foreign person to be launched by the U.S. Space program. The crew members were John W. Young, Commander; Major Brewster H. Shaw Jr., Pilot; Owen K. Garriott PhD, and Robert A. Parker PhD,

mission specialists; and Byron K. Lichtenberg, PhD, and Ulf Merbold, PhD, payload specialists. The six crew members were divided into two teams, red and blue, enabling the two 12-hour work shifts each day and thereby maximizing the scientific data gathering from the 71 experiments onboard Spacelab. This mode of operation was very successful as indicated by the vast amount of scientific data collected and the successful completion of all 94 planned flight test objectives.

The ascent phase was nominal with the vehicle being inserted into a 135 nautical mile (155 statute mile) circular orbit, as planned.

Spacelab activation was initiated on time and all experiment systems operated normally, thus causing no switchover to backup systems. One apparently temperature-related problem occurred in the remote acquisition unit (RAU) 21. This unit served all NASA instruments on the pallet and horizon sensor. Analysis during the mission suggested a correlation between the freon fluid temperature and the RAU 21 problem. Subsequent operations of RAU 21 with temperatures about 22 °C (71 °F) resulted in problem-free operation.

**Spacelab Experiments Summary.** The degree of achievement of scientific objectives is evidence of successful payload integration. The scientific portion of the SL-1 mission showed a high degree of objectives accomplished. A "quick-look" assessment

by the scientists indicate the following percent accomplishment; however, the scientific success can only be completely determined after all collected data are evaluated.

In the discipline of life sciences, 11 of 16 experiments were 100-percent successful, and the other five achieved 50 to 90 percent of their planned objectives.

The astronomy and solar physics experiments discipline indicate 100-percent success with four of six experiments and 95 percent with another. The sixth experiment, INA008 (Active Cavity Radiometer), has not been assessed at this date.

The plasma physics discipline indicates 100-percent success with one experiment and 80 to 90 percent with the other four.

The atmospheric physics and earth observation discipline experienced 75 to 100-percent success with five experiments. The other one indicated limited success because of the launch slip to November 28, 1983.

Five materials processing experiments, including the tribology, had 100-percent successful accomplishment of objectives. The remaining were processed in IES300 (Double Rack Facility). Within that facility (materials science double rack), the gradient heating facility experiments and fluid physics module experiments were 100-percent successful, and the isothermal heating facility experiments and mirror heating facility experiments achieved 50 percent and 60 percent, respectively.

ESA experiment 1ES300 (materials science double rack) started operations on day two and was very successful in operating the fluid physics module and the gradient heating facility; however, the isothermal heating facility and the mirror heating facility failed on day three due to power supply problems. The mirror heating facility was later restored to operation by crew action.

ESA experiments 1ES020 (phenomena induced by charged

particles—passive unit) and 1ES022 (very wide field galactic camera) were both successfully installed and operated from the scientific airlock on days two and five, respectively.

ESA experiment 1EA034 (microwave remote sensing) began operations on day three and operated successfully in a passive mode, but would not function in an active mode.

INS002 (Space Experiments with Particle Accelerators—SEPAC) operations began on day zero and were successfully conducted throughout the mission except for the failure of the EBA (electron beam assembly) to operate in a high-power beam mode.

Even though experiment INS003 (Atmospheric Emissions Photometric Imaging — AEPI) had to remain locked in position, Orbiter attitude pointing enabled 80 percent of the data collection objectives to be achieved.

Significant materials science findings included the first silicon melt/crystal growth in space, confirmation of Marangoni convection effect in space, and suggestive results in fluid physics.

Significant life science findings included indications of increased reliance upon vision for orientation in space, mildly provocative testing appears practical for study of space adaptation syndrome, early and significant adaptation for mass discrimination observed, fungus maintained circadian growth cycle in microgravity and interesting caloric nystagmus results.

The commander and pilot, who spent their shifts on the flight deck supporting Spacelab-1 operations, exposed about 7,000 frames of film in out-the-window photographic activities.

The *Columbia*/Spacelab-1 interfaces involving electrical, fluid and mechanical was excellent with only one significant anomaly. On two occasions the Spacelab Subsystem Computer Operating System (SCOS) rejected MCC-H uplinked high data rate recorder (HDDR) “standby” commands as invalid.

Partial explanations for the-less-than-Spacelab-1-predicted power consumption are that some Spacelab-1 experiments were not operated as much as originally timed and heater duty cycles were less than predicted during Spacelab-1 cold test and some experiments as well as the Verification Flight Instrumentation (VFI) operated at less than predicted power levels.

With the exception of a minor number of anomalies, the Spacelab system operated satisfactorily to support the secondary objective of the mission that was to obtain valuable scientific, applications, and technology data from the joint United States and European multidisciplinary payload and to demonstrate, to the user community, the broad capability of Spacelab for scientific research. Among the highlights of the mission were the successful on-orbit repair of several malfunctioning instruments, the excellent television coverage and voice communications, and many opportunities for repeated or modified experiment operations.

After the completion of planned and extended Spacelab activities, the Spacelab was deactivated and stowage preparations were begun for entry.

At 342:11:10:21 G.M.T., about five hours prior to the planned landing time, GPC (general purpose computer)-1 failed. About six minutes later, GPC-2 also failed. Attempts to bring GPC-1 back on line were unsuccessful and it was powered down for the rest of the mission. A ground review of the GPC-2 memory dump indicated that memory alterations had occurred, however, GPC-2 was reinitialized and was placed back in the redundant set. Also, IMU (inertial measurement unit)-1 failed during this last day of the mission. Because of the GPC and IMU failures and analysis required, the landing time was delayed about 7-3/4 hours to 342:23:47:24 G.M.T. No activities were planned during this period of delay except to maintain the crew in a state of readiness for entry.

Nominal entry preparations were completed well ahead of the deorbit maneuver which was performed at 342:22:52:00 G.M.T. for a duration of 156 seconds. All scheduled PTI (pro-

grammed test input) maneuvers were performed except PTI 10, which was deleted due to the HAC (heading alignment circle) maneuver. The entry was nominal in all respects until about 4-1/2 minutes before landing when an APU (auxiliary power unit)-1 temperature measurement showed a rapid rise rate, and when the nose wheel touched the ground, GPC-2 failed. The crew successfully landed at Edwards Air Force Base at 342:23:47:24 G.M.T. The rollout required 2,577 meters (8,456 feet).

About 6-1/2 minutes after landing, APU-1 prematurely shut down because of an underspeed condition. About 11 minutes after touchdown, APU-2 also prematurely shut down because of an underspeed condition. Postflight examination of the compartment where the APU's are located showed localized damage had occurred in the vicinity of both APU's. An investigation board has been formed and the complete evaluation of these two anomalies will be reported in a board report.

**Solid Rocket Booster Performance.** The solid rocket motors performance was well within specification limits and pressures and propellant burn rates were very close to that predicted for both motors. All solid rocket booster systems performed satisfactorily. Six of eight aft-booster-separation-motor-nozzle areo-heating-shield retainer rings were found mission (four on the left SRB and two on the right SRB). Physical evidence indicates the ring fasteners failed during descent and the rings were lost at water impact.

**External Tank Performance.** All prelaunch requirements were met and ET separation and entry were as predicted and impact was within the foot print.

**Space Shuttle Main Engines.** Space Shuttle Main Engines (SSME) prestart, start, mainstage and cutoff performances were all good. The high pressure oxidizer turbopump (HPOTP) and high pressure fuel turbopump (HPFTP) turbine temperatures were close to predicted. Engine controller performance was satisfactory during prelaunch and launch mission phases with no hardware or software failures experienced.

**Main Propulsion System.** Propellant preconditioning was satisfactory; all interface pressures and temperatures were met and SSME prestart requirements were satisfied. The engine start buildups and transitions to mainstage were normal: Engine operation and performance during mainstage appeared satisfactory. During steady-state performance, ET/ORB (Orbiter) pressures and temperatures, and ORB/SSME pressures and temperatures satisfied interface requirements. Mixture ratio and thrust values from the flight indicate repeatable engine perform-

ance. Power-level throttling operation appeared normal. Engine shutdown was satisfactory. Main engine cutoff occurred approximately one second later than predicted.

The sticking closed of the gaseous hydrogen flow control valve No. 1, which failed to respond to 13 of 16 commands from T+10 to T+375 seconds remains under investigation. However, satisfactory tank pressurization was maintained throughout the required time period.

## STS-9 TIMELINE

Day of Year	GMT* Hr:Min:Sec	Event	Day of Year	GMT* Hr:Min:Sec	Event
332	15:55:07	APU-1 activation	335	02:30	Verification flight test cold-attitude terminated
	15:55:08	APU-2 activation	339	18:25	Verification flight test hot test start
	15:55:09	APU-3 activation	340	01:26	Verification flight test hot test terminated
	15:59:32	SRB HPU activation	340	12:50:55.5	FCS OPS-8 checkout start
	15:59:53	MPS — start (Engine 3)		12:54:54.4	FCS OPS-8 checkout complete
	15:59:59.991	SRB ignition command from GPC (lift-off)	342	09:36	Spacelab deactivation complete
	16:00:28	Initiate throttle down to 78 percent thrust for max q (Engine 3)	342	22:46:59.1	APU-1 activation
	16:00:51	Max q	342	22:52:00.2	Deorbit OMS engine ignition
	16:01:02	Initiate throttle up to 104 percent (Engine 3)		22:54:36.5	Deorbit OMS engine cutoff
	16:02:06	SRB separation initiation		23:02:33	APU-2 and -3 activation
	16:07:27	Throttle down for 3 “g” acceleration (Engine 3)		23:16:00	Entry interface
	16:08:29	MECO (main engine cutoff) command		23:32:07	End blackout
	16:08:47	ET separation		23:40:57.5	TAEM
	16:10:29.4	OMS-1 engine ignition		23:47:24	Main landing gear contact
	16:11:33.2	OMS-1 engine cutoff		23:47:38	Nose landing gear contact
	16:13:09	APU-1 deactivation		23:48:17	Wheels stop
	16:13:11	APU-2 deactivation		23:54:14	APU-1 underspeed shutdown
	16:13:12	APU-3 deactivation		23:58:38	APU-2 underspeed shutdown
	16:40:37.4	OMS-2 engine ignition		23:59:18.7	APU-3 shutdown
	16:42:18.9	OMS-2 engine cutoff			
	20:31	Spacelab activation complete			
334	03:11	Verification flight test cold-attitude initialization			

\*GMT—Subtract 5 hours for EST  
6 hours for CST  
7 hours for MST  
8 hours for PST

## ASTRONAUT CREWS

Beginning in 1984, astronaut crews are announced by payload assignment rather than an STS-number. Mission designations consist of a numerical designator for the launch ("1" for a KSC launch and "2" for a Vandenburg AFB launch), and a letter suffix which reflects the originally scheduled order of launch.

Mission 41-B, for example is a 1984 launch—"4"; to occur at KSC—"1"—and was originally manifested as the second mission of that fiscal year—"B". Mission 51-A for example as a 1985 launch—"5"; to occur at KSC—"1", and was originally manifested as the first mission of that fiscal year. If the launch moves in sequence, the mission designator will not change.

The 41-B mission payloads are: SPAS-01, PALAPA-B2 and WESTAR VI. Projected launch is scheduled for January 29, 1984.

The 41-C mission payloads are: Solar Maximum Mission (SMM) Repair and the Long Duration Exposure Facility (LDEF). Projected launch is scheduled for April 4, 1984.

The 41-D mission payloads are: TELESAT-I, SYNCHOM VI-1, Large Format Camera (LFC) and Office of Aeronautics and Space Technology (OAST)-1. Projected launch is scheduled for June 4, 1984.

The 41-E mission is a Department of Defense flight.

The 41-F mission payloads are: TELESTAR 3-C SBS-D, SYNCHOM IV-2 and SPARTAN (Shuttle Pointed Autonomous Research Tool for Astronomy). Projected launch is scheduled for August 9, 1984.

The 41-G mission payloads are Office of Space and Terrestrial Applications (OSTA)-3 and Earth Radiation Budget Satellite (ERBS). Projected launch date is August 30, 1984.

The 41-H mission payload is a Department of Defense flight. Projected launch date is September 29, 1984.

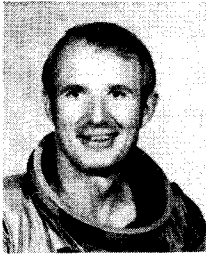
The 51-A mission payloads are: Materials Science Laboratory (MSL)-1, TELESAT-H and GAS bridge. Projected launch date is October 24, 1984.

The 51-B mission payload is Spacelab-3. Projected launch date is November 22, 1984.

The 51-C mission payload is either TDRS-B or TDRS-C. Projected launch date is December 20, 1984.

The 51-F mission payload is Spacelab-2. Projected launch date is March 29, 1985.

## 41-B FLIGHT CREW



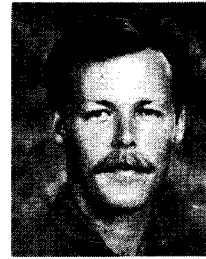
**VANCE D. BRAND**, is the spacecraft commander for the 41-B mission. Brand was also the commander on the STS-5 flight. He has logged 339 hours and 43 minutes in space flight as command module pilot of the Apollo-Soyuz Test Project and commander of the STS-5 flight. A graduate of the University of Colorado with a bachelor of science degree in business (1953) and a bachelor of science degree in aeronautical engineering (1960), and a masters degree in business administration from UCLA in 1964, Brand was commissioned a naval aviator and served as a Marine Corps fighter pilot until 1957. He was with the Marine Reserve and Air National Guard until 1964. He joined

Lockheed Aircraft as a flight test engineer in 1960, and following completion of the Navy's Test Pilot School was assigned to Palmdale, Calif., as an experimental test pilot on the F-104. He was selected as an astronaut in 1966, and was a crew member of the prototype command module in thermal-vacuum chamber program. He was a support crewman on Apollo 8 and 13, and was backup pilot for Apollo 15 and the Skylab 3 and 4 missions. Brand is a Fellow, American Astronautical Society, Associate Fellow of AIAA, and a member of SETP. He has the NASA Distinguished and Exceptional Service Medals, the JSC Certificate of Commendation, the Richard Gottheil Medal, the Wright Brothers International Manned Space Flight Award, the VFW National Sapce Award, the FAI Yuri Gagarin Gold Medal, the AIAA Special Presidential Citation and the Hanley Astronautics Award, the AAS's Flight Achievement Award, and the University of Colorado's Alumnus of the Century award. Brand was born in Longmont, Colo, May 9, 1931, is married and has five children. He is 5'11" in height, and weighs 175 pounds. He has blond hair and gray eyes.



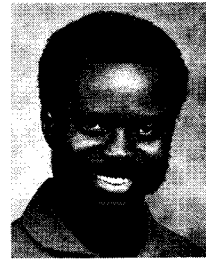
**BRUCE McCANDLESS**, is a mission specialist for the 41-B mission. He received a bachelor of science degree in Naval Sciences from the United States Naval Academy in 1958 and a master of science degree in electrical engineering from Stanford University in 1965. McCandless received flight training at Navy bases in Florida and Texas and was designated a naval aviator in March of 1960 and proceeded to Key West, Florida for weapons system and carrier landing training in the F-6A. From December, 1960 to February 1964 he flew the Skyray and F-4B from the USS Forrestal and USS Enterprise. In early 1964, he was an instrument flight instructor at the Naval Air Station,

Apollo Soucek Field, Oceana, Virginia and then reported to the Naval Reserve Officer's Training Corps Unit at Stanford University for graduate studies in electrical engineering. McCandless has logged more than 3,650 flying hours, 3,300 hours in jet aircraft. He was selected as an astronaut by NASA in April 1966. He was a member of the astronaut support crew for the Apollo 14 mission and was backup pilot for the Skylab 2 mission. His awards include the National Defense Service Medal, American Expeditionary Service Medal, NASA Exceptional Service Medal (1974) and the American Astronautical Society Victor A. Prather Award (1975). He is a member of the U.S. Naval Institute and Institute of Electrical and Electronic Engineers. McCandless was born in Boston, Massachusetts, June 8, 1937, is married and has two children. He is 5'10" and weighs 155 pounds. He has brown hair and blue eyes.



**ROBERT L. GIBSON**, is the pilot for the 41-B mission. He received a bachelor of science degree in aeronautical engineering from California Polytechnic State University in 1969. Gibson entered active duty with the Navy in 1969. He received primary and basic flight training at Naval Air Stations in Florida and Mississippi and completed advanced flight training at the Naval Air Station Kingsville, Texas. From April 1970 to September 1975 he saw duty aboard the USS Coral Sea and the USS Enterprise, flying 56 combat missions in Southeast Asia. He returned to the United States and was assigned as an F-14A instructor pilot with Fighter Squadron 124. He graduated from the

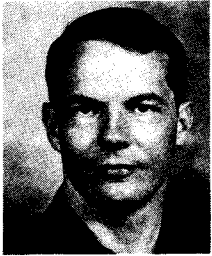
U.S. Naval Test Pilot School, Patuxent River, Maryland in June 1977 and later became involved in the test and evaluation of F-14A aircraft while assigned to the Naval Air Test Center's Strike Aircraft Test Directorate. His flight experience includes over 2,500 hours in over 35 types of civil and military aircraft. He holds commercial pilot, multi-engine, and instrument ratings, and has held private pilot rating since age 17. He was selected as an astronaut candidate in January 1978 and completed his one year training and evaluation in August, 1979 making him eligible for assignment as a pilot. Gibson was awarded three Air Medals, the Navy Commendation Medal with Combat V, a Navy Unit Commendation, Meritorious Unit Commendation, Armed Forces Expeditionary Medal, Humanitarian Service Medal, an RVN Cross of Gallantry, RVN Meritorious Unit Commendation, and Vietnam Service Medal. Gibson was born in Cooperstown, New York, October 30, 1946 but considers Lakewood, California his hometown. He married Astronaut Margaret Seddon and has two children. Gibson is 5'11" and weighs 165 pounds. He has blond hair and blue eyes.



**RONALD E. McNAIR**, is a mission specialist on the 41-B mission. He received a bachelor of science degree in physics from North Carolina A&T State University in 1971 and a doctor of philosophy in physics from Massachusetts Institute of Technology in 1976 and presented an honorary doctorate of Laws from North Carolina A&T State University in 1978. Dr. McNair performed some of the earliest development of chemical HF/DF and high pressure CO lasers while at Massachusetts Institute of Technology. In 1975 Dr. McNair studied laser physics at E'cole D'ete Theorique de Physique, Les Houches, France with many authorities in the field. Following

graduation from MIT in 1976, McNair became a staff physicist with Hughes Research Laboratories in Malibu, California. Dr. McNair was selected as an astronaut candidate by NASA in January 1978 and completed a one year training and evaluation period in August 1979, making him eligible for assignment as a mission specialist. He was named a Presidential Scholar (1967-1971), a Ford Foundation Fellow (1971-1974), a National Fellowship Fund Fellow (1974-1975), a NATO Fellow (1975) and a recipient of the National Society of Black Engineers Distinguished National Scientist Award (1979). He was born in Lake City, South Carolina, October 21, 1950, is married. He is 5'8" and weighs 158 pounds. He has black hair and brown eyes.

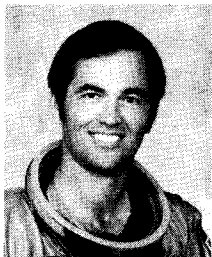
## 41-B FLIGHT CREW



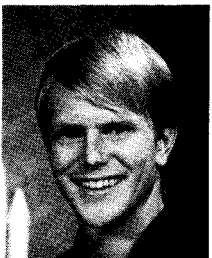
**ROBERT L. STEWART**, is a mission specialist for the 41-B mission. He received a bachelor of science degree in mathematics from the University of Southern Mississippi in 1964 and a master of science in Aerospace Engineering from the University of Texas in 1972. Stewart entered active duty with the United States Army in May 1964 and was designated an Army aviator in July 1966 upon completion of rotary wing training. He flew 1,035 hours combat time from August 1966 to 1967. He was an instructor pilot at the U.S. Army Primary Helicopter school. Stewart is a graduate of the U.S. Army's Air Defense School's Air Defense Officers Advanced Course and Guided Missile System Officers Course. From 1972 to 1973 he served in Seoul, Korea.

He next attended the U.S. Naval Test Pilot School at Patuxent River, Maryland, completing rotary wing Test Pilot Course in 1974 and then assigned as an experimental test pilot to the U.S. Army Aviation Engineering Flight Activity at Edwards Air Force Base, California. He has military and civilian experience in 38 types of airplanes and helicopters and has logged approximately 4,600 hours of flying time. Stewart was selected as an astronaut candidate by NASA in January 1978 and completed a one year training and evaluation period in August, 1979, making him eligible for assignment as a mission specialist. He was awarded three Distinguished Flying Crosses, a Bronze Star, Meritorious Service Medal, 33 Air Medals, Army Commendation Medal with Oak Leaf Cluster and "V" Device, two Purple Hearts, the National Defense Service Medal, the Armed Forces Expeditionary Medal, and the U.S. and Vietnamese Vietnam Service Medals. He is a member of the Society of Experimental Test Pilots, the National Geographic Society and the Scabbard and Blade (military honor society). He was born August 13, 1942 in Washington, D.C., but considers Arlington, Texas his hometown. He is married and has two children. Stewart is 5' 6" and weighs 138 pounds. He has brown hair and brown eyes.

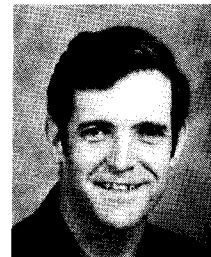
## 41-C FLIGHT CREW



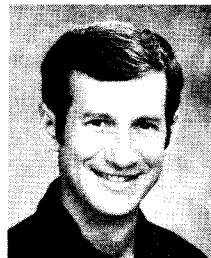
**ROBERT L. CRIPPEN**, is the commander for the 41-C mission. He was the pilot in the 54-1/2 hour STS-1 flight and the commander in the 146 hour 25 minute STS-7 flight. He has logged more than 4,980 hours of flying time—most of it in jet-powered aircraft—as a U.S. Navy pilot and astronaut. A graduate of the University of Texas in aerospace engineering, Crippen entered naval service and was a carrier pilot. He completed the U.S. Air Force's Aerospace Research Pilot School at Edwards AFB and remained as an instructor until he was selected for the Manned Orbiting Laboratory program in 1966. He transferred to the NASA Astronaut Office in 1969 and was a crew member of the Skylab Medical Experiments Altitude Test—a 56-day simulation of the Skylab mission. He was a member of the support crew for Skylab 2, 3, and 4, and the ASTP mission. He has been awarded the NASA Distinguished Service Medal and Exceptional Service Medal and the JSC Group Achievement Award. Crippen was born in Beaumont, Tex., September 11, 1937, is married and has three children. He is 5'10" in height, weighs 160 pounds, and has brown hair and eyes.



**GEORGE D. NELSON**, is a mission specialist for the 41-C mission. Nelson received a bachelor of science degree in physics from Harvey Mudd College in 1972 and a master of science and a doctorate in astronomy from the University of Washington in 1974 and 1978, respectively. Dr. Nelson has performed various astronomical research at the Sacraments Peak Solar Observatory, Sunspot, New Mexico; the Astronomical Institute of Utrecht, the Netherlands; and the University of Gottingen Observatory, Gottingen, West Germany. Prior to reporting for training as an astronaut candidate, he was a postdoctoral research associate at the Joint Institute for Laboratory Astrophysics in Boulder, Colorado. Dr. Nelson was selected as an astronaut candidate in January, 1978 and completed a one year training and evaluation period in August, 1979, making him eligible for assignment as a mission specialist. Dr. Nelson is a member of the American Association for Advancement of Science and the American Astronomical Society. Dr. Nelson was born July 13, 1950, in Charles City, Iowa but considers Willmar, Minnesota to be his hometown. Dr. Nelson is married and has two children. He has blond hair and blue eyes. He is 5'9" and weighs 160 pounds.

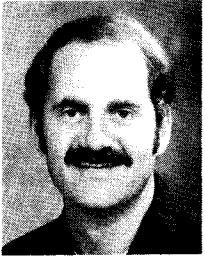


**FRANCIS R. (DICK) SCOBEE**, is the pilot for the 41-C mission. Scobee received a bachelor of science degree in aerospace engineering from the University of Arizona in 1965. Scobee enlisted in the United States Air Force in October 1957, trained as an reciprocating engine mechanic and stationed at Kelly AFB, Texas. While there, he attended night school and acquired two years of college credit which led to his selection for the airman's education and commissioning program. Upon graduation from the University of Arizona, he was assigned to officer's training school and pilot training. He received his commission in 1965 and received his wings in 1966. He completed a number of assignments including a combat tour in Vietnam. Scobee returned to the United States and attended the USAF Aerospace Research Pilot School at Edwards Air Force Base, California, graduating in 1972. He has participated in test programs on the C-5, 747, X-24B and F-111. He has logged more than 5,300 hours flying time in 40 types of aircraft. Scobee was selected as an astronaut candidate by NASA in January, 1978 and completed a one year training and evaluation period in August, 1979 making him eligible for assignment as a pilot. He retired from the United States Air Force in January, 1980 after more than 22 years of active service but continues his assignment as a NASA astronaut in a civilian capacity. He has received the Air Force Distinguished Flying Cross and Air Medal. He is a member of the Society of Experimental Test Pilots, the Experimental Aircraft Association, and the Air Force Association. Scobee was born May 19, 1939, in Cle Elum, Washington. Scobee is married and has two children. He is 6'1" and weighs 175 pounds. He has brown hair and blue eyes.



**TERRY J. HART**, is a mission specialist for the 41-C mission. Hart received a bachelor of science degree in mechanical engineering from Lehigh University in 1968, a master of science in mechanical engineering from the Massachusetts Institute of Technology in 1969, and a master of science in electrical engineering from Rutgers University in 1978. Hart entered active duty with the Air Force Reserve in June, 1969. He completed undergraduate pilot training in Georgia and in December 1970 to 1973, he flew F-106 aircraft at Tyndall Air Force Base, Florida, Loring Air Force Base, Maine, and at Dover Air Force Base, Delaware. He joined the New Jersey Air National Guard and continued flying the F-106 until 1978. From 1968 to 1978, Hart was employed as a member of the technical staff of Bell Telephone Laboratories. He has logged 2,000 hours flying time, 1,400 hours in jets. Mr. Hart was selected as an astronaut candidate by NASA in January, 1978 and completed a one year training and evaluation period in August 1979, making him eligible for assignment as a mission specialist. Hart has received the National Defense Medal. He was born October 27, 1946 in Pittsburgh, Pennsylvania. Hart is married and has two children. He has brown hair and brown eyes. He is 5'8" and weighs 145 pounds.

## 41-C FLIGHT CREW



**JAMES D. van HOFTEN**, is a mission specialist for the 41-C mission. He received a bachelor of science degree in civil engineering from the University of California, Berkeley, in 1966; and a master of science degree in hydraulic engineering and a doctor of philosophy in fluid mechanics from Colorado State University in 1968 and 1976, respectively. From 1969 to 1974 van Hoften was a pilot in the United States Navy. He received flight training at Pensacola, Florida, and completed jet pilot training at Beeville, Texas, in November 1970. He was assigned to the Naval Air Station, Miramar, California to fly F-4's and subsequently assigned to the carrier USS Ranger in 1972 and participated in two cruises to Southeast Asia where he flew 60 combat missions. He has logged 1,850 hours flying time, 1,750 hours in jet aircraft. He resumed his academic studies in 1974 and in September 1976, he accepted an assistant professorship of civil engineering at the University of Houston teaching fluid mechanics and conducted research on biomedical fluid flows concerning flows in artificial internal organs and valves until his selection as an astronaut candidate. Dr. van Hoften was selected by NASA as an astronaut candidate in January, 1978, and completed a one year training and evaluation period in August, 1979, making him eligible for assignment as a mission specialist. Dr. van Hoften has received two Navy Air Medals, the Vietnam Service Medal, and the National Defense Service Medal. He is a member of the American Society of civil engineers. He was born on June 11, 1944, in Fresno, California, but considers Burlingame, California his hometown. He is married and has two children. He has brown hair and hazel eyes. He is 6'4" and weighs 208 pounds.

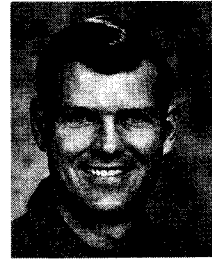
## 41-D FLIGHT CREW



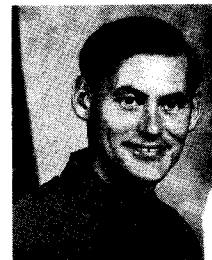
**HENRY W. HARTSFIELD, JR.**, is the commander for the 41-D mission. He was the pilot on the STS-4 flight. He has logged 169 hours and 10 minutes in space. Hartsfield was a member of the Development Flight Test missions group of the astronaut office and was responsible for supporting the development of the Space Shuttle entry flight control system and its associated interface. In 1977, he retired from the U.S. Air Force with more than 22 years of service, but continues his assignment as a NASA astronaut in a civilian capacity. Hartsfield became a NASA astronaut in 1969. He was a member of the astronaut support crew for Apollo 16 and Skylab 2, 3, and 4 missions. Hartsfield was assigned in 1966 to the USAF Manned Orbiting Laboratory program as an astronaut until the program was canceled in 1969, when he was reassigned to NASA. He has logged over 5,270 flying hours—of which over 4,700 hours are in the F-86, F-100, F-104, F-105, F-106, T-33 and T-38A. Hartsfield received his commission through the Reserve Officers Training program at Auburn University. He entered the Air Force in 1955, and his assignments included a tour with the 53rd Tactical Fighter Squadron in Germany. He is also a graduate of the USAF Test Pilot school at Edwards Air Force Base, California and was an instructor there prior to his assignment as an astronaut in the USAF Manned Orbiting Laboratory program. He was awarded the Air Force Meritorious Service Medal and the General Thomas D. White Space Trophy. Hartsfield was born in Birmingham, Alabama, November 21, 1933, is married and has two children. He is 5'10" in height, weighs 165 pounds, and has green eyes and brown hair.



**JUDITH A. RESNIK**, is a mission specialist for the 41-D mission. She received a bachelor of science degree in electrical engineering from Carnegie-Mellon University in 1970 and a doctorate in electrical engineering from the University of Maryland in 1977. Upon graduating from Carnegie-Mellon in 1970, Dr. Resnik was employed by RCA Missile and Surface Radar in Morristown, New Jersey and in 1971, she transferred to the RCA Service Company in Springfield, Virginia. While with RCA, her projects as a design engineer included circuit design and development of custom integrated circuitry for phased array radar control systems. From 1974 to 1977 Dr. Resnik was a biomedical engineer and staff fellow in the Laboratory Neurophysiology at the National Institute of Health in Bethesda, Maryland, where she performed biological research experiments concerning the physiology of visual systems. Immediately preceding her selection by NASA in 1978, she was a senior systems engineer in product development with Xerox Corporation at El Segundo, California. Dr. Resnik was selected as an astronaut candidate by NASA in January 1978 and completed one year training and evaluation period in August 1979, making her eligible for assignment as a mission specialist. She is a member of the Institute of Electrical and Electronic Engineers, American Association for the Advancement of Science, American Institute of Aeronautics and Astronautics and Senior Member of the Society of Women Engineers. Dr. Resnik's special honors include the American Association of University Women Fellow, 1975-1976. Dr. Resnik was born April 5, 1949 in Akron, Ohio. She is single and is 5'4" and weighs 115 pounds. She has black hair and brown eyes.



**MICHAEL L. COATS**, is the pilot for the 41-D mission. He received a bachelor of science degree from the United States Naval Academy in 1968, a master of science in administration of science and technology from George Washington University in 1977, and master of science in aeronautical engineering from the U.S. Naval Postgraduate School in 1979. Coats was designated a naval aviator in September 1969. After training as an A-7E pilot, he was assigned from August 1970 to September 1972 aboard the USS Kitty Hawk and flew 315 combat missions in Southeast Asia. He served as a flight instructor with A-71 at Naval Air Station, Lemoore, California from September 1972 to December, 1973, and was then selected to attend the U.S. Naval Test Pilot School, Patuxent River, Maryland. Following test pilot training in 1974, he was project officer and test pilot for A-7 and A-4 aircraft at Strike Aircraft Test Directorate. Coats served as a flight instructor at the U.S. Naval Postgraduate School from April 1976 until May 1977 and then attended U.S. Naval Postgraduate School at Monterey, California. He has logged 2,600 hours of flying time and 400 carrier landings in 22 different types of aircraft. Coats was selected as an astronaut candidate by NASA in January 1978 and completed a one year training and evaluation in August, 1979, making him eligible for assignment as a pilot. Coats was awarded two Navy Distinguished Flying Crosses, 32 Strike Flight Air Medals, three Individual Action Air Medals, and nine Navy Commendation Medals with Combat V. Coats was born in Sacramento, California, January 16, 1946, but considers Riverside, California his hometown. He is married and has two children. He is 6' and weighs 185 pounds. He has brown hair and blue eyes.



**RICHARD M. MULLANE**, is a mission specialist for the 41-D mission. He received a bachelor of science degree in military engineering from the United States Military Academy in 1967 and awarded a master of science degree in aeronautical engineering from the Air Force Institute of Technology in 1975. Mullane, an Air Force Major completed 150 combat missions as an RF-4C weapon system operator in Vietnam from January to November 1969 and a subsequent four tour of duty in England. In July 1976, he completed the USAF Test Pilot School's Flight Test Engineer Course at Edwards Air Force Base, California and assigned as a flight test weapon system operator at Eglin Air Force Base, Florida. He was selected as an astronaut by NASA in January 1979, and completed a one year training and evaluation in August 1979 making him eligible for assignment as a mission specialist. Mullane was awarded six Air Medals, the Air Force Distinguished Flying Cross, Meritorious Service Medal, Vietnam Campaign Medal, National Defense Service Medal, Vietnam Service Medal and Air Force Commendation Medal. He is a member of the Air Force Association. He was born September 10, 1945 in Wichita Falls, Texas, but considers Albuquerque, New Mexico his hometown. He is married and has three children and is 5'10" and weighs 146 pounds. He has brown hair and brown eyes.

## 41-D FLIGHT CREW



**STEVEN A. HAWLEY**, is a mission specialist on the 41-D mission. He received a bachelor of arts degree in physics and astronomy from the University of Kansas in 1973 and a doctor of philosophy in astronomy and astrophysics from the University of California in 1977. During his tenure as an undergraduate at the University of Kansas he was employed by the Department of Physics and Astronomy as a teaching assistant. In 1971, he was awarded an undergraduate research grant from the College of Liberal Arts and Sciences for an independent studies project on stellar spectroscopy. He spent the summers of 1972, 1973 and 1974 as a research assistant at the U.S. Naval Observatory in Washington, D.C., National Radio Astronomy Observatory in Green Bank, West Virginia. He attended graduate school at Lick Observatory, University of California, Santa Cruz and while there held a research assistantship for three years. Prior to his selection as an astronaut, Dr. Hawley was a postdoctoral research associate at Cerro Tololo Inter-American Observatory in La Serena, Chile. Dr. Hawley was selected by NASA as an astronaut candidate in January 1978 and completed a one year training and evaluation period in August 1979, making him eligible for assignment as a mission specialist. He has received the Evans Foundation Scholarship (1970), Veta B. Lear Award (1970), University of California Regents Fellowship (1974) and is a member of the American Astronomical Society and Astronomical Society of the Pacific. He was born December 12, 1951 in Ottawa, Kansas, but considers Salina, Kansas his hometown. He married Astronaut Sally Ride on July 24, 1982. He is 6' and weighs 150 pounds. He has blond hair and blue eyes.

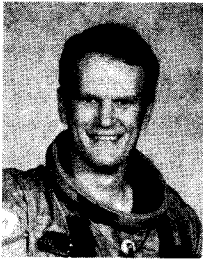


**CHARLES D. WALKER** is a payload specialist on the 41-D mission. He received a bachelor of science degree in aeronautical and astronautical engineering from Purdue University. While attending Purdue, Walker worked summers as a civil engineering technician with the U.S. Forest Service in Indiana. In 1972 he was a design engineer with Bendix Aerospace Company in Mishawaka, Indiana, working on aerodynamic analysis, missile subsystem design and specification. While at Bendix he was temporarily stationed at the National Parachute Test Facility, El Centro, California, where he participated in flight development testing. He was then employed by the Naval Sea Systems Command Engineering Center located at Crane, Indiana, as a project engineer on computer based manufacturing process controls, ordnance production equipment design and project management. Walker joined McDonnell Douglas in 1977 as a test engineer on the Space Shuttle Orbiter aft propulsion subsystem. In 1978, he was assigned as chief test engineer for the McDonnell Douglas Electrophoresis Operations in Space (EOS). His contributions include design engineering planning, development, and space flight test and evaluation. He has been involved in the EOS program's orbiter mid deck payload integration at Kennedy Space Center and flight operations at Mission Control Center, Houston, Texas. Walker is responsible for training the flight crews in the operation of the EOS device. Walker is a member of the American Institute of Aeronautics and Astronautics, the American Astronautical Society, The National Space Institute. He is a professional engineer registered in California. Walker was born August 29, 1948 in Bedford, Indiana. He is married. He is 5'9" in height and weighs 150 pounds. He has brown hair and blue eyes.



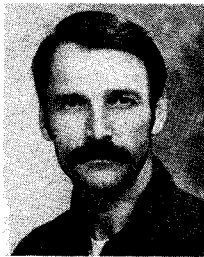
**41-E FLIGHT CREW  
DEPARTMENT OF DEFENSE (DOD) MSSION**

## 41-F FLIGHT CREW



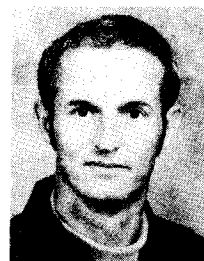
**KAROL J. BOBKO**, is the commander for the 41-F mission. He was the pilot on the STS-6 mission, logging 120 hours in space. He was a member of the Skylab Medical Experiments Altitude Test (SMEAT)—a 56 day simulation of the Skylab mission—and a member of the astronaut support crew for the ASTP mission and a member of the support crew for the Space Shuttle Approach and Landing Test program. He was then involved with the ground test and checkout of the Columbia. He received a bachelor of science degree from the Air Force Academy in 1959 and a master of science degree in Aerospace Engineering from the University of Southern California in 1970. Bobko

received his wings in 1960 and flew F-100 and F-105 aircraft from 1961 to 1965, then attended the Aerospace Research Pilots school and was assigned as an astronaut in the USAF Manned Orbiting Laboratory Program in 1966 and became a NASA astronaut in 1969. He has logged over 4,800 hours of flying time in the F-100, F-104, F-105, T-33 and T-38. Bobko was awarded the NASA Exceptional Service Medal, three JSC Group Achievement Awards and two USAF Meritorious Service Medals. He is married and has two children. He was born in New York, New York December 23, 1937. He is 5'11" in height and weighs 190 pounds. He has blond hair and blue eyes.



**S. DAVID GRIGGS**, is a mission specialist on the 41-F mission. He received a bachelor of science degree from the United States Naval Academy in 1962 and a master of science in Administration from George Washington University in 1970. Griggs entered pilot training after graduation from Annapolis, receiving his wings in 1964. He was assigned to Attack Squadron 72 flying A-4 aircraft and completed two Southeast Asia Cruises and one Mediterranean Cruise aboard the aircraft carrier USS Independence and Roosevelt. Griggs entered the U.S. Naval Test Pilot School at Patuxent River, Maryland, in 1967 and upon completion was assigned to the Flying Qualities and Performance Branch, Flight Test Division where he flew various test projects on fighter and attack-type aircraft. In 1970 he resigned his regular United States Navy Commission and affiliated with the naval air reserve. In July, 1970 Griggs was employed at the Johnson Space Center as a research pilot working on various flight test and research projects. In 1974, he was the project pilot for the Shuttle trainer aircraft and participated in the design, development and testing. In 1976 he was appointed chief of the Shuttle training aircraft operations. He has logged 6,200 hours flying time, 5,100 hours in jet aircraft and has flown over 40 different types of aircraft. He holds an airline transport license and is a certified flight instructor. He was awarded the Navy Distinguished Flying Cross and Air Medal, Navy Unit Commendation, NASA Achievement Award, and NASA Sustained Superior Performance Award. He is a member of the Society of Experimental Test Pilots and a Colonel in the Conferate Air Force. He was selected as an astronaut candidate in January 1978, completing a one year training and evaluation period in August 1979, making him eligible for an assignment as a pilot. Griggs was born in Portland, Oregon, September 7, 1939. He is married and has two children. He is 5' 10" and weighs 175 pounds. He has brown hair and eyes.

ance Branch, Flight Test Division where he flew various test projects on fighter and attack-type aircraft. In 1970 he resigned his regular United States Navy Commission and affiliated with the naval air reserve. In July, 1970 Griggs was employed at the Johnson Space Center as a research pilot working on various flight test and research projects. In 1974, he was the project pilot for the Shuttle trainer aircraft and participated in the design, development and testing. In 1976 he was appointed chief of the Shuttle training aircraft operations. He has logged 6,200 hours flying time, 5,100 hours in jet aircraft and has flown over 40 different types of aircraft. He holds an airline transport license and is a certified flight instructor. He was awarded the Navy Distinguished Flying Cross and Air Medal, Navy Unit Commendation, NASA Achievement Award, and NASA Sustained Superior Performance Award. He is a member of the Society of Experimental Test Pilots and a Colonel in the Conferate Air Force. He was selected as an astronaut candidate in January 1978, completing a one year training and evaluation period in August 1979, making him eligible for an assignment as a pilot. Griggs was born in Portland, Oregon, September 7, 1939. He is married and has two children. He is 5' 10" and weighs 175 pounds. He has brown hair and eyes.



**DONALD E. WILLIAMS**, is the pilot of the 41-F mission. He received a bachelor of science degree in Mechanical Engineering from Purdue University in 1964. Williams received his commission through the NROTC program at Purdue University. He completed flight training at Pensacola, Florida, Meridian, Miss., and Kingsville, Texas, receiving his wings in May 1966. After A-4 training, he made two Vietnam deployments aboard the USS Enterprise with attack squadron 113. He served as a flight instructor in Attack Squadron 125 at Naval Air Station Lemoore, California, for two years and transitioned to A-7 aircraft. He made two additional Vietnam deployments aboard the USS

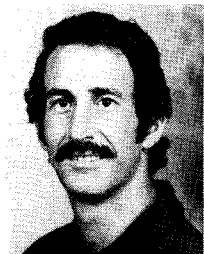
Enterprise. Williams completed a total of 330 combat missions. He attended the U.S. Naval Test Pilot School at Patuxent River, Maryland, in June 1974 and was assigned to Naval Air Test Center's Suitability Branch of Flight Test Division. From August 1976 to June 1977, he became head of the Carrier Systems Branch, Strike Aircraft Test Directorate. He reported next for A-7 refresher training and was assigned to Attack Squadron 94 when selected by NASA. He has logged 3,400 hours of flying time, which includes 3,200 hours in jets and 745 carrier landings. Williams was awarded 31 Air Medals, two Navy Commendation Medals with Combat V, two Navy Unit Commendations, a Meritorious Unit Commendation, the National Defense Medal, an Armed Forces Expeditionary Medal, the Vietnam Service Medal (with four stars), a Vietnamese Gallantry Cross (with gold star), and the Vietnam Campaign Medal. Williams is a member of the Society of Experimental Test Pilots. He was selected as an astronaut candidate in January 1978, completing a one year training and evaluation period in August 1979, making him eligible for assignment as a pilot. Williams was born in Lafayette, Indiana, February 13, 1942. He is married and has two children. He is 5' 11" and weighs 155 pounds. He has brown hair and eyes.



**MARGARET RHEA SEDDON**, is a mission specialist for the 41-F mission. She received a bachelor of arts degree in physiology from the University of California, Berkeley, in 1970, and a doctorate of Medicine from the University of Tennessee College of Medicine in 1973. After med school Dr. Seddon completed a surgical internship and three years of a general surgery residency in Memphis, Tennessee, with a particular interest in surgical nutrition. Between the period of her internship and residency, she served as an emergency room physician at a number of emergency rooms in Mississippi, and Tennessee, hospitals and serves in this capacity in the Houston, Texas area

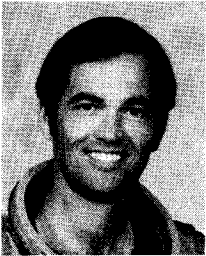
in her spare time. Dr. Seddon has also performed clinical research into the effects of radiation therapy on nutrition in cancer patients. She is a member of the 99's (International Women Pilots Association), the American College of Emergency Physicians, the Harris County, Texas Medical Society, the Texas Medical Association, charter member of the American Society of Parenteral and Enteral Nutrition, and a member of the National Society of the Daughters of the American Revolution. Dr. Seddon was selected as an astronaut candidate in January 1978, completing a one year training and evaluation period in August 1979, making her eligible for assignment as a mission specialist. She is married to astronaut Robert L. Gibson. They have one son. She was born in Murfreesboro, Tennessee, November 8, 1947. She is 5' 3" and weighs 110 pounds. She has blond hair and blue eyes..

## 41-F FLIGHT CREW



**JEFFREY A. HOFFMAN**, is a mission specialist on the 41-F mission. Hoffman received a bachelor of arts degree in Astronomy from Amherst College in 1966 and a doctor of philosophy in Astrophysics from Harvard University in 1971. Dr. Hoffman's research interests are in high-energy astrophysics, specifically cosmic gamma ray and X-ray astronomy. His doctoral work at Harvard was the design, construction, testing, and flight of a balloon-borne low energy gamma ray telescope. During three years (1972 to 1975) of postdoctoral work at Leicester University, he worked on three rocket payloads — two for the observation of lunar occultations of X-ray sources and one for an observation of the crab nebula with a solid state detector and concentrating X-ray mirror. During his last year at Leicester, he was project scientist for the medium-energy X-ray experiment on the European Space Agency's (ESA) EXOSAT satellite. He worked in the center for Space Research at MIT from 1975 to 1978 as a project scientist in charge of the orbiting HEAO-1 A4 hard X-ray and gamma ray experiment. He was also involved extensively in analysis of X-ray data from the SAS-3 satellite operated by MIT performing research on the study of X-ray bursts. Dr. Hoffman has authored or co-authored more than 20 papers on this subject since bursts were first discovered in 1976. He has received a Woodrow Wilson Foundation Pre-Doctoral Fellowship, 1966-67, a National Science Foundation Pre-Doctoral Fellowship, 1966-71, a National Academy of Sciences Post-Doctoral Vesting Fellowship, 1971-72, a Harvard University Sheldon International Fellowship, 1972-73, and a NATO Post-Doctoral Fellowship, 1973-74. He is a member of the International Astronomical Union and the American Astronomical Society. Dr. Hoffman was selected as an astronaut candidate in January 1978, completing a one year training and evaluation period in August 1979, making him eligible for assignment as a mission specialist. He was born in Brooklyn, N.Y., November 2, 1944 but considers Scarsdale, New York, his hometown. He is married and has two children. He is 6' 2" and weighs 160 pounds. He has brown hair and eyes.

## 41-G FLIGHT CREW



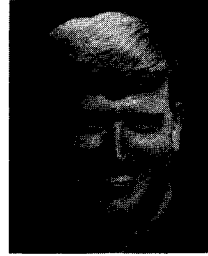
**ROBERT L. CRIPPEN**, is the commander for the 41-G mission. He is commander on the 41-C mission. He was the pilot in the 54-1/2 hour STS-1 flight and the commander in the 146 hour 25 minute STS-7 flight. He has logged more than 4,980 hours of flying time—most of it in jet-powered aircraft—as a U.S. Navy pilot and astronaut. A graduate of the University of Texas in aerospace engineering, Crippen entered naval service and was a carrier pilot. He completed the U.S. Air Force's Aerospace Research Pilot School at Edwards AFB and remained as an instructor until he was selected for the Manned Orbiting Laboratory program in 1966. He transferred to the NASA

Astronaut Office in 1969 and was a crew member of the Skylab Medical Experiments Altitude Test—a 56-day simulation of the Skylab mission. He was a member of the support crew for Skylab 2, 3, and 4, and the ASTP mission. He has been awarded the NASA Distinguished Service Medal and Exceptional Service Medal and the JSC Group Achievement Award. Crippen was born in Beaumont, Texas, September 11, 1937, is married and has three children. He is 5'10" in height, weighs 160 pounds, and has brown hair and eyes.



**DAVID C. LEESTMA**, is a mission specialist in the 41-G mission. Leestma was selected as an astronaut candidate by NASA in May 1980, completing a one year training and evaluation period in July 1981, making him eligible for assignment as a mission specialist. Leestma received a bachelor of science in aeronautical engineering from the U.S. Naval Academy in 1971 and a master of science degree in aeronautical engineering from the U.S. Naval Post Graduate school in 1972. He was assigned as a first lieutenant on the USS HEPBURN in Long Beach, California, before reporting in January 1972 to the U.S. Naval Post Graduate school. He completed flight training and received

his naval flight officer's wings in October 1973. He was assigned to VF-124 at San Diego, California, for inertial flight training in the F-14A Tomcat and transferred in June 1974 to Virginia Beach, Virginia. Leestma made three overseas deployments aboard the USS JOHN F. KENNEDY to the Mediterranean/North Atlantic areas. In 1977, he was assigned to the Air Test and Evaluation Squadron Four at the Naval Air Station, Point Mugu, California, as an operational test director with the F-14A. Leestma conducted the first operational testing of tactical software for the F-14 and completed follow-on test and evaluation of F-14A avionics and served as fleet model manager for F-14A tactical manual. He has logged 1,200 hours of F-14A flight time, including 300 arrested landings. Leestma is married and has one child. Leestma was born in Muskegon, Mich., May 6, 1949 but considers Tustin, California, his hometown. He is 5'8", weighs 150 pounds and has blond hair and blue eyes.



**JON A. McBRIDE**, is the pilot for the 41-G mission. He was selected as an astronaut candidate by NASA in January 1978, and completed a one year training and evaluation period in August 1979, making him eligible for assignment as a pilot. McBride received a bachelor of science degree in aeronautical engineering from the U.S. Naval post-graduate school in 1971. His naval service began in 1965 with flight training at Pensacola, Florida, and after winning his wings as a naval aviator, he was assigned to Fighter Squadron 101 at Naval Air Station Oceana, Virginia, for training in the F-4 Phantom II aircraft. He served three years as a fighter pilot and division officer with Fighter

Squadron 41 and several tours with Fighter Squadrons 11 and 103. He flew 64 combat missions in Southeast Asia. He then attended the U.S. Air Force Test Pilot School at Edwards AFB, California, prior to reporting to the Air Test and Development Squadron Four at Point Mugu, California, where he served as maintenance officer and Sidewinder project officer. McBride has flown over 40 different types of military and civilian aircraft and piloted the Navy "Spirit of 76" bicentennial-painted F-4J Phantom in various air shows in 1976, 1977, and 1978. He holds current FAA ratings which include commercial pilot (multi-engine), instrument, and glider; and he previously served as a certified flight instructor. McBride has logged more than 3,200 hours flying time — including 2,700 hours in jet aircraft. McBride has been awarded three Air Medals, the Navy Commendation Medal with Combat V, the Vietnamese Service Medal, a Navy Unit Commendation, the National Defense Medal, and a recipient of West Virginia Secretary of State's State Medallion and appointed West Virginia Ambassador of Good Will Among Men, 1980. He is a member of Association of Naval Aviation, Tailhook Association and associate member of the Society of Experimental Test Pilots. McBride was born in Charleston, West Virginia, August 14, 1943, but considers Beckley, West Virginia as his hometown. He is married and has three children. He is 6'2" in height, weighs 205 pounds, and has red hair and blue eyes.



**SALLY K. RIDE**, is a mission specialist for the 41-G mission. She was a mission specialist on the 146 hour 25 minute STS-7 flight. She was selected as an astronaut candidate by NASA in 1978. Dr. Ride received a bachelor of arts in English from Stanford University in 1973, a bachelor of science, a master of science, and doctorate degrees in Physics in 1973, 1975, and 1978, respectively from Stanford University. Dr. Ride has held teaching assistant and research assignments while a graduate student in the Physics Department at Stanford University. Her research includes one summer with the low-temperature group working in experimental general relativity and three years in

X-ray astrophysics. She was born in Los Angeles, California She was born May 26, 1951 and considers Encino, California her hometown. Dr. Ride is 5'5" in height and weighs 115 pounds. She has brown hair and blue eyes. She married Astronaut Steve Hawley on July 24, 1982.

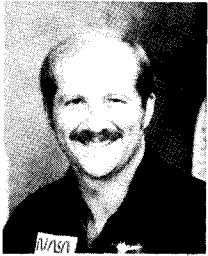
## 41-G FLIGHT CREW



**KATHRYN D. SULLIVAN**, is a mission specialist in the 41-G mission. Dr. Sullivan was selected as an astronaut candidate by NASA in January 1978, and completed a one year training and evaluation period in August 1979, making her eligible for assignment as a mission specialist. Dr. Sullivan received a bachelor of science degree in Earth Sciences from the University of California, Santa Cruz, in 1973, and a doctorate in Geology from Dalhousie University, Halifax, Nova Scotia, in 1978. She spent 1971-1972 as an exchange student at the University of Bergen, Norway, before receiving a bachelor's degree with honors. She commenced her doctoral studies at Dalhousie

University in 1973 and had taken part in a variety of oceanographic expeditions under the auspices of the U.S. Geological Survey, Menlo Park, California, Wood's Hole Oceanographic Institute, and Bedford Institute. Her research included the Mid-Atlantic Ridge, the Newfoundland Basin, and the offshore extent of Southern California faults. She taught second year and first year labs and tutorials during 1973-1975 and worked for Geological Survey of Canada as a research student during the summer of 1975. Her doctoral thesis concerned the structure and evolution of the continental margin and deep seafloor east of the Grand Banks of Newfoundland. Since joining NASA, her research interests have focused on spaceborne remote sensing and has been involved with several remote sensing projects in Alaska. She is a qualified systems engineer operator in NASA's B-57 high altitude research aircraft. Dr. Sullivan is a member of the Geological Society of America, the American Geophysical Union, the Association of Geoscientists for International Development, the American Institute of Aeronautics and Astronautics, and the Sierra Club. She is single. Dr. Sullivan was born in Paterson, New Jersey, October 3, 1951, but considers Woodland Hills, California, her hometown. She is 5'6", weighs 150 pounds and has brown hair and green eyes.

## 41-H FLIGHT CREW



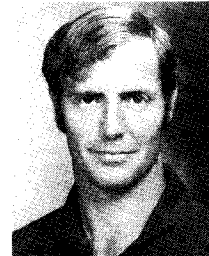
**FREDERICK H. HAUCK**, is the commander for the 41H mission. He was the pilot on the STS-7 mission, logging 146 hours in space. He was a member of the support crew for STS-1 and capsule communicator during reentry for the STS-2 flight. He was selected as an astronaut candidate by NASA in 1978. Hauck received a bachelor of science degree in Physics from Tufts University in 1962 and a master of science degree in Nuclear Engineering from MIT in 1966. He was a Navy ROTC student at Tufts University and was commissioned upon graduation and served as communications officer and CIC officer on the USS Warrington. In 1964 he attended the U.S. Naval

Postgraduate School, Monterey, California, in math and physics and studied Russian at the Defense Language Institute in Monterey. He was then selected for the Navy's Advanced Science Program. He received his wings in 1968. He flew 114 combat and combat support missions in the Western Pacific aboard the USS Coral Sea. He graduated from the U.S. Naval Test Pilot School in 1971. Hauck then served as a project test pilot for automatic carrier landing systems in the A-6, A-7, F-4 and F-14 aircraft. In 1974 he was assigned to the USS Enterprise flying A-6, A-7 and F-14 aircraft. He was an executive officer in February 1977 until he was selected as an astronaut. He was born in Long Beach, California, April 11, 1941 but considers Winchester, Mass., and Washington, D.C. as his hometown. He is married and has two children. He is 5'9" in height and weighs 175 pounds. He has blond hair and blue eyes.



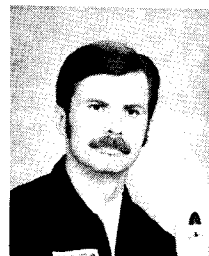
**JOSEPH P. ALLEN**, is a mission specialist on the 41H mission. He was a mission specialist on the STS-5 mission, logging 122 hours in space. He received a bachelor of arts degree in math-physics from DePauw University and a master of science degree and doctorate in physics from Yale University. He was a staff physicist at the Nuclear Structure Lab at Yale from 1965 to 1966 and served as a guest research associate at Brookhaven National Laboratory from 1963 to 1967 and was a research associate in the Nuclear Physics Laboratory at the University of Washington from 1967 until he was selected as a scientist astronaut in 1967. He was a mission scientist while a member of

the astronaut support crew for Apollo 15 and served as a staff consultant on science and technology for the President's Council on International Economic Policy. From 1975 to 1978, Allen served as NASA Assistant Administrator for Legislative Affairs in Washington, D.C. Allen has received two NASA Group Achievement Awards, the Yale Science and Engineering Association Award, the DePauw University Distinguished Alumnus Award, the NASA Exceptional Scientific Achievement Medal, a NASA Exceptional Service Medal. He is a member of the American Physical Society, the American Astronomical Society, the AIAA, the American Association for the Advancement of Science, and the AAS. He has logged more than 2,800 hours of flying time in jet aircraft. Allen is married and has two children. He was born in Crawfordsville, Indiana, June 27, 1937. He is 5'6" and weighs 125 pounds. He has brown hair and blue eyes.



**DAVID M. WALKER**, is the pilot for the 41-H mission. He received a bachelor of science degree from the United States Naval Academy in 1966. Upon graduation from Annapolis, he received his flight training at Naval Air Training Command bases in Florida, Mississippi, and Texas. He was designated a Naval Aviator in December 1967 and proceeded to Naval Air Station Miramar, California, for assignment to Fighter Squadron 92 where he completed two combat cruises in Southeast Asia as a fighter pilot flying F-4 Phantoms aboard carriers USS Enterprise and America. From December 1970 to 1971, he attended the USAF Aerospace Research Pilot School at Edwards AFB,

California, and was subsequently assigned in January 1972 as an experimental and engineering test pilot in the flight test division at the Naval Air Test Center, Patuxent River, Maryland. He participated in the Navy's preliminary evaluation and Board of Inspection and Survey trails of the F-14 and F-4 Phantom. He then attended the U.S. Navy Safety Officer School at Monterey, California, and completed replacement pilot training in the F-14 at Naval Air Station Miramar, California. In 1975, Walker was assigned to Fighter Squadron 142 at Naval Air Station Oceana, Virginia, and was deployed to the Mediterranean aboard the USS America. He has logged more than 3,000 hours flying time, 2,800 hours in jet aircraft. He was awarded six Navy Air Medals, a Battle Efficiency Ribbon, the Armed Forces Expeditionary Medal, the National Defense Service Medal, the Vietnamese Cross of Gallantry, the Vietnam Service Medal, and the Republic of Vietnam Campaign Medal. He is a member of the Society of Experimental Test Pilots. Walker was selected as an astronaut candidate in January 1978, completing a one year training and evaluation period in August 1979, making him eligible for assignment as a pilot. He was born in Columbus, Georgia, May 20, 1944, but considers Eustis, Florida his hometown. He is married and has two children. He is 5' 10" and weighs 165 pounds. He has red hair and blue eyes.



**DALE A. GARDNER**, is a mission specialist on the 41H mission. He was a mission specialist on the STS-8 mission, logging 145 hours in space. He was selected as an astronaut candidate in 1978. He received a bachelor of science degree in Engineering Physics from the University of Illinois in 1970. Gardner entered the U.S. Navy in 1970 upon graduation from college and was assigned to Aviation Officer Candidate School. In 1970 he attended basic naval officer training and was graduated with the highest academic average ever achieved in the 10-year history of the squadron. He proceeded to the Naval Aviation Technical Training Center for advanced naval flight officer training and

received his wings in 1971. From 1971 to 1973 he was assigned to weapons system test division at the Naval Test Center in F-14A development test and evaluation as project officer for testing inertial navigation system. He then flew F-14A aircraft and participated in two WESTEC cruises while deployed aboard the USS Enterprise. From 1976 until reporting to NASA, Gardner was with the Air Test and Evaluation Squadron in the operational test and evaluation of fighter aircraft. Gardner is married and has one child. He was born in Fairmont, Minnesota, November 8, 1948, but considers Clinton, Iowa, his hometown. He is 6' in height and weighs 160 pounds. He has brown hair and eyes.

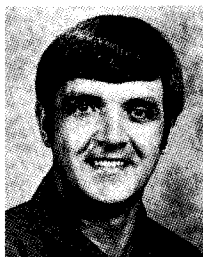
## 41-H FLIGHT CREW



**ANNA L. FISHER**, is a mission specialist on the 41H mission. She received a bachelor of science in chemistry and a doctor of medicine from the University of California, Los Angeles, in 1971 and 1976 respectively, completing a one year internship at Harbor General Hospital in Torrance, California, in 1977. After graduating from UCLA in 1971, Dr. Fisher spent a year in graduate school in chemistry at UCLA working in the field of X-ray crystallographic studies of metallocarboranes. She co-authored three publications relating to these studies for the journal of Inorganic Chemistry. She has specialized in emergency medicine and had worked in several hospitals in the Los Angeles

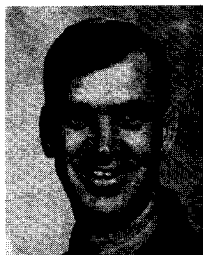
area. She was awarded a National Science Foundation Undergraduate Research Fellowship in 1970, and 1971. She is a member of the American College of Emergency Physicians and instructor for the American Heart Association's Advanced Cardiac Life Support. Dr. Fisher was selected as an astronaut candidate in January 1978, completing a one year training and evaluation period in August 1979, making her eligible for assignment as a mission specialist. She is married to astronaut Dr. William F. Fisher. She was born in St. Albans, New York, August 24, 1949. She is 5' 4" and weighs 110 pounds. She has brown hair and hazel eyes.

## 51-A FLIGHT CREW



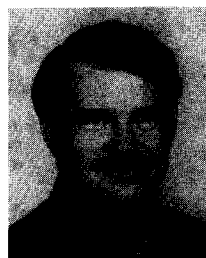
**DANIEL C. BRANDENSTEIN**, is the commander for the 51-A mission. He was the pilot on the 145 hour 9 minute STS 8 flight. Brandenstein was selected as an astronaut candidate in 1978. He was a member of the STS-1 and STS-2 astronaut support crew and served as ascent capcom. He received a bachelor of science degree in Mathematics and Physics from the University of Wisconsin in 1965. He entered the Navy in 1965 and was designated a naval aviator in 1967. He flew 192 combat missions in Southeast Asia from the USS Constellation and Ranger. He graduated from the U.S. Naval Test Pilot School. He then served aboard the USS Ranger in the Western Pacific and Indian

Ocean flying A-6 aircraft. He has logged 3,600 hours flying time in 19 different types of aircraft and has 400 carrier landings. Brandenstein is married and has one child. He was born in Watertown, Wisconsin, January 17, 1943. He is 5'11" in height and weighs 185 pounds. He has brown hair and blue eyes.



**JOHN M. FABIAN**, is a mission specialist for the 51-A mission. He was a mission specialist in the 146 hour 25 minute STS-7 flight. He was selected as an astronaut candidate in 1978. He received a bachelor of science degree in Mechanical Engineering from Washington State University in 1962, a master of science in Aerospace Engineering from the Air Force Institute of Technology in 1964 and a doctorate in Aeronautics and Astronautics from the University of Washington in 1974. Fabian was an Air Force ROTC student at Washington State University and was commissioned in 1962. He had various assignments in the Air Force Institute of Technology at Wright-Patterson Air

Force Base, Ohio, aeronautical engineer at San Antonio Air Material Area, Kelly AFB, Texas, then attended flight training at Williams AFB, Arizona, and spent five years as a KC-135 pilot at Wurtsmith AFB, Michigan, and flew 90 combat missions in Southeast Asia. Following additional graduate work at the University of Washington, he served four years on the faculty of the Aeronautics Department at the USAF Academy in Colorado. He has logged 3,400 hours flying time, including 2,900 hours in jet aircraft. He is a member of AIAA. He is married and has two children. He was born in Goosecreek, Texas, January 28, 1939, but considers Pullman, Washington, his hometown. He is 6'1" in height and weighs 175 pounds. He has brown hair and green eyes.



**JOHN O. CREIGHTON**, is the pilot in the 51-A mission. He was selected as an astronaut candidate by NASA in January 1978, completing a one year training and evaluation period in August 1979, making him eligible for assignment as a pilot. Creighton received a bachelor of science degree from the U.S. Naval Academy in 1966 and a master of science in Administration of Science and Technology from George Washington University in 1978. He started flight training following graduation from Annapolis and received his wings in October, 1967. From July 1968 to May 1970, he flew F-4 J's and made two combat deployments to Vietnam aboard the USS RANGER. He attended

the U.S. Naval Test Pilot School at Patuxent River, Maryland, from June 1970 to February 1971, and upon graduation was assigned as a project test pilot with the Service Test Division at the Naval Air Station, Patuxent River as the F-14 engine development project officer for two years. In July 1973, Creighton commenced a four year assignment with VF-2 aboard the USS ENTERPRISE as a member of the first F-14 operational squadron, completing two deployments to the Western Pacific. In July 1977, he returned to the U.S. and was assigned to the Naval Air Test Center's Strike Directorate as operations officer and F-14 program manager. Creighton has logged 3,300 hours flying time—the majority of it in jet fighters and has completed 500 carrier landings and flown 175 combat missions. He has been awarded 10 Air Medals, the Navy Commendation Medal, the Armed Force Expeditionary Medal, and the Vietnam Cross of Gallantry. He is a member of the Society of Experimental Test Pilots. He is single. Creighton was born in Orange, Texas, April 28, 1943, but considers Seattle, Washington, his hometown. He is 5'10", weighs 160 pounds and has brown hair and hazel eyes.



**SHANNON W. LUCID**, is a mission specialist for the 51-A mission. Dr. Lucid was selected as an astronaut candidate by NASA in January 1978, completing a one year training and evaluation period making her eligible for assignment as a mission specialist. Dr. Lucid received a bachelor of science degree in chemistry from the University of Oklahoma, in 1963 and a master of science and doctor of philosophy degrees in Biochemistry from the University of Oklahoma in 1970 and 1973, respectively. She was a teaching assistant at the University of Oklahoma's Department of Chemistry from 1963 to 1964; senior laboratory technician at the Oklahoma Medical

Research Foundation from 1964-1966; chemist at Kerr-McGee, Oklahoma City, Oklahoma, 1966-1968; graduate assistant at the University of Oklahoma Health Science Center's Department of Biochemistry and Molecular Biology from 1969-1973; and research associate with the Oklahoma Medical Research Foundation in Oklahoma City, Oklahoma, from 1974 until her selection to the astronaut candidate program. Dr. Lucid has logged 1,700 hours of commercial, instrument, and multi-engine flying time. She is a member of the Aircraft Owners and Pilots Association. Dr. Lucid is married and has three children. She was born in Shanghai, China, January 14, 1943, but considers Bethany, Oklahoma, to be her hometown. She is 5'11" and weighs 150 pounds. She has brown hair and blue eyes.

## 51-A FLIGHT CREW



**STEVEN R. NAGEL**, is a mission specialist for the 51-A mission. He was selected as an astronaut candidate by NASA in January 1978, completing a one year training and evaluation period in August 1979, making him eligible for assignment as a mission specialist. Nagel received a bachelor of science degree in aeronautical and astronautical engineering from the University of Illinois in 1969, and a master of science degree in mechanical engineering from California State University, Fresno, California, in 1978. Nagel received his commission in 1969 through the Air Force Reserve Officer Training Corps program at the University of Illinois. He completed undergraduate pilot training at Laredo

Air Force Base, Texas, in February 1970 and reported to Luke Air Force Base, Arizona, for F-100 checkout training. From October 1970 to July 1971, Nagel was an F-100 pilot with the 68th Tactical Fighter Squadron at England Air Force Base, Louisiana. He served a one year tour of duty as a T-28 instructor for the Laotian Air force at Udon RTAFB, Udon, Thailand, prior to returning to the U.S. in October 1972 to assume A-7D instructor pilot and flight examiner duties at England Air Force Base, Louisiana. Nagel attended the USAF Test Pilot School at Edwards Air Force Base, California, from February to December 1975; and in January 1976, he was assigned to the 6512th Test Squadron at Edwards. As a test pilot, he has worked on various projects which have included flying the F-4 and A-7D. He has logged 3,900 hours flying time—2,100 hours in jet aircraft. He has been awarded the Air Force Distinguished Flying Cross, Air Medal with seven Oak Leaf clusters, Orville Wright Achievement Award (Order of Daedaleans), and Air Force Meritorious Service Medal, 1978. Nagel is a member of the Order of Daedaleans. He is married. He was born in Canton, Illinois, October 27, 1946. He is 6'1 1/2" and weighs 165 pounds. He has brown hair and blue eyes.

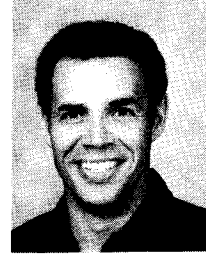
## 51-B FLIGHT CREW



**ROBERT F. OVERMYER**, is the commander for the 51-B mission. He was a pilot on the STS-5 flight, logging 122 hours in space. He was previously assigned engineering development duties on the Space Shuttle program and the Development Flight Test missions group of the astronaut office. His first assignment with NASA was engineering development duties on Skylab. Overmyer then served on the support crews for the Apollo 17 and Apollo-Soyuz Test Project. In 1976 he was the prime T-38 chase pilot for the Approach and Landing Test program on orbiter free flights 1 and 3. Overmyer was selected as a NASA astronaut when the U.S. Air Force Manned Orbiting Laboratory program was canceled in 1969. Colonel Overmyer entered active duty with the Marine Corps in January 1958. After flight training, several squadron tours, and graduate school, he attended the Air Force Test Pilots school in 1965. He was selected as an astronaut for the U.S. Air Force Manned Orbiting Laboratory program in 1966. He is a member of the Society of Experimental Test Pilots. He has the USAF Meritorious Service Medal and the USMC Meritorious Award. Overmyer was born in Lorain, Ohio, July 14, 1936, but considers Westlake, Ohio his hometown. He is married and has three children. He is 5'11-3/4" and weighs 180 pounds. He has brown hair and blue eyes.



**NORMAN E. THAGARD**, is a mission specialist on the 51-B mission. He was a mission specialist on the STS-7 flight logging 146 hours in space and conducted medical tests to collect additional data on several physiological changes that were associated with space adaptation syndrome. These tests focused on the neurological system and were a continuation of the new approach to making inflight measurements which began on STS-4. These efforts were directed toward initiation of an inflight search for countermeasures and to provide a more complete understanding of the space adaptation syndrome. He received a bachelor and master of science degrees in Engineering Science in 1965 and 1966 and subsequently performed pre-med coursework and received a doctor of Medicine from the University of Texas Southwestern Medical School in 1977. September 1966, he entered on active duty with the United States Marine Corps Reserve. In 1967, he achieved the rank of Captain and was designated a naval aviator in 1968 and was assigned to duty flying F-4s at Marine Corps Air Station, Beaufort, South Carolina. He flew 163 combat missions in Vietnam from January 1969 to 1970. He returned to the United States and was assigned aviation weapons division officer at the Marine Corps Air Station, Beaufort, South Carolina. Thagard resumed his academic studies in 1971, pursuing a degree in medicine. His internship was in the Department of Internal Medicine at the Medical University of South Carolina. Thagard was selected as an astronaut candidate in January 1978 and in August 1979, he completed a one-year training and evaluation period making him eligible for assignment as a mission specialist. He has logged 1,100 hours flying time, 1,000 hours in jet aircraft. He was awarded 11 Air Medals, the Navy Commendation Medal with Combat V, the Marine Corps "E" Award, the Vietnam Service Medal and the Vietnamese Cross of Gallantry with Palm. Thagard is a member of AIAA. He was born in Marianna, Florida, July 3, 1943, but considers Jacksonville, Florida his hometown. He is married and has three children. He has brown hair, blue eyes. He is 5'9" in height and weighs 164 pounds.

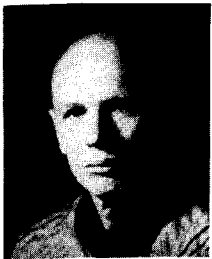


**FREDERICK D. GREGORY**, is the pilot for the 51-B mission. He received a bachelor of science degree from the United States Air Force Academy in 1964, and a masters degree in information systems from George Washington University in 1977. Gregory entered pilot training after graduation from the United States Air Force Academy in 1964 and received his wings from undergraduate training in 1965. After three years of helicopter flying, including a Vietnam tour, he was re-trained as a fighter pilot and flew the F-4. He attended the U.S. Naval Test Pilot School in 1970 and was subsequently assigned as a research/engineering test pilot for the Air Force and for NASA from 1971 until 1977. Gregory has flown more than 40 different types of single and multi-engine fixed and rotary wing aircraft including gliders. He has logged over 4,100 hours of flight time and holds an FAA commercial and instrument certificate for single, multi-engine and rotary aircraft. Gregory was selected as an astronaut candidate by NASA in January 1978, and completed a one year training and evaluation period in August 1979, making him eligible for assignment as a pilot. Gregory was awarded the Air Force Distinguished Flying Cross, the Meritorious Service Medal, the Air Medal with 15 Oak Leaf Clusters, the Air Force Commendation Medal and recipient of the National Society of Black Engineers Distinguished National Scientist Award (1979). He is a member of the Society of Experimental Test Pilots, the American Helicopter Society, the Air Force Association and the National Technical Association. He was born January 7, 1941, in Washington, D.C. He is married and has two children. He has brown hair and brown eyes. He is 5'11" and weighs 175 pounds.



**DON LESLIE LIND**, is a mission specialist for the 51-B mission. Lind received a bachelor of science with high honors in physics from the University of Utah in 1953 and a doctor of philosophy degree in high energy nuclear physics in 1964 from the University of California, Berkeley and performed post-doctoral study at the Geophysical Institute, University of Alaska, in 1975-1976. Lind served four years on active duty with the Navy at San Diego and later aboard the carrier USS Hancock. He received his wings in 1957. Lind has logged more than 3,800 hours flying time, 3,300 hours in jet aircraft. Before his selection as an astronaut, he worked at the NASA Goddard Space Flight Center as a space physicist. He had been at Goddard since 1964 and was involved in experiments to determine the nature and properties of low energy particles within the earth's magnetosphere and interplanetary space. Previous to this, he worked at the Lawrence Radiation Laboratory, Berkeley, California, doing research in basic high energy particle interaction. Dr. Lind was selected as a NASA astronaut in April 1966. He served as a backup science pilot for Skylab 3 and 4 and as a member of the rescue crew for the Skylab missions. Lind has received the NASA Exceptional Service Medal (1974). Lind is a member of the American Geophysical Union, and the American Association for Advancement of Science. He is married and has seven children. Lind was born May 18, 1930, in Midvale, Utah. He has brown hair and hazel eyes. He is 5'11-3/4" and weighs 180 pounds.

## 51-B FLIGHT CREW



**WILLIAM E. THORNTON**, is a mission specialist for the 51-B mission. He was a mission specialist on the STS-8 flight, logging 145 hours in space and conducted medical tests to collect additional data on several physiological changes that were associated with the space adaptation syndrome. These tests focused on the neurological system and were a continuation of the new approach to making inflight measurements which began on STS-4. These efforts were directed toward initiation of an inflight search for countermeasures and to provide a more complete understanding of the space adaptation syndrome. He received a bachelor of science degree in Physics and a

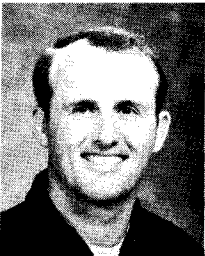
doctorate in Medicine from the University of North Carolina in 1952 and 1963. Following graduation from the University of North Carolina and having completed Air Force ROTC training, Thornton served as officer-in-charge of the Instrumentation Lab at the Flight Test Air Proving Ground. From 1955 to 1959 he was chief engineer of the electronics division of the Del Mar Engineering labs in Los Angeles, Calif. and directed its Avionics Division. He returned to the University of North Carolina Medical School in 1959 and graduated in 1963. Thornton completed his internship training in 1964 at the Wilford Hall USAF Hospital at Lackland AFB, San Antonio, Texas. He returned to active duty with the USAF and was assigned to the USAF Aerospace Medical Division at Brooks AFB in San Antonio, Texas and became involved in space medicine research during his two year duty. Dr. Thornton was selected as a scientist astronaut in August 1967. He completed flight training at Reese AFB, Texas. He was physician crew member on the 56 day simulation of Skylab Medical Experiments Altitude Test (SMEAT). He was a member of the astronaut support crew for Skylab 2, 3, and 4 missions and principle investigator of Skylab experiments on mass measurement, anthropometric measurements, hemodynamics, and human fluid shifts and physical conditioning. Dr. Thornton holds more than 15 issued patents. He is recipient of the Air Force Legion of Merit, the NASA Exceptional Service Medal in 1972, NASA Exceptional Scientific Achievement Medal in 1974, and presented the American Astronautical Society's Melbourne W. Boynton Award for 1975 and 1977. He has logged over 2,375 hours in jet aircraft. Dr. Thornton was born in Faison, North Carolina, April 14, 1929. He is married and has two children. He has blond hair and blue eyes. He is 6' in height and weighs 200 pounds.

## 51-C FLIGHT CREW



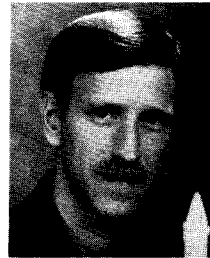
**JOE H. ENGLE**, is the spacecraft commander for the 51-C mission. He was the spacecraft commander for the Space Shuttle orbiter's second, 54-1/2 hour flight into space. He earned his astronaut wings as an Air Force pilot of the X-15. Three of his 16 flights in the high-speed, high-altitude research craft exceeded 50 miles in altitude. He was spacecraft commander on the Shuttle ALT flights. Engle graduated from the University of Kansas with a BS in aeronautical engineering and entered the Air Force (he presently is a colonel). Following duty with fighter aircraft squadrons, he was accepted and graduated from the USAF Experimental Test Pilot School and the Air Force Aerospace

Research Pilot School. As an Air Force test pilot, he was assigned to the X-15 and during his career has flown more than 130 different types of aircraft. He has been awarded the NASA Exceptional Service Medal, the Distinguished Flying Cross, was named the Air Force Association's Outstanding Young Officer (1964), was selected by the U.S. Junior Chamber of Commerce as one of the Ten Outstanding Young Men in America, and received the AIAA's Lawrence Sperry Award. He is a member of SETP. Engle was born in Abilene, Kansas, Aug. 26, 1932, is married and has two children. He is 6' in height, weighs 155 pounds, and has hazel eyes and blond hair.

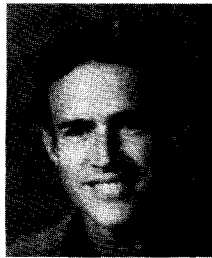


**JAMES F. BUCHLI**, is a mission specialist on the 51-C mission. He received a bachelor of science degree in Aeronautical Engineering from the United States Naval Academy in 1967 and a master of science degree in Aeronautical Engineering Systems from the University of West Florida in 1975. He received his commission in the United States Marine Corps following graduation from the United States Naval Academy at Annapolis in 1967. He served a one year tour of duty in the Republic of Vietnam and upon his return to the United States in 1969, he reported to naval flight officer training at Pensacola, Florida. Buchli spent the next three years assigned to the Marine

Fighter/Attack Squadron at Kaneohe Bay, Hawaii and Iwakuni, Japan and in 1973 he proceeded to duty with Marine Fighter/Attack Squadron at Nampohong, Thailand, and Iwakuni, Japan. At completion of this tour of duty he returned to the United States and participated in the Marine Advanced Degree Program at the University of West Florida. He was assigned subsequently to Marine Fighter/Attack Squadron at the Marine Corps Air Station, Beaufort, South Carolina, and in 1977, to the U.S. Test Pilot School, Patuxent River, Maryland. He was selected as an astronaut candidate by NASA in January 1978 and in August 1979, he completed a one-year training and evaluation period making him eligible for assignment as a mission specialist. He has logged 1,900 hours flying time, 1,780 hours in jet aircraft. Buchli is the recipient of an Air Medal, Navy Commendation Medal, Purple Heart, Combat Action Ribbon, Presidential Unit Citation, Navy Unit Citation, a Meritorious Unit Citation, and a Vietnamese Cross of Gallantry with the Silver Star. He was born in New Rockford, North Dakota, June 20, 1945, but considers Fargo, North Dakota his hometown. He is married and has two children. He has brown hair and hazel eyes. He is 5'7" in height and weighs 160 pounds.

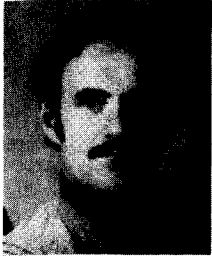


**RICHARD O. COVEY** is the pilot for the 51-C mission. Covey was selected as an astronaut candidate by NASA in January 1978, completing a one year training and evaluation period in August 1979, making him eligible for an assignment as a pilot. Covey received a bachelor of science degree in engineering sciences from the U.S. Air Force Academy in 1968 and a master of science degree in aeronautics and astronautics from Purdue University in 1969. He completed pilot training at Williams Air Force Base, Arizona in 1970. He was then assigned to Luke Air Force Base, Arizona, for combat crew training on the F-100 D/F. Following A-37B upgrade training at England Air Force Base, Louisiana, he flew 324 combat missions as an A-37 pilot with the 8th Special Operations Squadron, Bien Hoa Air Base, Republic of Vietnam in 1971. Upon his return to the U.S. in 1972, he was assigned to the 74th Tactical Fighter Squadron at England Air Force Base, Louisiana, as an A-7D pilot/weapons officer, with subsequent deployment with the 74th to Korat RTAFB, Thailand, where he flew an additional 15 combat missions in 1973. From 1974 to 1975, he attended the USAF Test Pilot School at Edwards Air Force Base, California, and was then assigned to the Armament Development and Test Center at Eglin Air Force Base, Florida, as a test pilot on the F-4 and A-7. Covey served as Commander, Detachment 2, Air Force Flight Test Center, Eglin Air Force Base, Florida, in 1977 and was Director of the F-15 Tactical Electronic Warfare Systems Joint Test Force at the time of his selection by NASA. He has logged 2,200 hours flying time in over 20 different types of aircraft. Covey was awarded four Air Force Distinguished Flying Crosses, 16 Air Medals, an Air Force Meritorious Service Medal, an Air Force Commendation Medal, a Combat Readiness Medal, an Armed Forces Expeditionary Medal, and the Vietnam Service Cross. He is married and has two children. He was born in Fayetteville, Arkansas, August 1, 1946, but considers Fort Walton Beach, Florida, his hometown. He is 5'11 1/2" and weighs 150 pounds. Covey has brown hair and gray eyes.



**WILLIAM F. FISHER**, is a mission specialist on the 51-C mission. Dr. Fisher was selected as an astronaut candidate by NASA in May 1980, completing a one year training and evaluation program in July 1981, making him eligible for an assignment as a mission specialist. Dr. Fisher received a bachelor of arts in pre-med from Stanford University in 1968, a doctorate in medicine from the University of Florida in 1975, and a master of science degree in engineering from the University of Houston in 1980. After med school, Dr. Fisher completed a two year surgical internship and residency at UCLA's General Hospital in Torrance, California. He specialized in emergency medicine from June 1977 to 1980 — initially as an instructor at the University of South Florida, and later as a private practitioner and instructor at Northeast Regional Medical Center in Anniston, Alabama. He is a member of the American College of Emergency Physicians, the American Heart Association and the Institute of Electrical and Electronic Engineers. Dr. Fisher holds a private pilot's license and has logged over 800 hours in fixed- and rotary-wing aircraft. He is married to astronaut Anna L. Fisher. He was born in Dallas, Texas, April 1, 1946. He is 5'10" and weighs 160 pounds. He has brown hair and brown eyes.

## 51-C FLIGHT CREW



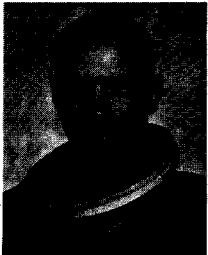
**JOHN M. LOUNGE**, is a mission specialist on the 51-C mission. Lounge was selected as an astronaut candidate by NASA in May 1980, completing a one year training and evaluation period in July 1981, making him eligible for assignment as a mission specialist. Lounge received a bachelor of science degree in physics and mathematics from the U.S. Naval Academy in 1969 and a master of science degree in astrophysics from the University of Colorado in 1970; and is currently working on an advanced degree in Operations Research, with specialization in Human Factors Engineering, at the University of Houston. Lounge upon graduation from the U.S. Naval Academy completed flight training at Pensacola, Florida, went on to advanced training as a radar intercept officer in the F4-J phantom and subsequently reported to Fighter Squadron 142 based at Naval Air Station Miramar, California. He completed a nine month Southeast Asia cruise aboard the USS Enterprise, participating in 99 combat missions followed with a seven month Mediterranean cruise aboard the USS America. He returned to the U.S. Naval Academy as an instructor in the Physics Department in 1974. In 1976, he served a two year tour as a staff project officer at the Navy Space Project Office in Washington, D.C. Lounge resigned his regular U.S. Navy Commission in 1978 and affiliated with the Naval Air Reserve, flying F-4N's with Reserve Fighter Squadron 201 at the Naval Air Station in Dallas, Texas. He is a member of the Texas Air National Guard with the 147th Fighter Interceptor Group at Ellington Air Force Base, Texas. He was employed at NASA's Johnson Space Center as an engineer in the Payloads Operations Division in July 1978 and worked as lead engineer for the integration of the Payload Assist Module and served as a member of the Skylab reentry flight control team. He was awarded six Navy Air Medals, three Navy Commendation Medals with Combat V, and the JSC Superior Achievement Award. Lounge is a member of the Aircraft Owners and Pilots Association, the American Institute of Aeronautics and Astronautics, and the Human Factors Society. He is married and has one child. He was born in Denver, Colorado, but considers Burlington, Colorado his hometown. Lounge is 5'10" and weighs 155 pounds. He has brown hair and brown eyes.

## 51-F FLIGHT CREW



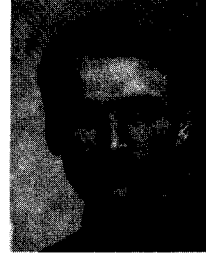
**C.G. (GORDON) FULLERTON**, is the commander for the 51-F mission. He was the pilot in the 192 hour 6 minute STS-3 flight. He served as the Enterprise's pilot on the Approach and Landing Test program. A graduate of California Institute of Technology with both bachelor and master of science degrees in mechanical engineering, Fullerton entered active duty with the U.S. Air Force (he is presently a lieutenant colonel). He has served as both an interceptor and bomber pilot and is a graduate of the USAF Aerospace Research Pilot School. He was a test pilot at Wright-Patterson Air Force Base prior to being selected for the Manned Orbiting Laboratory program. Fullerton transferred to

the Astronaut Office in 1969, and served on the support crews for Apollo 14 and 17. He is a member of SETP and an honorary member of the National World War II Glider Pilots Assn. Fullerton has been awarded the NASA Exceptional Service Award, the JSC Group Achievement Award, and the USAF Commendation and Meritorious Service medals. He was born in Rochester, New York, Oct. 11, 1936. Fullerton is married, and has two children. He is 6' in height, weighs 165 pounds, and has blond hair and blue eyes.



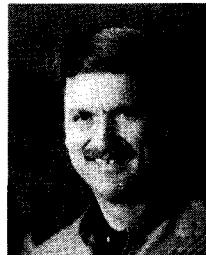
**STORY MUSGRAVE**, is a mission specialist for the 51-F mission. He was a mission specialist on the 120 hour 24 minute STS-6 mission. Dr. Musgrave was selected as a scientist astronaut in 1967. He worked on the design and development of Skylab program, as a back-up science pilot for the first Skylab mission and has been participating in the design and development of all Space Shuttle extravehicular activity equipment. He received a bachelor of science degree in mathematics and statistics from Syracuse University in 1958, a master of business administration degree in Operations Analysis and Computer Programming from the University of California at Los

Angeles in 1959, a bachelor of arts degree in chemistry from Marietta College in 1960, a doctorate in Medicine from Columbia University in 1964. He served his surgical internship at the University of Kentucky Medical Center in Lexington from 1964 to 1965 and continued there as a USAF post-doctoral fellow working in aerospace medicine and physiology from 1965 to 1966 and received his master of science in Physiology and Biophysics from the University of Kentucky in 1966. From 1966 to 1967, as a National Heart Institute post-doctoral fellow, Dr. Musgrave was teaching and doing research in cardiovascular and exercise physiology. He is continuing clinical and scientific training as a part-time surgeon at the Denver General Hospital and as a part-time professor of physiology and biophysics at the University of Kentucky Medical Center. He has flown 90 different types of civilian and military aircraft, logging over 13,200 flying hours, including 5,500 in jet aircraft, and holds instructor, instrument instructor, glider instructor and airline transport ratings. He has received the National Defense Service Medal, USAF Post-doctoral Fellowship, National Heart Fellowship, American College of Surgeons I. S. Ravdin Lecture, NASA Exceptional Service Medal and Flying Physicians Association Airmen of the Year Award. He has five children. He was born in Boston, Massachusetts, August 19, 1935 but considers Lexington, Kentucky his hometown. He is 5'10" in height and weighs 149 pounds. He has blond hair and blue eyes.



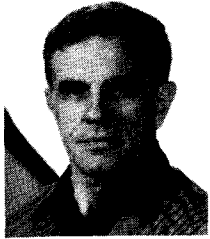
**S. DAVID GRIGGS**, is the pilot for the 51-F mission. He is a mission specialist on the 41-F mission. He received a bachelor of science degree from the United States Naval Academy in 1962 and a master of science in Administration from George Washington University in 1970. Griggs entered pilot training after graduation from Annapolis, receiving his wings in 1964. He was assigned to Attack Squadron 72 flying A-4 aircraft and completed two Southeast Asia Cruises and one Mediterranean Cruise aboard the aircraft carrier USS Independence and Roosevelt. Griggs entered the U.S. Naval Test Pilot School at Patuxent River, Maryland, in 1967 and upon completion was

assigned to the Flying Qualities and Performance Branch, Flight Test Division where he flew various test projects on fighter and attack-type aircraft. In 1970 he resigned his regular United States Navy Commission and affiliated with the naval air reserve. In July, 1970 Griggs was employed at the Johnson Space Center as a research pilot working on various flight test and research projects. In 1974, he was the project pilot for the Shuttle trainer aircraft and participated in the design, development and testing. In 1976 he was appointed chief of the Shuttle training aircraft operations. He has logged 6,200 hours flying time, 5,100 hours in jet aircraft and has flown over 40 different types of aircraft. He holds an airline transport license and is a certified flight instructor. He was awarded the Navy Distinguished Flying Cross and Air Medal, Navy Unit Commendation, NASA Achievement Award, and NASA Sustained Superior Performance Award. He is a member of the Society of Experimental Test Pilots and a Colonel in the Confederate Air Force. He was selected as an astronaut candidate in January 1978, completing a one year training and evaluation period in August 1979, making him eligible for an assignment as a pilot. Griggs was born in Portland, Oregon, September 7, 1939. He is married and has two children. He is 5' 10" and weighs 175 pounds. He has brown hair and eyes.



**ANTHONY W. ENGLAND**, is a mission specialist for the 51-F mission. He received bachelor and master of science degrees in Geology and Physics from Massachusetts Institute of Technology in 1956 and a doctor of philosophy from the Department of Earth and Planetary Sciences at MIT in 1970. He was a graduate fellow at MIT for three years immediately preceding his assignment to NASA. He has performed heat flow measurements throughout the southwest, has taken part in a magnetic study in Montana, has performed radar sounding studies of glaciers in Washington state and Alaska, has performed microwave airborne surveys throughout the western United States, and has participated in and led field parties during two seasons in Antarctica. Dr. England was selected as a scientist-astronaut by NASA in August 1967. He completed academic training and a 53 week course in flight training at Laughlin Air Force Base, Texas. He has logged over 2,000 hours in flying time. He served as a support crewman for the Apollo 13 and 16 flights. From August 1972 to June 1979, England was a research geophysicist with the U.S. Geological Survey. He returned to the Johnson Space Center in 1979 as a senior scientist astronaut. England was presented the Johnson Space Center Superior Achievement Award (1970); the NASA Outstanding Achievement Medal (1973); and the U.S. Antarctic Medal (1979). He is a member of the American Geophysical Union, the American Geological Institute, the Society of Exploration Geophysicists, the American Association for the Advancement of Science, and the International Glaciological Society. England was born May 15, 1942 in Indianapolis, Indiana, but considers Fargo, North Dakota his hometown. England is married and has two children. He has brown hair and blue eyes. He is 5'10" and weighs 165 pounds.

## 51-F FLIGHT CREW



**KARL C. HENIZE**, is a mission specialist for the 51-F mission. He received a bachelor of arts degree in Mathematics in 1947 and a master of arts degree in Astronomy in 1948 from the University of Virginia; and awarded a doctor of Philosophy in Astronomy in 1954 by the University of Michigan. Henize was an observer for the University of Michigan Observatory from 1948 to 1951, stationed at the Lamont Hussey Observatory in Bloemfontein, Union of South Africa. In 1954, he became a Carnegie post-doctoral fellow at the Mount Wilson Observatory in Pasadena, California. From 1956 to 1959 he served as a senior astronomer at the Smithsonian Astrophysical Observatory. Dr. Henize was appointed associate professor in Northwestern University's Department of Astronomy in 1959 and was awarded a professorship in 1964. In addition to teaching he conducted research on planetary nebulae, peculiar emission-line stars, S-stars, and T-associations. During 1961 and 1962, he was guest observer at Mt. Stromoto Observatory in Canberra, Australia. He became principal investigator of experiment S-013 which obtained ultraviolet stellar spectra during the Gemini 10, 11, and 12 flights. He also became principal investigator of experiment S-019 used on Skylab to obtain ultraviolet spectra of faint stars. Spectra were obtained of hundreds of stars and these are being studied at the University of Texas where Dr. Henize now holds an adjunct professorship. He is the author and/or co-author of 56 scientific publications dealing with astronomy research. Dr. Henize was selected as a scientist-astronaut by NASA in August 1967. He completed the academic training and the 53-week jet pilot training program at Vance Air Force Base, Oklahoma. He has logged 1,900 hours of flying time in jet aircraft. He was a member of the astronaut support crew for the Apollo 15 mission and for the Skylab 2, 3, and 4 missions. He was presented the Robert Gordon Memorial Award for 1968; recipient of the NASA Group Achievement Award (1971, 1974, 1975, 1978); awarded the NASA Exceptional Scientific Achievement Medal (1974). He is a member of the American Astronomical Society; the Royal Astronomical Society; the Astronomical Society of the Pacific; and the Astronomical Union. He was born October 17, 1926, in Cincinnati, Ohio. He is married and has four children. He has brown hair and brown eyes. He is 5'7" and weighs 170 pounds.

