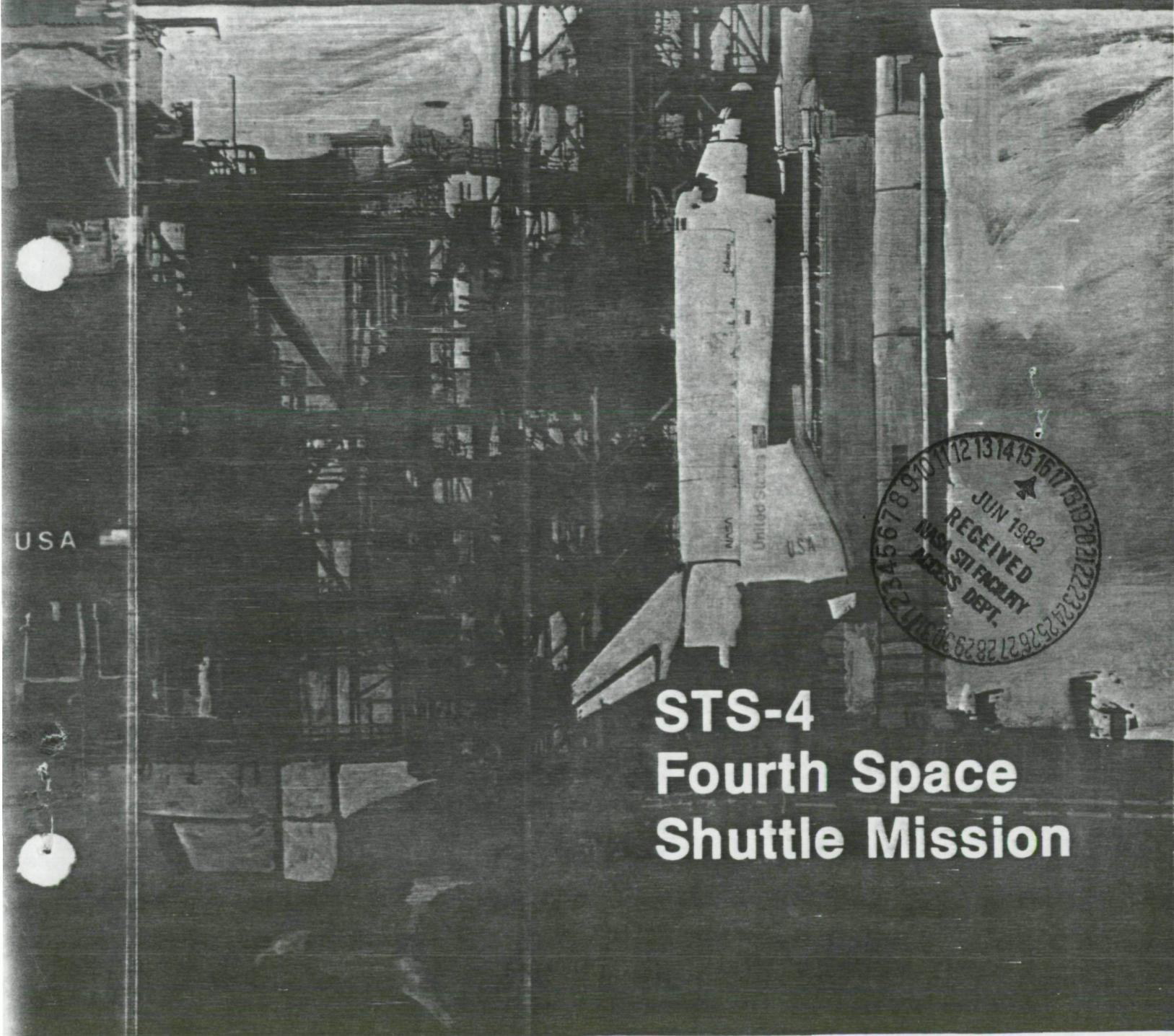


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UNDERGOES FINAL SHAKEDOWN DURING SEVEN-DAY  
STS-4 MISSION (National Aeronautics and  
Space Administration) 94 p CSCI 22A Unclas  
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# STS-4 Fourth Space Shuttle Mission

Mr. FRENCH

P82-10086

# NASA News

National Aeronautics and  
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RELEASE NO: 82-84

## COLUMBIA UNDERGOES FINAL SHAKEDOWN DURING SEVEN-DAY STS-4 MISSION

The fourth and final development flight of the Space Shuttle is scheduled for launch June 27, 1982, from Complex 39's Pad A at NASA's Kennedy Space Center in Florida.

Columbia's fourth mission is scheduled for seven days and will complete the shakedown of the Shuttle orbiter and booster systems. The nation's Space Transportation System becomes operational with flight five, now scheduled for November.

Among top priorities listed for STS-4 are the continued studies of the effects of long-term thermal extremes on the orbiter subsystems and a survey of orbiter induced contamination on the payload bay.

June 7, 1982

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The flight crew for STS-4 is Commander Thomas K. (Ken) Mattingly II, 46, and Pilot Henry W. Hartsfield, 48.

Columbia will be launched into a circular orbit above the Earth with an inclination to the equator of 28.5 degrees. Two burns of the orbital maneuvering engines will place Columbia in a 241 kilometer (130 nautical mile) circular orbit. A third and fourth burn of the Orbital Maneuvering System engines on the fourth revolution will place Columbia in a circular orbit 296 km (160 nm) above the Earth.

The launch window for STS-4 will be for 4 hours and 34 minutes. The window will open at 11 a.m. EDT and extend until 3:24 p.m. for a nominal late June launch. The end of the window is restricted to a trans-Atlantic abort into Rota, Spain, no later than 15 minutes after sunset.

Columbia will operate in several different attitudes during the 168-hour flight -- "barbeque" fashion, or passive thermal control; top to the Sun; tail to Sun; and belly to Sun. To stabilize its systems prior to reentry, Columbia will fly the final 10 hours of the mission in the passive thermal control attitude.

An experiment that marks the first use of the Space Shuttle by a commercial concern tops the list of non-government payloads scheduled to be carried into space on the fourth Shuttle flight.

The Continuous Flow Electrophoresis System (CFES) experiment which will separate biological materials in a fluid according to their surface electrical charge, will make its maiden flight on STS-4. The experiment is part of a NASA/McDonnell Douglas Astronautics Co. "joint endeavor agreement" to conduct research in space.

The electrophoresis process has a high probability of being able to separate substances that cannot be separated in sufficient quantities or purity on Earth into commercially attractive substances which may be useful in the diagnosis, treatment or prevention of human or animal diseases.

The experiment involves separation of proteins and other natural biological matter.

The first operational "Getaway Special" will fly on STS-4. Inside the 61-by-91-centimeter (24-by-36-inch) canister will be nine experiments that range from algae and duckweed growth in space to fruit fly and brine shrimp genetic studies. The Getaway Special was purchased by R. Gilbert Moore, a manager at the Thiokol Corp. in Ogden, Utah. He subsequently donated it to Utah State University where it is being used in a program for student constructed experiments.

Several experiments will be making their third and fourth flights aboard the Shuttle. Among those carried on previous missions are the Development Flight Instrumentation Package, Aerodynamic Coefficient Identification Package and several orbiter experiments such as the catalytic surface effects and tile gap heating effects.

The Induced Environmental Contamination Monitor will be making its third flight into space on STS-4. The desk-sized package will measure the contaminants within and around the cargo bay which may affect scientific experiments or other cargo on future flights.

The mechanical remote manipulator arm will get its stiffest test to date. The robot arm will lift the 363-kilogram (800-pound) contamination monitor up out of the cargo bay and move it to various locations around the bay area to provide a more complete survey of the payload bay environment.

A Department of Defense Payload, DOD 82-1, shares the payload bay.

Other experiments, both making their second trip into space, include the Nighttime/Daytime Optical Survey of Lightning, flown aboard STS-2 but which produced limited results because of the shortened mission, and the Monodisperse Latex Reactor, an STS-3 passenger, will make a repeat performance aboard Columbia.

The lightning survey experiment is designed to record motion pictures and photo cell readings of lightning and thunderstorms as seen from orbit. These techniques may be adaptable in the development of sensors to identify severe weather situations from future meteorological satellites.

The second flight of the Monodisperse Latex Reactor is designed to test the feasibility of making large size, monodisperse (same size), polystyrene latex micro-spheres using the products of the STS-3 mission as seed particles. The latex spheres are used in calibration of scientific and industrial equipment and have potential medical and research applications.

STS-3 carried the first student-developed experiment on-board, and NASA will continue its Shuttle Student Involvement Project on STS-4 with two more student experiments. They are:

"The effect of prolonged space travel on levels of trivalent chromium in the body" - - proposed by Karla R. Hauersperger, a senior at East Mecklenburg High School in Charlotte, N.C.

"The effect of exercise, diet and zero gravity on lipoprotein profiles" - - proposed by Amy M. Kusske, a graduate of Hill Junior High School in Long Beach, Calif.

These two studies involve the physiological effects of space travel on the human body. Neither experiment will require any hardware. Instead, the astronauts will fill out data cards about their exercise on the treadmill, and their daily food intake.

The mission is scheduled to last 168 hours with 112 orbits around the Earth.

Mattingly and Hartsfield will follow the same course in returning from orbit as did early STS crews: retrofire over the Indian Ocean, atmospheric entry over the western Pacific Ocean, and then a transition to aerodynamic controls in the atmosphere to land as an aircraft.

NASA officials have made the cross-wind landing tests a highly desirable flight objective on STS-4. Columbia will land at Edwards Air Force Base, Calif., on Runway 17, a dry lakebed runway, or on Runway 22, a hard surface runway, if acceptable cross-wind conditions are not available. The 3-mile long paved runway at Kennedy Space Center will be the prime backup landing site.

Columbia will be guided to its landing site by a microwave scanning beam landing system at the landing site. As the orbiter descends, Mattingly will put the craft through rolls and other maneuvers to test how the spacecraft handles under stress. The craft will remain in the automatic mode through 762 meters (2,500 feet) and will be flown to landing and controlled through rollout by the crew.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS.)

STS-4 PRESS BRIEFING SCHEDULE

<u>Date</u>	<u>EDT</u>	<u>Time</u> <u>CDT</u>	<u>PDT</u>	<u>Event</u>	<u>Origin</u>
T-3	9:00 am	8:00 am	6:00 am	Countdown Status	KSC
	10:30 am	9:30 am	7:30 am	STS-4 Vehicle & Facilities/ Terminal Countdown and Mission Rules	KSC
	1:30 pm	12:30 pm	10:30 am	NASA/DOD STS-4 Public Affairs Operations	KSC
	9:00 am	8:00 am	6:00 am	Countdown Status	KSC
T-2	10:30 am	9:30 am	7:30 am	STS-4 Flight Plan	KSC
	1:00 pm	12 noon	10:00 am	Orbiter Experiments Continuous Flow Electrophoresis System (CFES) Experiment Getaway Special (GAS) Shuttle Student Experiments	KSC
T-1	9:00 am	8:00 am	6:00 am	Countdown Status	KSC
	10:30 am	9:30 am	7:30 am	Prelaunch Press Conference	KSC
T-Day	(Approximately 90 minutes after launch)			Post Launch Press Conference	KSC
T thru T+7	See TV Schedule			Flight Director's Change of Shift Briefings	JSC
T+3	2:00 pm	1:00 pm	11:00 am	Space Suit Briefing	JSC
T+6	2:00 pm	1:00 pm	11:00 am	Landing Operations Briefing	DFRF
	4:00 pm	3:00 pm	1:00 pm	Landsat-D Briefing	DFRF
T+7	(Approximately 2 hours after landing)			Post Landing Briefing	DFRF
T+8	2:00 pm	1:00 pm	11:00 am	Orbiter Status Briefing	DFRF
	TBD			Departure of NASA 905 with 0-99 Challenger	DFRF



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NASA SELECT TELEVISION SCHEDULE for STS-4  
REVISED- 6/02/82

\*\*\*\*\*----- PRE-LAUNCH ACTIVITES -----\*\*\*\*\*

		<u>EDT</u>
T MINUS 3 DAYS	- Countdown Status Briefing from KSC	9:00 AM
	- Terminal Countdown/Mission Rules and Vehicle Status	10:30 AM
	- NASA/DOD STS-4 Public Affairs Operations from KSC	1:30 PM
T MINUS 2 DAYS	- Countdown Status Briefing from KSC	9:00 AM
	- STS-4 Flight Plan Briefing from KSC	10:30 AM
	- PAYLOADS Briefing from KSC	1:00 PM
T MINUS 1 DAY	- Countdown Status Briefing from KSC	9:00 AM
	- Pre-Launch Press Conference from KSC	10:30 AM

----- LAUNCH DAY -----

T-MINUS 80 MINUTES      Satellite feed down for ten minutes for weather data.

T-MINUS 30 MINUTES      Satellite feed down for five minutes for weather data.

<u>ORBIT</u>	<u>SUBJECT</u>	<u>MET</u> (DD/HH:MM)	<u>EDT</u>
	LAUNCH		11:00 AM
2	OTV LAUNCH VIDEO from KSC	00/00:45-01:00	11:45 AM
2	KSC POST LAUNCH PRESS CONFERENCE	00/01:30	12:30 PM
5	SHIFT BRIEFING-ASCENT TOMMY HOLLOWAY-FLIGHT DIRECTOR - JSC	00/06:30	5:30 PM

-----FLIGHT DAY TWO-----

10	SHIFT BRIEFING-ORBIT (Sleep) CHUCK LEWIS-FLIGHT DIRECTOR - JSC	00/14:30	1:30 PM
18	TV01 CFES TRAY OPERATIONS HAW T=8:13	01/01:24-01:32	12:24 AM
18	SHIFT BRIEFING- ENTRY HAROLD DRAUGHAN-FLIGHT DIRECTOR - JSC	01/01:40	12:40 AM
20	PLAYBACK of TV01 CFES TRAY OPERATIONS	01/02:20	1:20 PM
23	SHIFT BRIEFING-ORBIT CHUCK LEWIS-FLIGHT DIRECTOR - JSC	01/09:30	8:30 PM

-----FLIGHT DAY THREE-----

28	SHIFT BRIEFING-ASCENT (Sleep +1/2 hr.) TOMMY HOLLOWAY-FLIGHT DIRECTOR - JSC	01/17:30	4:30 AM
33	SHIFT BRIEFING-ENTRY HAROLD DRAUGHAN-FLIGHT DIRECTOR -JSC	02/01:00	12:00 NOON
35	SPACE SUIT BRIEFING from JSC	02/03:00	2:00 PM
38	SHIFT BRIEFING-ORBIT CHUCK LEWIS-FLIGHT DIRECTOR - JSC	02/08:30	7:30 PM

-----FLIGHT DAY FOUR-----

44	SHIFT BRIEFING-ASCENT (Sleep +1/2 hr.) TOMMY HOLLOWAY-FLIGHT DIRECTOR - JSC	02/16:30	3:30 AM
49	SHIFT BRIEFING-ENTRY HAROLD DRAUGHAN-FLIGHT DIRECTOR - JSC	03/00:30	11:30 AM
50	TV03 CFES SAMPLE OPERATIONS HAW GDS T=8:11/6:19/7:49 MIL	03/01:43-01:52 /01:54-02:00 /02:02-02:10	12:44 PM
50	PLAYBACK of TV03 CFES SAMPLE OPERATIONS T=22:31	03/02:20	1:20 PM
52	SHIFT BRIEFING-ORBIT CHUCK LEWIS-FLIGHT DIRECTOR - JSC	03/07:30	6:30 PM

-----FLIGHT DAY FIVE-----

59	SHIFT BRIEFING-ASCENT (Sleep + $\frac{1}{2}$ hr.) TOMMY HOLLOWAY-FLIGHT DIRECTOR - JSC	03/15:30	2:30 AM
64	TV06 VTR of RCS PULSE MIL T=9:23	03/23:00-23:09	10:00 AM
64	PLAYBACK VTR of RCS PULSE	03/23:15	10:15 AM
64	SHIFT BRIEFING-ENTRY HAROLD DRAUGHAN-FLIGHT DIRECTOR - JSC	03/23:30	10:30 AM
69	SHIFT BRIEFING-ORBIT CHUCK LEWIS-FLIGHT DIRECTOR - JSC	04/07:30	6:30 PM

-----FLIGHT DAY SIX-----

75	SHIFT BRIEFING-ASCENT (Sleep +1hr.) TOMMY HOLLOWAY-FLIGHT DIRECTOR - JSC	04/15:30	2:30 AM
80	TV04 CREW EXERCISE HAW T=8:11	04/22:52-23:00	9:52 AM
80	SHIFT BRIEFING-ENTRY HAROLD M. DRAUGHAN-FLIGHT DIRECTOR - JSC	04/23:05	10:05 AM
80	PLAYBACK of TV04 CREW EXERCISE	04/23:45	10:45 AM
81	LANDING OPERATIONS BRIEFING from DFRF	05/03:00	2:00 PM
	LANDSAT-D BRIEFING FROM DFRF		4:00 PM
85	SHIFT BRIEFING-ORBIT CHUCK LEWIS-FLIGHT DIRECTOR - JSC	05/07:00	6:00 PM

-----FLIGHT DAY SEVEN-----

90	SHIFT BRIEFING-ASCENT (Sleep + $\frac{1}{2}$ hr.) TOMMY HOLLOWAY-FLIGHT DIRECTOR - JSC	05/15:00	2:00 AM
94	TV05 MEAL PREPARATION MIL T=7:45	05/20:08-20:16	7:08 AM
94	PLAYBACK TV05 MEAL PREPARATION	05/20:20	7:20 AM
95	SHIFT BRIEFING-ENTRY HAROLD DRAUGHAN-FLIGHT DIRECTOR - JSC	05/22:30	9:30 AM

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101	SHIFT BRIEFING-ORBIT CHUCK LEWIS-FLIGHT DIRECTOR - JSC	06/07:00	6:00 PM
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-----FLIGHT DAY EIGHT-----

106	SHIFT BRIEFING-ASCENT (Sleep $\frac{1}{2}$ hr.) TOMMY HOLLOWAY-FLIGHT DIRECTOR - JSC	06/15:00	2:00 AM
115	LANDING	06/23:37	10:37 AM

\*\*\*\*----- POST LANDING ACTIVITIES -----\*\*\*\*

LANDING plus APPROX. 2 Hours	- Post Landing Briefing from DFRF	12:37 PM
LANDING plus ONE Day	- Orbiter Status Briefing from DFRF	2:00 PM
Tentative Departure of Orbiter 099 (Challenger) from DFRF		TBD

Definition of Terms

MET: Mission Elapsed Time. The time which begins at the moment of launch.  
Read the clock by Days/Hours:Minutes.

EDT: Eastern Daylight Time.

ORBIT: The number of revolutions made by the spacecraft over a specific point on the Earth.

T=: Total time. In this case it will refer to the total time of the television pass.

Tracking Stations

GDS: Goldstone, Calif.  
HAW: Hawaii  
MIL: Merritt Island Launch Area, Fla.

Experiments

CFES: Continuous Flow Electrophoresis System

STS-4 OBJECTIVES: PROVING OPERATIONAL READINESS

Each successive flight in the series of four orbital test flights with orbiter Columbia is aimed at further verifying the Shuttle system's capability to do the job for which it was designed -- haul heavy payloads into and out of Earth orbit with a reusable vehicle. STS-4 will be the fourth of the planned four test flights in which flight worthiness of the Space Transportation System is demonstrated in a building-block scheme. Prime among the flight worthiness objectives is the operational compatibility of orbiter and its main tank and booster, and ground support facilities.

Among the varied tests of orbiter systems will be the orbiter's thermal response tests of passive thermal control for 20 hours (orbiter long axis perpendicular to the Sun line); 80 hours tail to Sun; 40 hours bottom to Sun and 10 hours payload bay toward Earth.

In addition to Developmental Flight Instrumentation in the payload bay, STS-4 will carry the first operational Getaway Special canister containing nine experiments from Utah State University; and Department of Defense payload DOD 82-1. The continuous-flow electrophoresis experiment, student experiments and other STS-4 investigations are described in the experiments section of this press kit.

Testing Columbia's Canadian-built robot arm, or payload deployment and retrieval system, will continue on STS-4. The arm will lift the Induced Environment Contamination Monitor from the payload bay rack two separate times for measuring space environment around the orbiter and as an exercise in payload handling before nesting the sensor back in its holddown each time.

During launch and entry, orbiter aerodynamic performance will be further measured to add to the knowledge gained in the first three orbital test flights. Each successive flight profile was designed to push the orbiter closer to its operational limits.

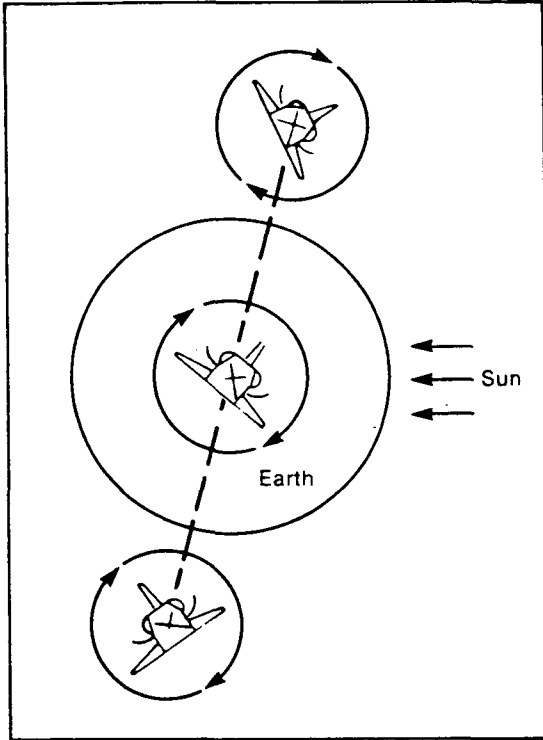
During entry, a series of aerodynamic response tests will be run in various speed regimes from hypersonic down through subsonic to evaluate orbiter stability and control system effectiveness.

Aerodynamic stick inputs and programmed test inputs will activate the reaction control system jets and cycle the aerosurface controls in combination and singly to induce attitude oscillations.

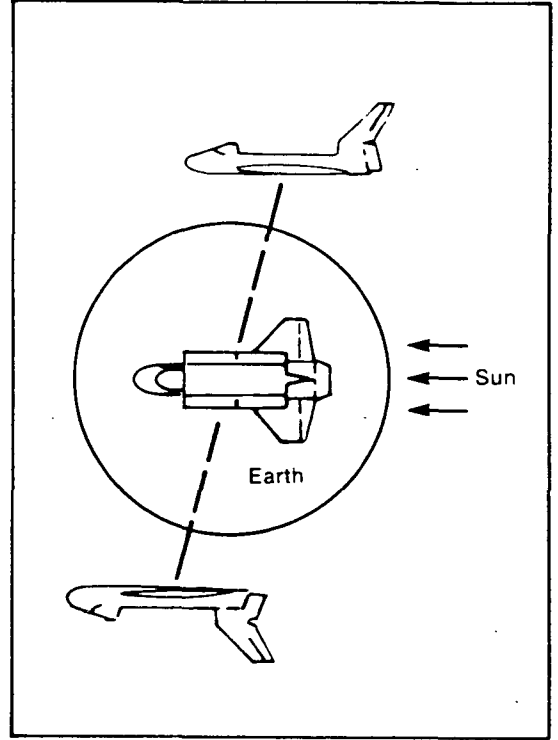
Similar tests were run at subsonic speeds during the 1977 approach and landing test flights with orbiter Enterprise and on the previous three orbiter test flights.

STS-4 THERMAL TEST ATTITUDES

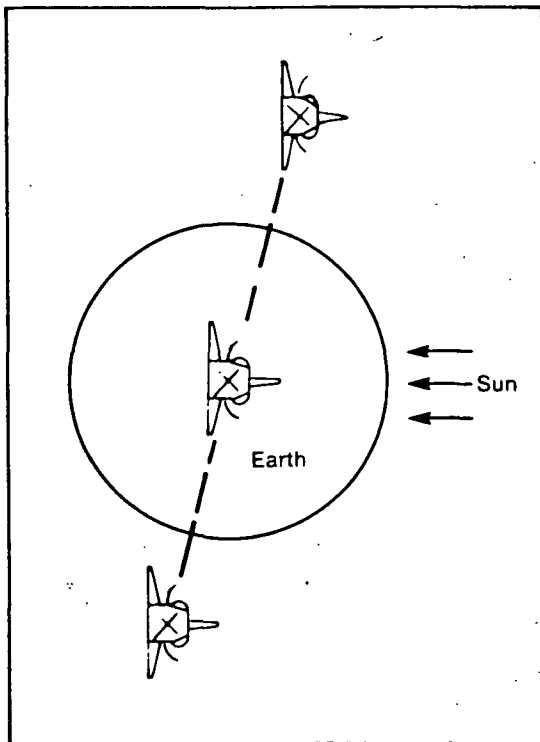
PASSIVE THERMAL CONTROL  
(20 Hours)



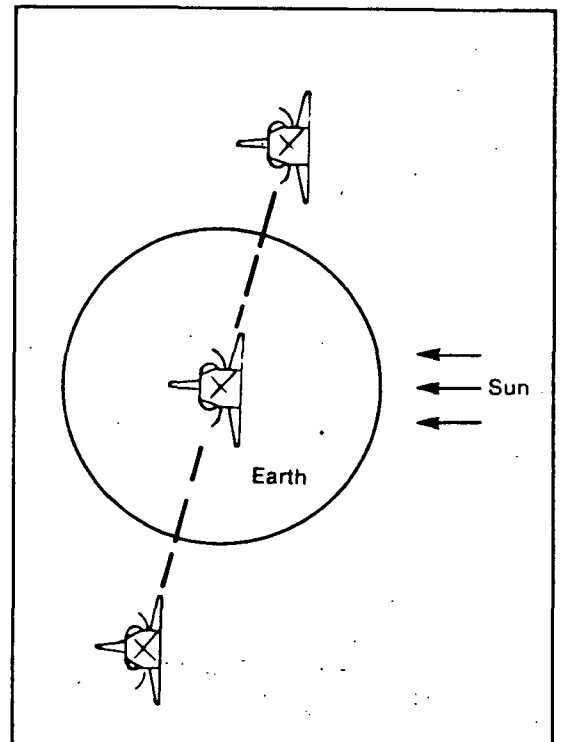
TAIL TO SUN  
(Payload Bay to Space)  
(166 Hours)



PAYLOAD BAY TO SUN  
(5 Hours)



BOTTOM TO SUN  
(33 Hours)



Shuttle spacesuits, or extravehicular mobility units, are stowed in the airlock for a contingency spacewalk to close balky payload bay doors. Should such a spacewalk become necessary, Columbia's cabin pressure would be lowered from 14.5 pounds per square inch (21/79 percent oxygen/nitrogen mix) to 9 psi (38/78 percent oxygen nitrogen). Lowering cabin pressure to 9 psi eliminates the need to prebreathe oxygen on an umbilical or on a portable oxygen system to "wash" suspended nitrogen from blood before going out to haul the doors shut.

#### LAUNCH PREPARATIONS, COUNTDOWN AND LIFTOFF

Assembly of the STS-4 vehicle began March 29 with the placement of the two solid rocket booster aft assemblies on the deck of the Mobile Launcher Platform in the Vehicle Assembly Building's High Bay 3 at Kennedy Space Center. The left hand solid rocket booster was topped off with its forward assembly on April 7.

Stacking of the right hand booster was completed the following day. As on all three previous flights, the vehicle was stacked on the deck of the No. 1 Mobile Launcher Platform.

Columbia arrived at Kennedy on April 6 aboard the modified 747 Shuttle Carrier Aircraft. Technicians worked overnight taking the orbiter off the top of the jumbo jet, and towed it into the Orbiter Processing Facility on April 7.

Before the orbiter was modified for its next mission, engineers concentrated on fixing problems that were encountered during the most recent flight. During the five days of postflight troubleshooting done in the Orbiter Processing Facility, the faulty S-Band communications transponder was removed and shipped back to the vendor, and the orbiter's toilet was taken out and sent back to its manufacturer.

Residual hypergolic propellants were drained out of the orbiter's orbital maneuvering and reaction control system modules and the payload carried on Columbia's third flight -- OSS-1 -- was taken out of the cargo bay April 13 and returned to the Operations and Checkout Building for removal of the experiments.

While work was progressing on the orbiter, stacking and pre-flight checkout of the other Shuttle elements was underway and on schedule. On April 16, the external tank was moved out of its checkout cell and mated to the twin booster rockets already assembled on the Mobile Launcher Platform. The tank, which had arrived Jan. 22 by ocean-going barge, underwent its preflight checkout and systems testing in High Bay 4.

Several components on the Columbia were changed out in preparation for its fourth flight. A new No. 3 inertial measurement unit was installed, and all the tires on both the main and nose landing gears were replaced.

One significant modification to Columbia for STS-4 and subsequent flights was the installation of a payload bay liner to reduce contamination to cargo bay experiments.

High pressure fuel pumps on all three main engines were removed and inspected. As a result, the fuel pump on the No. 2 engine was sent to the vendor for replacement of some components, and the pump was successfully tested at the NASA National Space Technology Laboratories, Bay St. Louis, Miss., during a 300-second single engine firing. The fuel pump on the No. 1 engine was also replaced due to a cracked turbine blade.

The modification period for STS-4 did not call for a scheduled "power down" period. However, it was necessary to power down Columbia for a week, starting April 24, while a heat interchanger was removed and replaced.

Also undertaken during the power down period was the removal and replacement of 12 attitude control jets. A postflight inspection of the thrusters found varying amounts of gypsum sand in the powerful small rocket engines, a result of Columbia's landing at the Northrup Strip in White Sands, N.M. The forward reaction control system was taken out of the spaceship April 24 and moved to the Hypergolic Maintenance Facility where six thrusters were pulled and replaced with new ones.

Six other thrusters were pulled out of the twin aft maneuvering pods (three right and three left thrusters) and also replaced with new ones.

The Induced Environmental Contamination Monitor was removed and shipped back to NASA's Marshall Space Flight Center, Huntsville, Ala., for analysis. It was returned to Kennedy and installed back in the cargo bay on May 5. Two other STS-4 experiments were also installed while Columbia was in the processing hangar. The first "Getaway Special" to fly aboard Columbia was installed May 11. That same day, installation started on the Continuous Flow Electrophoresis System experiment.

Astronauts Mattingly and Hartsfield participated in a Crew Equipment Interface Test on May 9 to familiarize themselves with the location and use of experiments and equipment carried onboard the STS-4 mission.

Just days before Columbia's scheduled move to the Vehicle Assembly Building, a faulty actuator was discovered during functional checks of the Shuttle main engines. The orbiter actuator was replaced and successfully retested. Another last-minute task was the replacement of a check valve in a gaseous oxygen line in the orbiter's main propulsion system feed system.



The payload bay doors were closed for Columbia's move to the Vehicle Assembly Building on May 17 and leak and functional checks of the three Shuttle main engines and checks of the hydraulically-controlled flight control system were completed. Finally, the orbiter was closed out for the move and weighed before moving out of the Orbiter Processing Facility on May 19.

Workers recorded their shortest turnaround time to date in the Orbiter Processing Facility, preparing the reusable spaceship for the STS-4 mission in 40 working days. Columbia spent 53 working days in the facility for the STS-3 mission and 99 days for Columbia's second flight.

On May 20, the Columbia was mechanically mated to the external tank and solid rocket boosters, completing assembly of the STS-4 vehicle.

A Shuttle Interface Test was conducted from May 21-25 to verify the mechanical, fluid and electrical connections between the orbiter, external tank and booster rockets and to verify the function of onboard systems.

Unlike previous flights, the mission simulations normally done at the end of the Shuttle Interface Test were not performed, reducing the amount of testing in the VAB.

The STS-4 vehicle was moved to Pad A of Complex 39 on May 26 to undergo final checkout and propellant servicing for launch.

Pad to vehicle connections were verified, followed by a Dry Countdown Demonstration Test with the STS-4 prime crew members on May 29. The test simulates as closely as possible the final hours of an actual Shuttle launch countdown, except that the external tank is not filled with cryogenic propellants.

A wet cryogenic tanking test was conducted on June 2 to verify the automatic propellant loading system and ability of Shuttle systems to perform under cryogenic conditions. The test also verifies the integrity of the external tank outer insulation. The flight crew did not participate in this test.

The preflight servicing of Columbia with hypergolic propellants was scheduled from June 8-12. During this time, the monomethyl hydrazine and nitrogen tetroxide propellants are loaded into the orbiter's forward and aft maneuvering and reaction control system tanks.

Countdown preparations were to begin June 14, leading to a pick up of the 87-hour Shuttle Launch Countdown on June 23.

The launch countdown for STS-4 will be conducted from Firing Room 1 of the Launch Control Center by a government/industry team of about 200 persons.

The STS-4 launch countdown will follow a similar schedule to earlier countdowns. The STS-4 countdown is longer, because of a requirement to open the payload bay doors during the count, and the duration and distribution of hold times have changed.

Precount activities should include activation of the fuel cell system, pressurization of the orbital maneuvering and reaction control systems, a review of flight software stored in the bulk memory units, loading of power reactant storage and distribution cryogenic oxygen and hydrogen tanks, installation of the mid-deck experiments and retraction of the rotating service structure.

The terminal portion of the countdown starts at T-6 hours with loading of cryogenic propellants into the external tank. A one-hour hold at T-3 hours will allow time for an inspection of the external tank insulation, and boarding of Columbia by the crew should occur at T-1 hour and 50 minutes.

At T-9 minutes, the automatic ground launch sequencer takes over command of the countdown, issuing critical commands down to main engine start at T-6.8 seconds and maintaining a cutoff capability to liftoff.

MAJOR COUNTDOWN MILESTONES

<u>Count Time</u>	<u>Event</u>
T-87 hours	Call to stations.
T-77 hours	Pressurize orbital maneuvering and reaction control system tanks.
T-70 hours	Fuel cell cold start and cathode activation test.
T-68 hours	Mass memory unit patch and compare.
T-56 hours	Position solid rocket booster deflectors.
T-48 hours	Power reactant storage and distribution LO <sub>2</sub> load and pressurize.
T-46 hours	Power reactant storage and distribution LH <sub>2</sub> load and pressurize.
T-42 hours	Open payload bay doors.
T-40 hours	Eight hour built-in hold.
T-36 hours	Disconnect orbiter mid-body umbilical and configure sound suppression water system.
T-32 hours	Install Continuous Flow Electrophoresis Experiment and Monodisperse Latex Reactor.
T-30 hours	Close payload bay doors.
T-25 hours	Inertial Measurement Unit warmup.
T-24 hours	Liquid oxygen/liquid hydrogen loading preparations.
T-18 hours	Merritt Island Tracking Station/Mission Control Interface Test.
T-16 hours	Retract rotating service structure.
T-13 hours	Extend gaseous oxygen vent arm.
T-11 hours	Fill sound suppression water tank.

T-9 hours, 15 minutes	Eight-hour-40 minute built-in hold.
T-9 hours, 15 minutes	Fuel cell flow through purge.
T-8 hours	LO <sub>2</sub> and LH <sub>2</sub> final loading preparations and inertial measurement unit preflight calibration. Mission Control communication switches to launch configuration.
T-6 hours, 30 minutes	Eastern Test Range open loop test.
T-6 hours	Clear to blast danger area and begin LO <sub>2</sub> /LH <sub>2</sub> chilldown and load. Fuel cell activation and load sharing.
T-4 hours	MILA antenna alignment.
T-3 hours, 30 minutes	Flight crew wakeup for medical, breakfast and weather briefing.
T-3 hours, 20 minutes	LO <sub>2</sub> in stable replenish.
T-3 hours	LH <sub>2</sub> in stable replenish.
T-3 hours	1 hour built-in hold.
T-3 hours (holding minutes).	Crew suitup (Launch-3 hours, 30 minutes).
T-3 hours (counting)	Closeout crew to white room.
T-2 hours, 5 minutes	Crew at white room.
T-2 hours	Fuel cell purge.
T-1 hour, 50 minutes	Crew entry into vehicle and hatch closeout.
T-1 hour, 5 minutes	Inertial measurement unit preflight alignment.
T-22 minutes	Transfer primary computer load to backup flight system and compare.
T-20 minutes	10-minute built-in hold.
T-20 minutes	Orbiter computers transition to launch configuration.
T-19 minutes	Backup flight system transition to launch configuration.
T-9 minutes	10 minute built-in hold.

T-9 minutes (holding)	"Go" for launch from launch director.
T-9 minutes (counting)	Start ground launch sequencer.
T-7 minutes	Retract orbiter access arm.
T-5 minutes	Start orbiter auxiliary power units and arm external tank and solid rocket booster ignition and range safety systems.
T-3 minutes, 30 seconds	Transfer orbiter to internal power.
T-2 minutes, 55 seconds	Start pressurizing liquid oxygen tank, retract gaseous oxygen vent hood.
T-2 minutes, 35 seconds	Transfer to onboard fuel cell reactants.
T-1 minute, 57 seconds	Start pressurizing liquid hydrogen tank.
T-28 seconds	Go from ground launch sequencer for four primary computers to start terminal launch sequencer, and start solid rocket booster hydraulic power units.
T-6.8 seconds	Go for main engine start.
T-3 seconds	Main engines at 90 percent thrust.
T-0	Solid rocket booster ignition, holddown post release and liftoff.
T+7 seconds	Tower clear.

#### LAUNCH WINDOW

STS-4 will be launched from Complex 39's Pad A at Kennedy Space Center no earlier than June 27, 1982. The launch window on that date extends from 11 a.m. to 3:24 p.m. EDT, for a launch opportunity of 3 hours and 24 minutes in duration.

The window assumes a nominal landing on a dry lake bed at Edwards Air Force Base, Calif.

STS-4 will be launched into a 241-km (130-nm) orbit with an inclination to the equator of 28.5 degrees.

STS-4 FLIGHT SEQUENCE OF EVENTS





Mission Elapsed Time

<u>Event</u>	<u>Day/Hrs:Min:Sec</u>	<u>Comments</u>
SRB Ignition	0/00:00:00	
Liftoff	0/00:00:00.3	
Pitchover	0/00:00:08	
Max Q (Dynamic Pressure)	0/00:00:53	26,479 ft. altitude, 680 lb/ft <sup>2</sup> max, 1.9 nm downrange
SRB separation	0/00:02:12	165,217 ft., 27 nm downrange
MECO 0/00:08:37		55 nm altitude, 770 nm downrange
ET separation	0/00:08:50	
OMS-1 ignition	0/00:10:34	162 fps, 34x130 nm orbit
OMS-2 ignition	0/00:37:39	175 fps, 130x130 nm orbit
OMS-3 ignition	0/04:29:12	62.3 fps, 130x165 nm orbit
OMS-4 ignition	0/05:14:12	61.6 fps, 165x165 nm orbit
Deorbit ignition	6/22:41:49	315.2 fps, two engines
Entry interface (400 K ft.)	6/23:08:36	
Terminal area energy management (TAEM)	6/23:25:28	
Landing	6/23:37:57	

GUIDE TO USING THE FLIGHT PLAN

1. Summary Level Timeline (12-hour timespan)

The following letters (a-j) reference those in Page 22.

- a. Timescales: Two time references are presented in this section. The two time references used are Central Standard Time (CST) (or TIG minus) and Mission Elapsed Time (MET). MET is referenced to liftoff beginning at 00/00:00:00 (days, hours, minutes and seconds).
- b. Crewmen (CDR & PLT): This is the column where titles of scheduled activities are shown for the commander (CDR) and pilot (PLT) at the appropriate times.
- c. Day/Night and Orbit:
  - 1) The orbital day/night intervals are shown by black bars when the orbiter is in darkness.
  - 2) Orbit - indicates which orbit the spacecraft is in by numerical sequence. The beginning of an orbit occurs when the orbiter crosses the Earth's equator going from the southern to the northern hemisphere (ascending node). The succession of orbits is numbered in this column starting with Orbit 1 for launch.
- d. Earth Trace W/SAA: This is a display of the ground track of the orbiter and when it passes over the South Atlantic Anomaly (SAA) (indicated by a ).
- e. GSTDN Coverage: The GSTDN communication coverage periods are indicated in this area with a horizontal line indicating when communication is available; the GSTDN site is identified to the right of the line.
- f. RMS OPS: This is a display of periods when the RMS is unstowed (indicated by a ).
- g. Deorbit OPT: Times are identified in this area when deorbit burn opportunities exist for Edwards AFB (EDW) and Kennedy Space Center (KSC).
- h. Attitudes and Maneuvers:
  - 1) Attitude - The current attitude of the vehicle is identified in this area, i.e., PCT, Nose to SUN.
  - 2) Maneuvers - An ' ' is placed at the time an attitude maneuver occurs if the duration in attitude is to be greater than 15 minutes.
- i. VTR: Indicates periods when the video tape recorder is running (indicated by a ). TV - TV is indicated in this area with a .
- j. Payload operating periods.







GMT (D:H:M)		MET (D:H:M)		CDT (D:H:M)		FD/DOY		BETA		MOON		HOUSTON DATE		FLIGHT		EDITION		PUB. DATE	
179:15:00/180:03:00		001:00:00/001:12:00		179:10:00/179:22:00		2/179		0.9				JUNE 28, 1982		STS-4		FINAL		5/14/82	
GMT 1179 15		16		17		18		19		20		21		22		23		24	
FD 12		1		2		3		4		5		6		7		8		9	
MET :001 0		0		1		2		3		4		5		6		7		8	
CDR		TV ACT		TV ACT		TV ACT		TV ACT		TV ACT		TV ACT		TV ACT		TV ACT		TV ACT	
PLT		TV ACT		TV ACT		TV ACT		TV ACT		TV ACT		TV ACT		TV ACT		TV ACT		TV ACT	
DAY/NIGHT		DAY		DAY		DAY		DAY		DAY		DAY		DAY		DAY		DAY	
ORBIT		ORBIT		ORBIT		ORBIT		ORBIT		ORBIT		ORBIT		ORBIT		ORBIT		ORBIT	
EARTH TRACE W/SAA		EARTH TRACE W/SAA		EARTH TRACE W/SAA		EARTH TRACE W/SAA		EARTH TRACE W/SAA		EARTH TRACE W/SAA		EARTH TRACE W/SAA		EARTH TRACE W/SAA		EARTH TRACE W/SAA		EARTH TRACE W/SAA	
GSTDN COVERAGE		GSTDN COVERAGE		GSTDN COVERAGE		GSTDN COVERAGE		GSTDN COVERAGE		GSTDN COVERAGE		GSTDN COVERAGE		GSTDN COVERAGE		GSTDN COVERAGE		GSTDN COVERAGE	
SGLS COVERAGE		SGLS COVERAGE		SGLS COVERAGE		SGLS COVERAGE		SGLS COVERAGE		SGLS COVERAGE		SGLS COVERAGE		SGLS COVERAGE		SGLS COVERAGE		SGLS COVERAGE	
OPSRB KSC EDW		OPSRB KSC EDW		OPSRB KSC EDW		OPSRB KSC EDW		OPSRB KSC EDW		OPSRB KSC EDW		OPSRB KSC EDW		OPSRB KSC EDW		OPSRB KSC EDW		OPSRB KSC EDW	
ATTITUDE		ATTITUDE		ATTITUDE		ATTITUDE		ATTITUDE		ATTITUDE		ATTITUDE		ATTITUDE		ATTITUDE		ATTITUDE	
MANEUVERS TV/VTR		MANEUVERS TV/VTR		MANEUVERS TV/VTR		MANEUVERS TV/VTR		MANEUVERS TV/VTR		MANEUVERS TV/VTR		MANEUVERS TV/VTR		MANEUVERS TV/VTR		MANEUVERS TV/VTR		MANEUVERS TV/VTR	
MLR		MLR		MLR		MLR		MLR		MLR		MLR		MLR		MLR		MLR	
NOTES:		NOTES:		NOTES:		NOTES:		NOTES:		NOTES:		NOTES:		NOTES:		NOTES:		NOTES:	

5/14/82 STS/41N

3-4

GMT (D:H:M)	MET (D:H:M)	CDT (D:H:M)	FD/DOY	BETA	MOON	HOUSTON DATE	FLIGHT	EDITION	PUB. DATE
180:03:00 / 180:15:00	001:12:00 / 002:00:00	179:22:00 / 180:10:00	3 / 179	CDT 2.1	☉	JUNE 29, 1982	STS-4	FINAL	5/14/82
GMT :180 FD :2 MET :001	3 4 5 6 7 8 9 10 11 12 13 14 15	12 13 14 15 16 17 18 19 20 21 22 23 24 25	FD: 3						
CDR	SLEEP	POST SLEEP ACT	MEAL	TECH CONTRM SURVEY	MEAL PREP				
PLT	SLEEP	POST SLEEP ACT	MEAL	TECH CONTRM SURVEY	MEAL PREP				
ORBIT	25 26 27 28 29 30 31 32								
EARTH TRACE M/SAR	[Graph showing Earth Trace M/SAR data]								
GSTDN COVERAGE	-GWN -ACN -DKR	-GWN -DKR	-GWN -DKR	-GWN -DKR	-GWN -DKR	-GWN -DKR	-GWN -DKR	-GWN -DKR	-GWN -DKR
SGLS COVERAGE	-GTS	-GTS	-GTS	-GTS	-GTS	-GTS	-GTS	-GTS	-GTS
OP5	GNEZ/SKZ								
DEWB XSC EDM	18:49	20:25	22:00	23:34	23:28				
ATTITUDE	NAV BASE/INU ALIGN								
MANEUVERS	PTC XPOP								
TV/VTR	TOP TO SUN								
CPES									
MLR									
NOTES:	<ul style="list-style-type: none"> <li>● FTD 467-02 LONG TERM VPC FREEZE TEMPERATURE STABILITY</li> <li>● FTD 412-01 ATT HOLD THERMAL RESPONSE</li> <li>● FTD 466-01 RAD PERFORMANCE TEST</li> <li>● GMS/RCS</li> <li>● FTD 474-01 NAV BASE STABILITY</li> <li>● FTD 453-01 CONTRINATION MAPPING</li> </ul>								

GMT (D:H:M)		MET (D:H:M)		CDT (D:H:M)		FD/DOY		BETA		MOON		HOUSTON DATE		FLIGHT		EDITION		PUB. DATE	
180:19:00		181:03:00		002:00:00 / 002:12:00		180:10:00 / 180:22:00		3 / 180		CDT 3.5		JUNE 29, 1982		STS-4		FINAL		5/14/82	
GMT 1:00		MET 13		CDT 3		DOY 5		BETA 3.5		MOON ☉		JUNE 29, 1982		STS-4		FINAL		5/14/82	
CDR		MEAL		TECH PLUME SURVEY		EXERCISE		MEAL		MEAL		PRE SLEEP		SLEEP		SLEEP			
PLT		MEAL		TECH PLUME SURVEY		RMS PAR DN		MEAL EXERCISE		RCS		PRE SLEEP		SLEEP		SLEEP			
DAY/NIGHT		ORBIT		33		34		35		36		37		38		39		40	
EARTH TRACE W/SAR		GSTDN COVERAGE		SCLS COVERAGE		OPS DEORB KSC EDM		ATTITUDE		MANEUVERS TV/VTR MLR		NOTES:							

○ STAR TRACKERS OFF  
 ○ FT0 412-02 STARTTRACKER COLDSORK  
 ○ FT0 412-01 ATT HOLD THERMAL RESPONSE  
 ○ FT0 454-01 RCS PLUME FLOW FIELD MEASUREMENT  
 ○ FT0 454-01 RCS PLUME FLOW FIELD MEASUREMENT  
 ○ FT0 412-01 ATT HOLD THERMAL RESPONSE  
 ○ OMS/RCS

GMT (D:H:M)		MET (D:H:M)		CDT (D:H:M)		FD/DOY		BETA		MOON		HOUSTON DATE		FLIGHT		EDITION		PUB. DATE					
181:03:00 / 181:15:00		002:12:00 / 003:00:00		180:22:00 / 181:10:00		4 / 180		4.9		☉		JUNE 30, 1982		STS-4		FINAL		5/14/82					
GMT : 181 3		4		5		6		8		9		10		11		12		13		14		15	
FD : 3		13		14		15		16		17		18		19		20		21		22		23	
MET : 002 12		13		14		15		16		17		18		19		20		21		22		23	
CDR	SLEEP		POST SLEEP ACT		MEAL		EXP DOC		EXERCISE		MEAL PREP		MEAL		MEAL		MEAL		MEAL		MEAL		
PLT	SLEEP		POST SLEEP ACT		MEAL		ACT/ SAMPLE PHOTO FLOW DOC		S F L W DOC		S F L W DOC		S F L W DOC		S F L W DOC		S F L W DOC		S F L W DOC		S F L W DOC		
DAY/NIGHT	DAY		NIGHT		DAY		NIGHT		DAY		NIGHT		DAY		NIGHT		DAY		NIGHT		DAY		
ORBIT	41		42		43		44		45		46		47		48		49		50		51		
NOON UP/DOWN	UP		DOWN		UP		DOWN		UP		DOWN		UP		DOWN		UP		DOWN		UP		
EARTH TRACE W/SAR	-CHN -ACD -DKR -ACN		-CHN -GHW -DKR -R60		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		
GSTON COVERAGE	-CHN -ACD -DKR -ACN		-CHN -GHW -DKR -R60		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		
SCLS COVERAGE	-CHN -ACD -DKR -ACN		-CHN -GHW -DKR -R60		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		
OPS DEORB YSC EDM	-CHN -ACD -DKR -ACN		-CHN -GHW -DKR -R60		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		
ATTITUDE	-CHN -ACD -DKR -ACN		-CHN -GHW -DKR -R60		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		
MANEUVERS	-CHN -ACD -DKR -ACN		-CHN -GHW -DKR -R60		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		
TV/ATR	-CHN -ACD -DKR -ACN		-CHN -GHW -DKR -R60		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		
CFES	-CHN -ACD -DKR -ACN		-CHN -GHW -DKR -R60		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		
MLR	-CHN -ACD -DKR -ACN		-CHN -GHW -DKR -R60		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		-GTS -CTS		
NOTES:	<ul style="list-style-type: none"> <li>• DMS/RCS • FSO 5436-01 CFES (SEQUENCE 11)</li> <li>• STAR TRACKERS ON</li> <li>• FTO 412-02 STARTTRACKER COLDSTART</li> <li>• FTO 412-01 ATT HOLD THERMAL RESPONSE</li> <li>• FSO 5436-01 CFES</li> <li>• FTO 466-01 RRD PERFORMANCE TEST</li> <li>• PHR LP TPC</li> <li>• FTO 479-01 - ON ORBIT TRACK NAV</li> <li>• FSO 5436-01 CFES</li> <li>• FSO 5436-01 CFES</li> <li>• (SAMPLE 4 SEPARATION &amp; COLLECTION)</li> <li>• FSO 5436-01 CFES</li> <li>• FTO 466-01 RRD PERFORMANCE TEST</li> </ul>																						











GMT (D:H:M)		MET (D:H:M)		CDT (D:H:M)		FD/DOY		BETA		MOON		HOUSTON DATE		FLIGHT		EDITION		PUB. DATE			
193:15:00/ 184:03:00		005:00:00/ 005:12:00		183:10:00/ 183:22:00		6/ 183 CDT		13.2		0		JULY 2, 1982		STS-4		FINAL		5/14/82			
GMT : 183 15		16		17		18		19		20		21		22		23		24			
FD : 16		1		2		3		4		5		6		7		8		9			
MET : 005 0		0		1		2		3		4		5		6		7		8			
CDR		RMS/PRCS INTERACT		RMS/PRCS INTERACT		RMS SINGULARITY		MEAL		IMU MONITOR		PRE SLEEP RCT		SLEEP							
PLT		RMS/PRCS INTERACT		RMS/PRCS INTERACT		RMS SINGULARITY		MEAL		HK		PRE SLEEP RCT		SLEEP							
DAY/NIGHT		DAY		DAY		DAY		DAY		DAY		DAY		DAY		DAY		DAY			
ORBIT		81		82		83		84		85		86		87		88					
EARTH TRACE W/SAA		-VTR -GMM -MLX -ACN -BOT -HAM -ACD -ACN -IOS -GMM -ACD -ACN -GMM		-GDS -ACN -BOT -IOS -GMM -HAM -ACD -ACN -IOS -GMM -BOT -IOS -GMM -ACD -ACN -GMM		-GDS -ACN -BOT -IOS -GMM -HAM -ACD -ACN -IOS -GMM -BOT -IOS -GMM -ACD -ACN -GMM		-GDS -ACN -BOT -IOS -GMM -HAM -ACD -ACN -IOS -GMM -BOT -IOS -GMM -ACD -ACN -GMM		-GDS -ACN -BOT -IOS -GMM -HAM -ACD -ACN -IOS -GMM -BOT -IOS -GMM -ACD -ACN -GMM		-GDS -ACN -BOT -IOS -GMM -HAM -ACD -ACN -IOS -GMM -BOT -IOS -GMM -ACD -ACN -GMM		-GDS -ACN -BOT -IOS -GMM -HAM -ACD -ACN -IOS -GMM -BOT -IOS -GMM -ACD -ACN -GMM		-GDS -ACN -BOT -IOS -GMM -HAM -ACD -ACN -IOS -GMM -BOT -IOS -GMM -ACD -ACN -GMM		-GDS -ACN -BOT -IOS -GMM -HAM -ACD -ACN -IOS -GMM -BOT -IOS -GMM -ACD -ACN -GMM		-GDS -ACN -BOT -IOS -GMM -HAM -ACD -ACN -IOS -GMM -BOT -IOS -GMM -ACD -ACN -GMM	
GSTDN COVERAGE		-GTS -HTS -VTS		-GTS -HTS -VTS		-GTS -HTS -VTS		-GTS -HTS -VTS		-GTS -HTS -VTS		-GTS -HTS -VTS		-GTS -HTS -VTS		-GTS -HTS -VTS		-GTS -HTS -VTS			
SCLS COVERAGE		-GTS -HTS -VTS		-GTS -HTS -VTS		-GTS -HTS -VTS		-GTS -HTS -VTS		-GTS -HTS -VTS		-GTS -HTS -VTS		-GTS -HTS -VTS		-GTS -HTS -VTS		-GTS -HTS -VTS			
OPS DEORB KSC EDM		1 00:06		1 01:33																	
ATTITUDE		BOTTOM TO SUN		BOTTOM TO SUN		BOTTOM TO SUN		BOTTOM TO SUN		BOTTOM TO SUN		BOTTOM TO SUN		BOTTOM TO SUN		BOTTOM TO SUN		BOTTOM TO SUN			
MANEUVERS		RMS PRCS		RMS PRCS		RMS PRCS		RMS PRCS		RMS PRCS		RMS PRCS		RMS PRCS		RMS PRCS		RMS PRCS			
TV/VIR		IMU ALIGN		IMU ALIGN		IMU ALIGN		IMU ALIGN		IMU ALIGN		IMU ALIGN		IMU ALIGN		IMU ALIGN		IMU ALIGN			
CFES		HOT		HOT		HOT		HOT		HOT		HOT		HOT		HOT		HOT			
MLR		FLDR		FLDR		FLDR		FLDR		FLDR		FLDR		FLDR		FLDR		FLDR			
NOTES:		ZSI MWR		FTO 412-01 ATT HOLD THERMAL RESPONSE		FTO 412-01 ATT HOLD THERMAL RESPONSE		FTO 412-01 ATT HOLD THERMAL RESPONSE		FTO 412-01 ATT HOLD THERMAL RESPONSE		FTO 412-01 ATT HOLD THERMAL RESPONSE		FTO 412-01 ATT HOLD THERMAL RESPONSE		FTO 412-01 ATT HOLD THERMAL RESPONSE		FTO 412-01 ATT HOLD THERMAL RESPONSE			
		FTO 412-05 PRCS THERMAL SORBACK, ONE F10 ENGINE		FTO 452-02 SINGULARITY MANAGEMENT		FTO 452-02 SINGULARITY MANAGEMENT		FTO 452-02 SINGULARITY MANAGEMENT		FTO 452-02 SINGULARITY MANAGEMENT		FTO 452-02 SINGULARITY MANAGEMENT		FTO 452-02 SINGULARITY MANAGEMENT		FTO 452-02 SINGULARITY MANAGEMENT		FTO 452-02 SINGULARITY MANAGEMENT			
		FTO 462-01 RRD SURFACE INSPECT		FTO 462-02 LONG TERM VPC FREEZER TEMPERATURE STABILITY		FTO 462-02 LONG TERM VPC FREEZER TEMPERATURE STABILITY		FTO 462-02 LONG TERM VPC FREEZER TEMPERATURE STABILITY		FTO 462-02 LONG TERM VPC FREEZER TEMPERATURE STABILITY		FTO 462-02 LONG TERM VPC FREEZER TEMPERATURE STABILITY		FTO 462-02 LONG TERM VPC FREEZER TEMPERATURE STABILITY		FTO 462-02 LONG TERM VPC FREEZER TEMPERATURE STABILITY		FTO 462-02 LONG TERM VPC FREEZER TEMPERATURE STABILITY			
		FTO 452-03 UNLOADED ARM RESPONSE TO PRCS		CHANGEOUT		CHANGEOUT		CHANGEOUT		CHANGEOUT		CHANGEOUT		CHANGEOUT		CHANGEOUT		CHANGEOUT			
		FTO 452-02 SINGULARITY MANAGEMENT																			

GMT (D:H:M)		MET (D:H:M)		CDT (D:H:M)		FD/DOY		BETA		MOON		HOUSTON DATE		FLIGHT		EDITION		PUB. DATE							
184:03:00 / 184:15:00		005:12:00 / 006:00:00		183:22:00 / 184:10:00		7 / 183		15.0		○		JULY 3, 1982		STS-4		FINAL		5/14/82							
CMT 1184 3		4		5		6		7		8		9		10		11		12		13		14		15	
FD 16		13		14		15		16		17		18		19		20		21		22		23		0	
MET: 005 12		13		14		15		16		17		18		19		20		21		22		23		0	
CDR		SLEEP		POST SLEEP ACT		MERL		EXERCISE		TV ACT		BU NAV		HK		MERL									
PLT		SLEEP		POST SLEEP ACT		MERL		EXERCISE		BU NAV		MERL PREP		HK		MERL									
DAY/NIGHT		89		90		91		92		93		94		95		96									
ORBIT		MOON UP/DOWN																							
EARTH TRACE M/SAR																									
CSTON COVERAGE		-RCO -DKR		-DKR -MAX		-YAR -ORR		-MAX -ORR		-ORR -YAR		-YAR -ORR		-ORR -YAR		-YAR -ORR		-ORR -YAR		-YAR -ORR		-ORR -YAR		-YAR -ORR	
SCLS COVERAGE		-DKR -MAX		-YAR -ORR		-MAX -ORR		-ORR -YAR		-YAR -ORR		-ORR -YAR		-YAR -ORR		-ORR -YAR		-YAR -ORR		-ORR -YAR		-YAR -ORR		-ORR -YAR	
OPS DEORB RCS EDM		16:17		17:53		19:29		21:05		22:30		23:32													
ATTITUDE		BOTTOM TO SUN		BOTTOM TO SUN		BOTTOM TO SUN		BOTTOM TO SUN		BOTTOM TO SUN		BOTTOM TO SUN		BOTTOM TO SUN		BOTTOM TO SUN		BOTTOM TO SUN		BOTTOM TO SUN		BOTTOM TO SUN		BOTTOM TO SUN	
WAKEOVERS																									
TV/VTR																									
MLR																									
NOTES:																									



GMT (D:H:M)	MET (D:H:M)	CDT (D:H:M)	FD/DOY	BETA	MOON	HOUSTON DATE		FLIGHT	EDITION	PUB. DATE
						JULY 4, 1982	STS-4			
185:03:00/ 185:15:00	006:12:00/ 007:00:00	184:22:00/ 185:10:00	8 / 184	18.8	○	0	0	0	FINAL	5/14/82
<p>YTC</p> <p>GMT: 185 3 4 5 6 7 8 9 10 11 12 13 14 15</p> <p>FD: 7 13 14 15 16 17 18 19 20 21 22 23 24</p> <p>MET: 006 12 13 14 15 16 17 18 19 20 21 22 23 24</p>										
CDR	SLEEP	POST SLEEP TPR MSG REVIEW	MEAL		SUIT DOWN	SECUR	ENT SH LIST/VER	BURN PREP	DEORBIT BURN	LANDING
PLT	SLEEP	POST SLEEP TPR MSG REVIEW	MEAL		SUIT DOWN	SECUR	ENT SH LIST/VER	BURN PREP	DEORBIT BURN	LANDING
DAY/NIGHT										
ORBIT	104	105	106	107	108	109	110	111	112	
MOON UP/DOWN										
EARTH TRACE M/SRA										
GSTON COVERAGE	<p>104: -DKR</p> <p>105: -DKR -YAR</p> <p>106: -DKR -YAR</p> <p>107: -DKR -YAR</p> <p>108: -DKR -YAR</p> <p>109: -DKR -YAR</p> <p>110: -DKR -YAR</p> <p>111: -DKR -YAR</p> <p>112: -DKR -YAR</p>									
SCLS COVERAGE	<p>104: -DKR</p> <p>105: -DKR -YAR</p> <p>106: -DKR -YAR</p> <p>107: -DKR -YAR</p> <p>108: -DKR -YAR</p> <p>109: -DKR -YAR</p> <p>110: -DKR -YAR</p> <p>111: -DKR -YAR</p> <p>112: -DKR -YAR</p>									
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ATTITUDE	<p>104: -DKR</p> <p>105: -DKR -YAR</p> <p>106: -DKR -YAR</p> <p>107: -DKR -YAR</p> <p>108: -DKR -YAR</p> <p>109: -DKR -YAR</p> <p>110: -DKR -YAR</p> <p>111: -DKR -YAR</p> <p>112: -DKR -YAR</p>									
MANEUVERS	<p>104: -DKR</p> <p>105: -DKR -YAR</p> <p>106: -DKR -YAR</p> <p>107: -DKR -YAR</p> <p>108: -DKR -YAR</p> <p>109: -DKR -YAR</p> <p>110: -DKR -YAR</p> <p>111: -DKR -YAR</p> <p>112: -DKR -YAR</p>									
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NOTES:	<p>○ ENTRY CONFIG ○ NO SH LIST/VER</p> <p>○ ENTRY CONFIG ○ NO SH LIST/VER</p> <p>○ LAST MEAL CLEANUP</p> <p>○ FTO 412-01 ATT HOLD THERMAL RESPONSE</p>									

### LANDING AND POSTLANDING OPERATIONS

Kennedy Space Center is responsible for ground operations of the orbiter vehicle once it has rolled to a stop on the dry lake bed at Edwards, including preparations for returning the reusable vehicle to Kennedy Space Center for STS-5.

As soon as Columbia rolls to a stop, the recovery convoy will head toward the vehicle to begin preliminary securing and safing operations.

At the same time, the flight crew will turn off the auxiliary power units and turn on cooling systems and safe the orbiter's maneuvering and reaction control systems.

After SCAPE (Self Contained Atmospheric Protection Ensemble) suited personnel have determined that hazardous vapor levels are below significant levels, the 100-member ground crew will perform such activities as connecting ground cooling and purge air units, conducting a post-landing inspection and attaching the ground tow vehicle.

The mobile wind machine is used only if highly concentrated levels of explosive vapors are detected by the ground team.

Once the initial safety assessment is made, other teams of SCAPE-suited personnel and vehicles with maneuverable access platforms will then be positioned at the rear of the orbiter, near the vehicle's T-0 umbilical connection panels. The two large transporters, the Purge and Coolant Umbilical Access Vehicles, will then be moved into place behind the orbiter and their lines will be connected to the orbiter umbilical panels.

If everything is normal, and no explosive gases are detected, the Purge and Coolant Umbilical Access Vehicles will be moved into position. Freon lines and purge duct connections will be completed and the flow of coolant and purge air through the umbilical lines will provide cooling to the orbiter's systems. This cooling process helps protect the orbiter's electronic equipment. Purge air will provide cool and humidified air conditioning to the orbiter's payload bay and other cavities to remove any residual explosive or toxic fumes and provide a safe, clean and cool environment inside the Columbia.

When further monitoring of vapor readings around the forward half of the orbiter indicate there are no concentrations of toxic gases, SCAPE-suited personnel working the forward section will be replaced by non-SCAPE personnel. The mobile white room will be moved into place around the orbiter crew access hatch. The hatch is opened and the flight crew is allowed to leave the crew cabin. The flight crew will be replaced by other astronauts who will complete the task of safing the vehicle.

The hatch on the side of the orbiter is scheduled to be opened within 30 minutes after landing. The crew will leave the orbiter at the direction of flight controllers at Mission Control, Johnson Space Center.

Columbia will undergo its initial preparations for a return to the Kennedy Space Center in the Air Force Weight and Balance Hangar at Edwards. There it will be weighed and the vehicle's center of gravity will be calculated. Also, flight samples from the electrophoresis experiment will be removed.

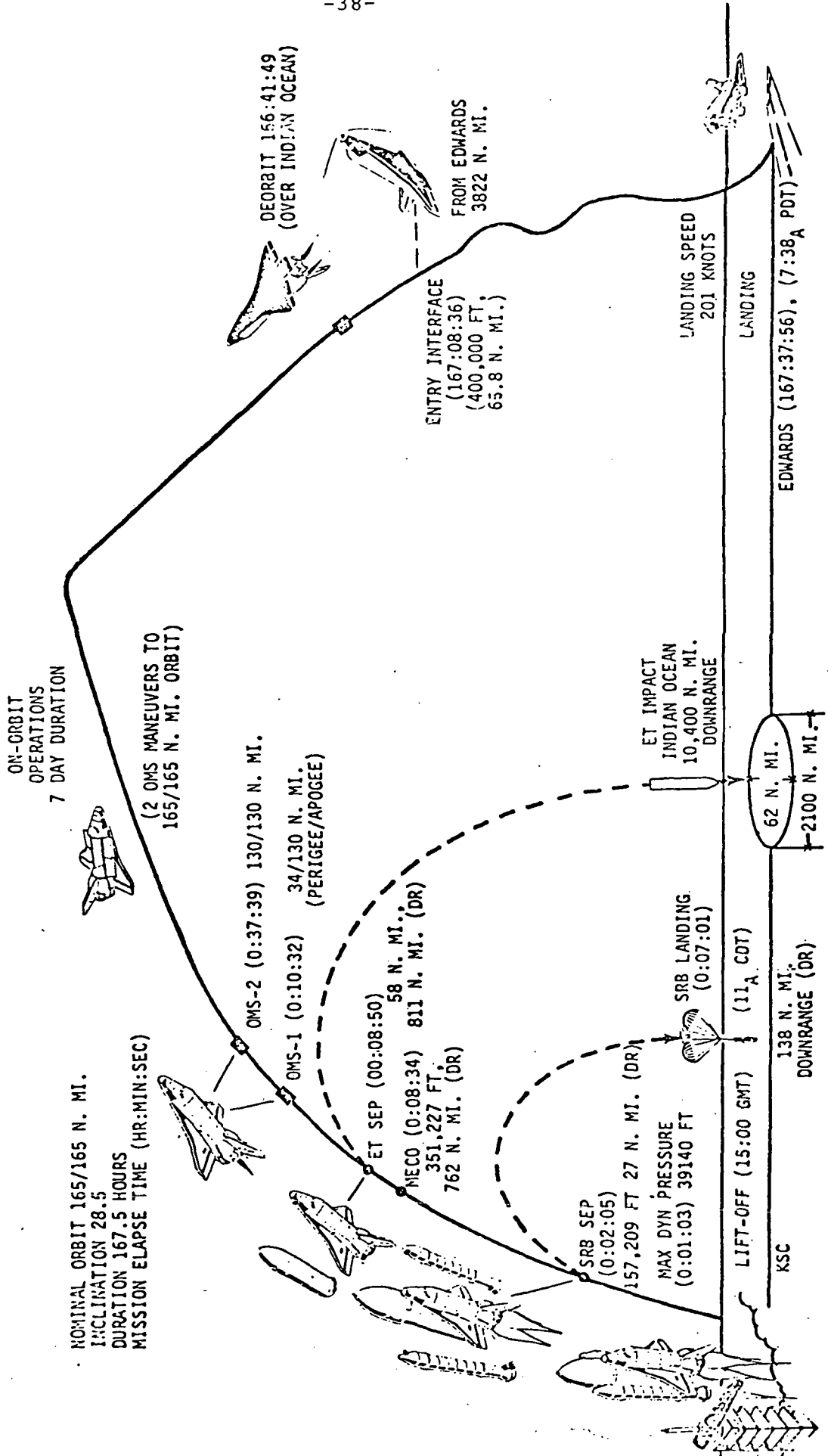
The orbiter will then be towed to the Mate/Demate Device at the nearby Dryden Flight Research Center.

Once in the Mate/Demate Device, Columbia's power reactant storage and distribution tanks will be drained of leftover liquid hydrogen and liquid oxygen reactants, the Shuttle main engines will be purged, and explosive charges will be disconnected.

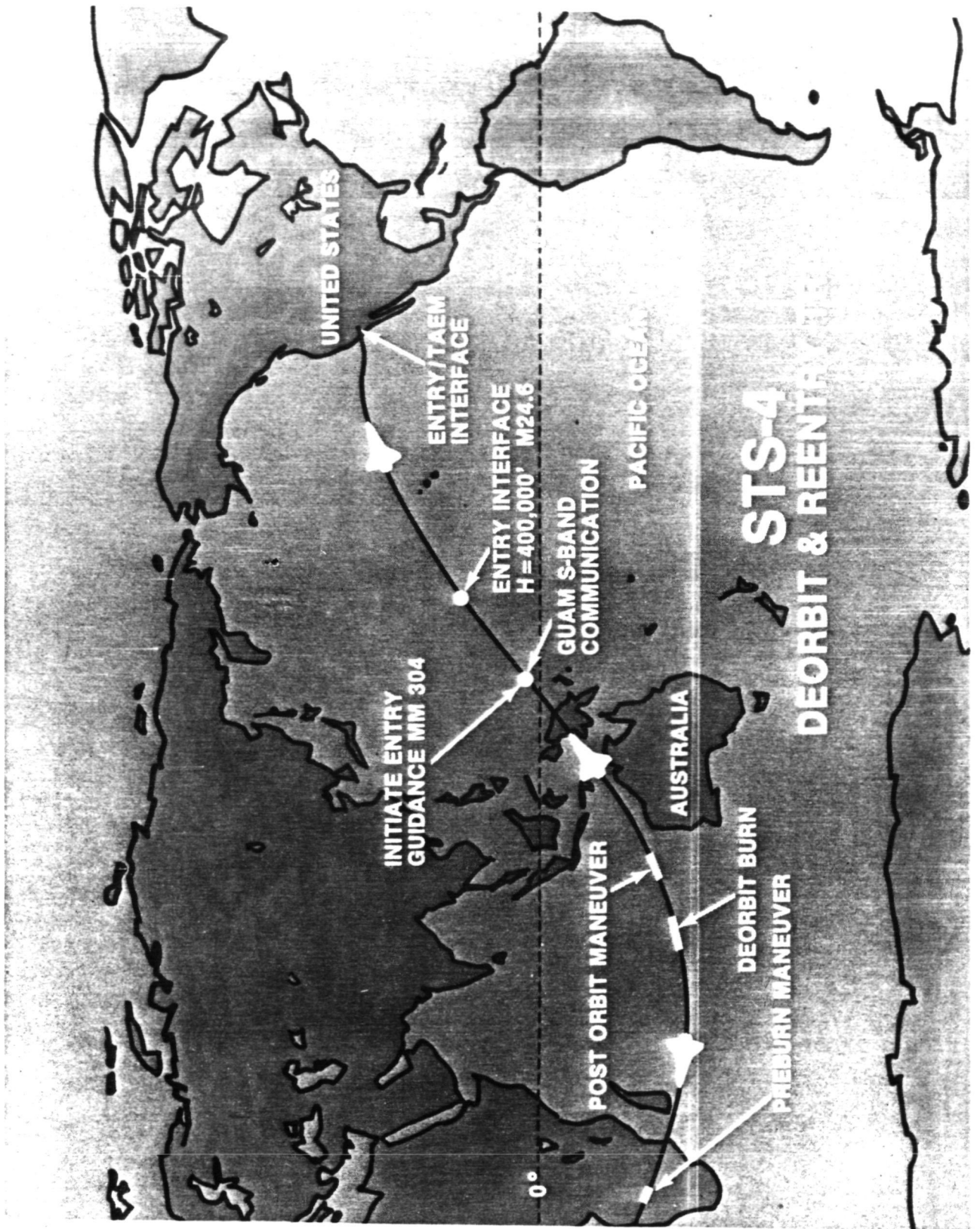
Removal of the Monodisperse Latex Reactor will be done within 48 hours after landing. Ferry plugs will be installed in the orbital maneuvering system engine nozzles and locks put in place to keep the engines and elevons from moving during the ferry flight. The tail cone will be installed and the orbiter mated to the top of the 747.

The orbiter/747 combination will make an overnight stop to refuel the carrier jet and rest the flight crew on its cross-country return trip to Kennedy Space Center.

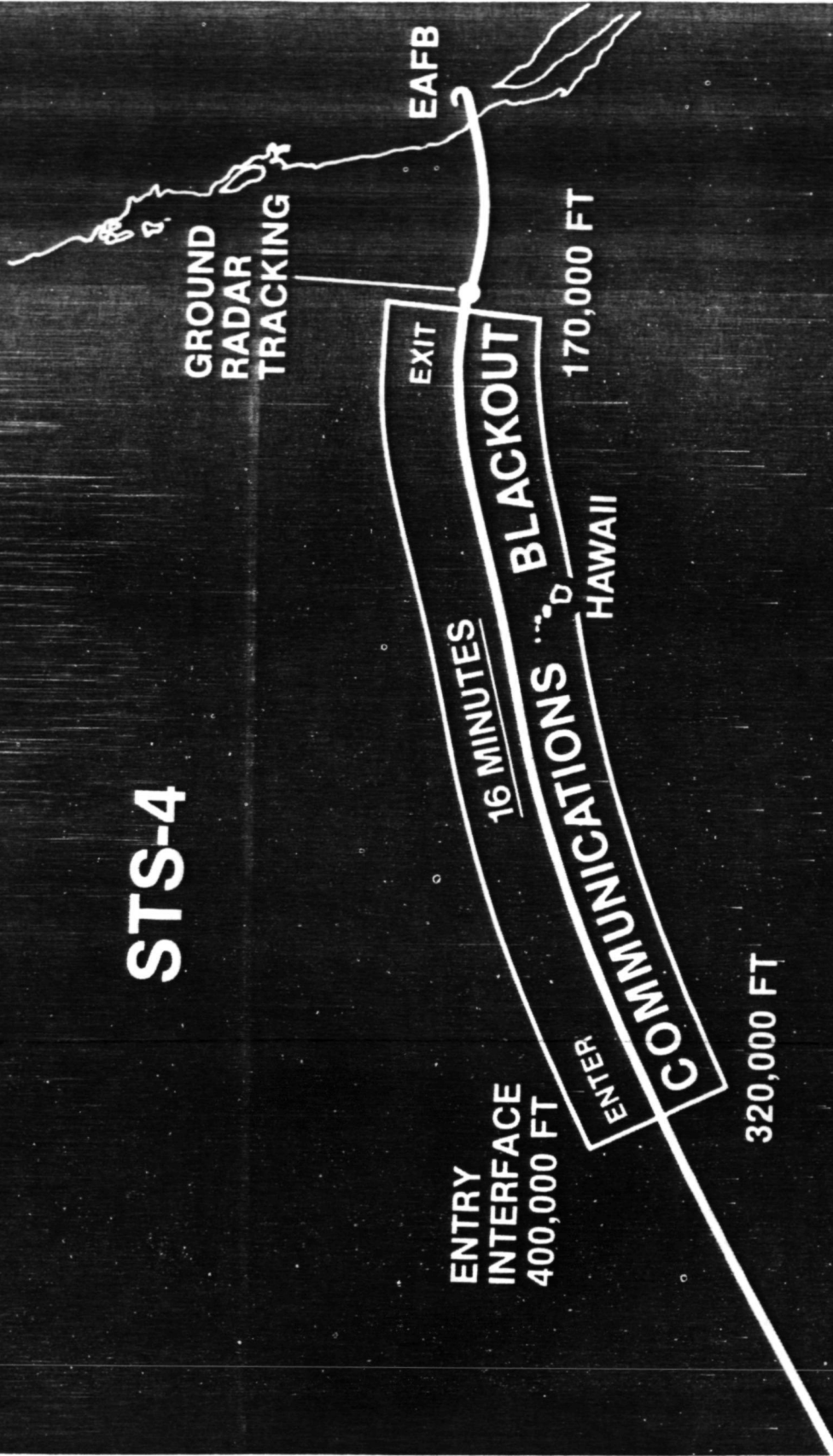
# SPACE SHUTTLE NOMINAL MISSION PROFILE FOR STS-4



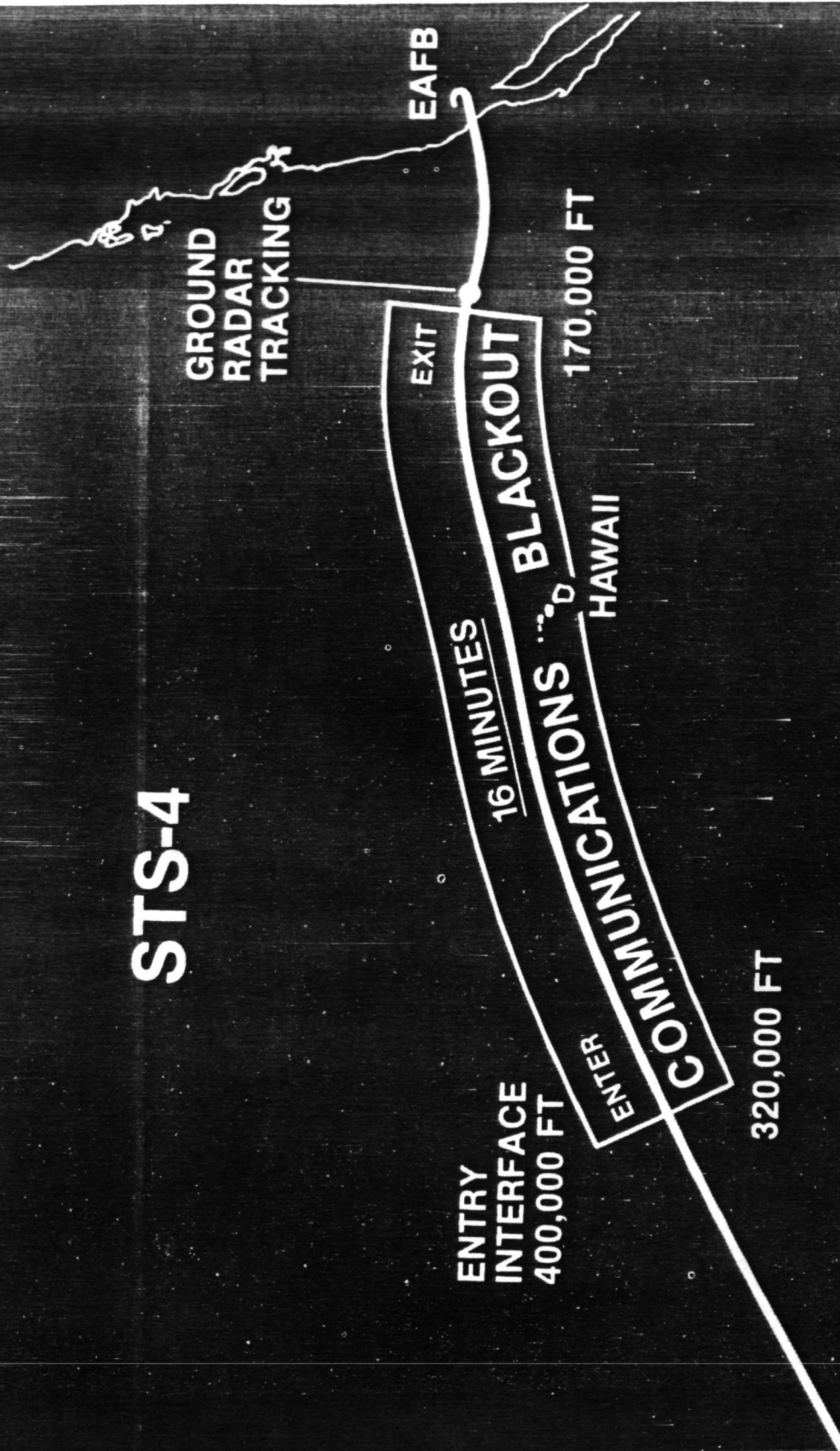




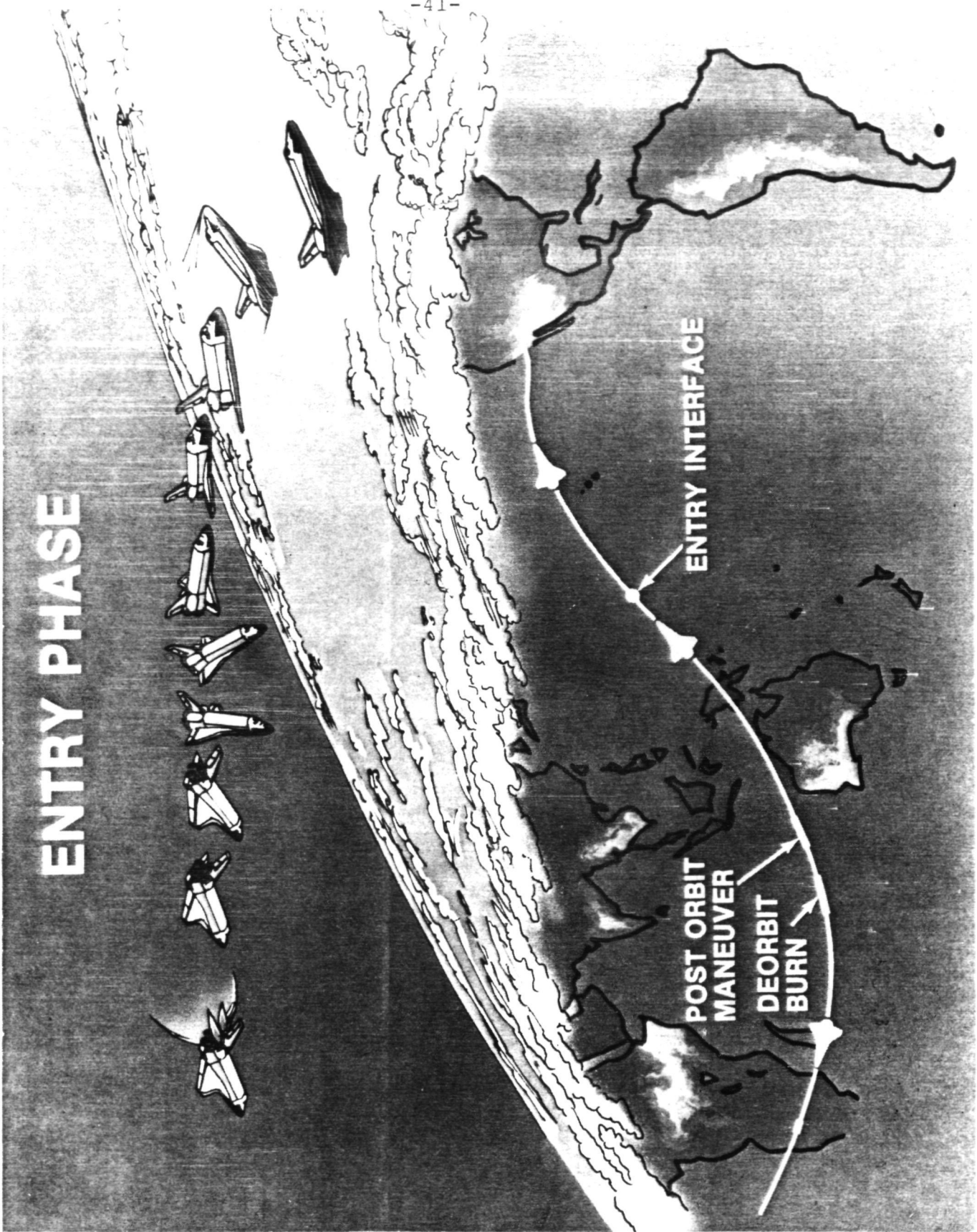
# STS-4



# STS-4



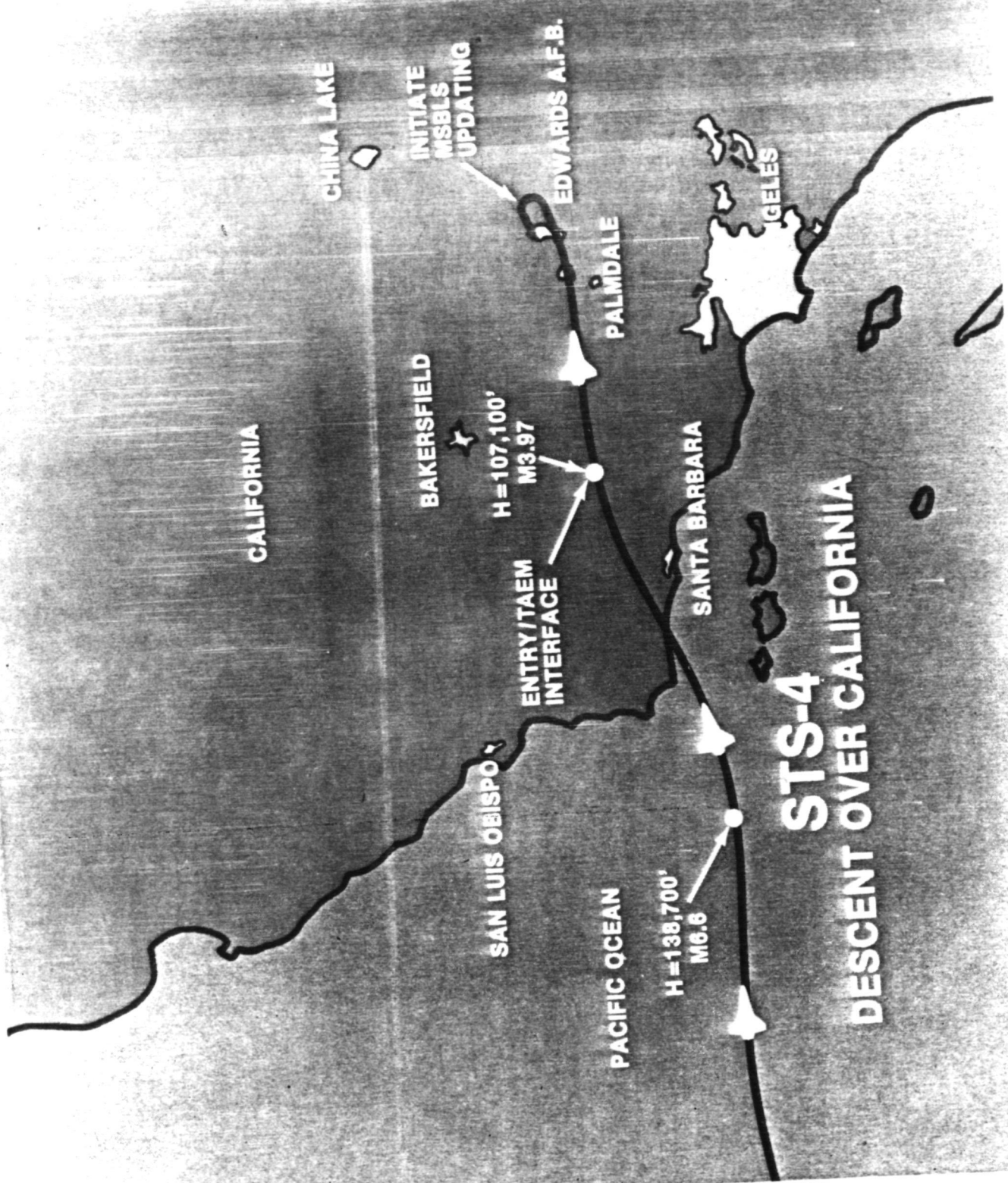
# ENTRY PHASE



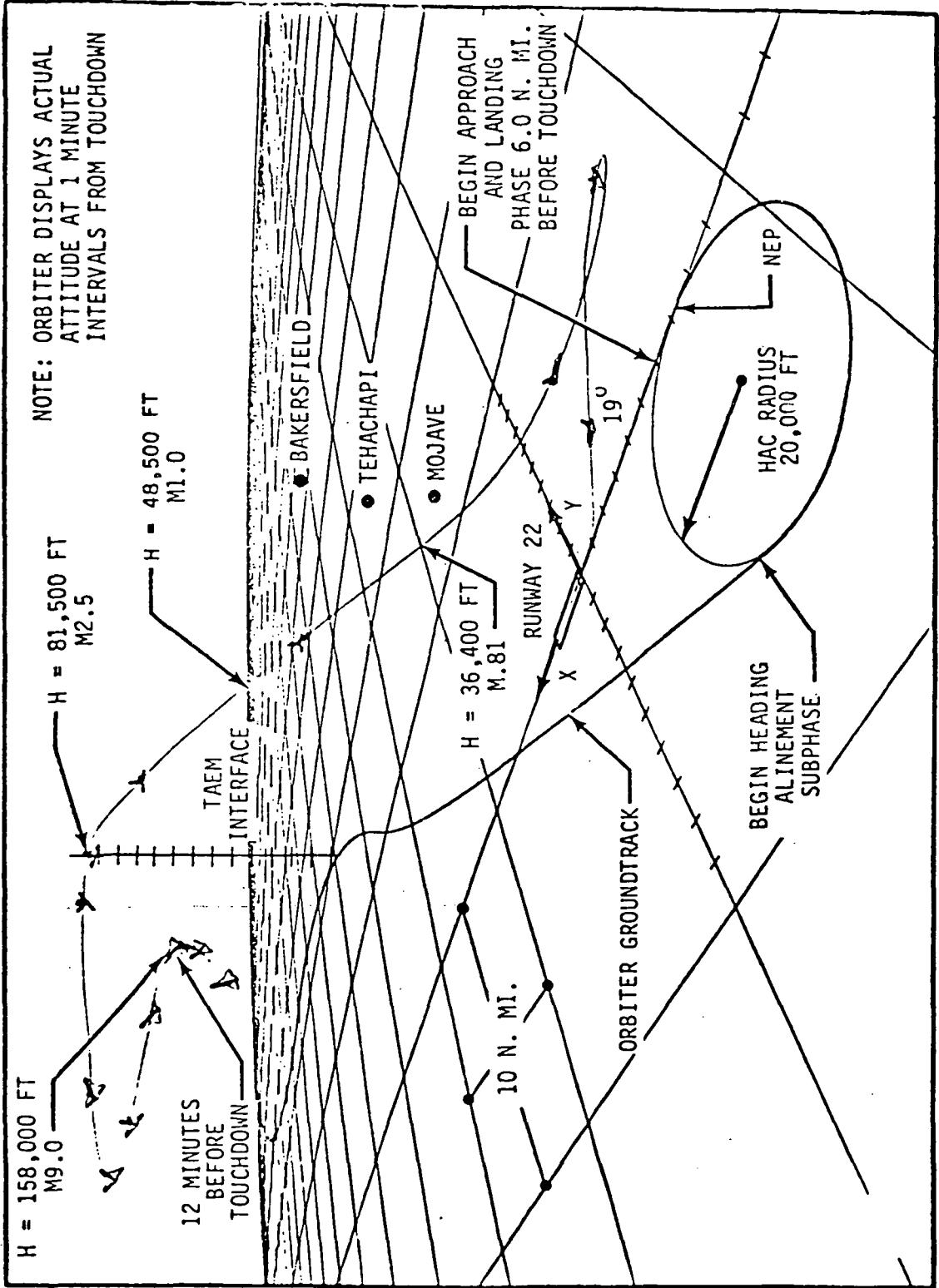
ENTRY INTERFACE

POST ORBIT  
MANEUVER

DEORBIT  
BURN



# NOMINAL STS-4 ENTRY FLIGHT PROFILE



IF THINGS GO WRONG

(Contingencies)

While there has never been a launch abort in any U.S. manned space flight program, flight crews and flight controllers must still train and plan for emergency early landing. The safe return of the flight crew, the orbiter and its payloads to an intact landing is emphasized in abort planning philosophy.

The preferred type of Shuttle launch abort is the abort-to-orbit in which combined thrust from main engines and orbital maneuvering system engines is enough to reach a minimal 194-km (105-nm) orbit. An abort-to-orbit would be called for if one main engine should shut down before enough velocity is reached to yield a 235-km (127-nm) orbit.

Earlier shutdown of one main engine would force an abort-once-around situation in which Columbia would land near the end of one orbit at Dryden Flight Research Facility. Also, any critical systems failure aboard Columbia immediately after orbital insertion calls for an abort-once-around landing.

Loss of a second main engine during launch forces a trans-Atlantic abort landing or "Press to Rota," depending on when the problem occurs.

Shutdown of one or more main engines early in the launch phase call for a return-to-launch-site abort. Once an abort decision is made, Columbia and the external tank would be flown in a pitch-around maneuver to heads-up and pointed back along the ground track to Kennedy Space Center. Whatever main engine thrust still available would then be used to kill off eastward velocity, and reverse direction until the Kennedy Space Center runway could be reached by gliding along a modified entry trajectory. Major orbiter systems failures during ascent could also force a return-to-launch-site abort.

Loss of control or impending catastrophic failure during ascent, from tower clear to 30,480 m (100,000 ft.) calls for crew ejection. Loss of two main engines prior to seven minutes of flight also calls for crew ejection after descending below 30,480 m (100,000 ft).

Contingency landing sites, in addition to Edwards and Northrup, are Hickam Air Force Base/Honolulu International Airport, Hawaii; Kadena Air Base, Okinawa; and Rota Naval Station, Spain. The Kennedy Space Center's 4,570-m (15,000-ft.) Shuttle Landing Facility is the designated secondary landing site.

CONFIGURATION

STS-4: COLUMBIA'S FINAL SHAKEDOWN FLIGHT

Aside from a quilted, plastic-film payload bay liner added since STS-3, Columbia's configuration remains unchanged from the third flight. The payload bay liner installation for STS-4 was planned prior to the start of the orbital flight test program.

Food stowed in middeck food lockers again will be heated by a carry-on food warmer.

Experiments stowed and operated on the middeck include the Monodisperse Latex Reactor, repeated from STS-3; and the Continuous Flow Electrophoresis System.

Payloads and experiments in the payload bay are the Development Flight Instrumentation with Induced Environment Contamination Monitor attached; one Getaway Special canister; the Aerodynamic Coefficient Identification Package; and Department of Defense payload DOD 82-1.

The STS-4 liftoff weight will be 2,033,404 kg (4,482,888 lb.).



## STS-4 EXPERIMENTS

### Induced Environment Contamination Monitor

The Induced Environment Contamination Monitor (IECM) is a desk-sized detector containing 11 instruments to check for contaminants in and around the Space Shuttle orbiter cargo bay which might adversely affect delicate experiments carried aboard.

The monitor, developed by Marshall Space Flight Center is scheduled to make its third flight into space on STS-4.

In addition to its regular in-place monitoring activities in the orbiter cargo bay during this seven-day flight, the crew will activate the remote manipulator system to pick up this 363-kg (800-lb.) package and place it at various locations around the orbiter. During this "mapping" exercise, the monitor will employ an instrument added for this mission, the plume pressure gauge. This instrument will measure the pressure wave of the plume emitted by the firing of reaction control jets at the nose of the orbiter.

The monitor will be attached to a release mechanism (also developed by Marshall) enabling it to be released and lifted up by the remote manipulator system.

Contaminants to be monitored during Shuttle flights include any outgassing from materials within the Shuttle, as well as gases from the reaction jets which control the vehicle in orbit.

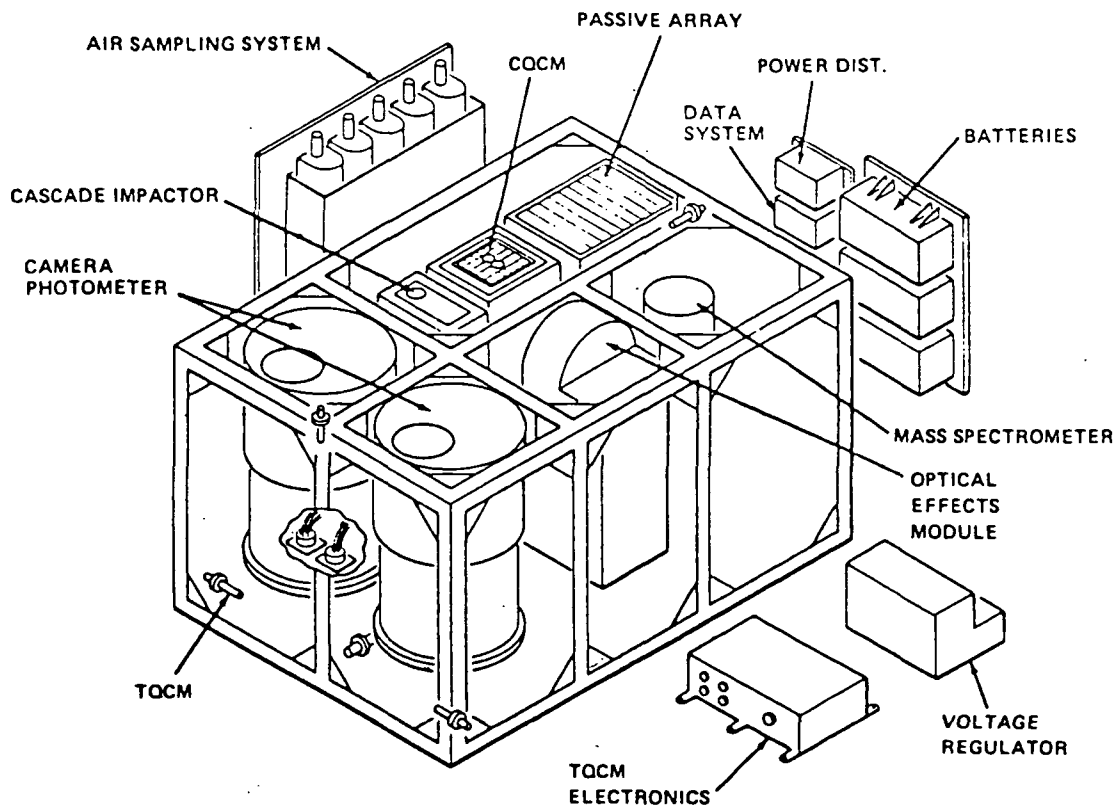
The monitor operates during pre-launch, ascent, on-orbit, descent, landing, and 45 minutes after landing. The on-orbit measurements include molecular return flux, background spectral intensity, molecular deposition and optical surface effects. During the other mission phases, dew point, humidity, aerosol content, and trace gases will be measured, as well as optical surface effects and molecular deposition.

These measurements are made with 11 separate instruments: a humidity monitor, dew point hygrometer, air sampler, cascade impactor, passive sample array, optical effects module, temperature-controlled quartz crystal microbalance, cryogenic quartz crystal microbalance, camera/photometer, mass spectrometer and a plume pressure gauge.

On the orbiter's return flight from its landing site to Kennedy Space Center aboard a 747 transport airplane, another passive sample array is added to further check for contaminants.

NASA began strong manned mission contamination control efforts during the Skylab missions of 1973-74 and, recognizing the possible limiting effects induced contamination might have on sophisticated observational programs planned for the 1980s, committed to an effort to insure that the induced environment would not be a problem on the Shuttle.

# INDUCED ENVIRONMENT CONTAMINATION MONITOR



The purpose of the monitor is to measure the actual environment to determine whether the strict controls placed on the Shuttle system have solved the contamination problem.

After each Shuttle flight, the unit is to be returned to the Marshall Center for refurbishment. The flight data is then to be combined with orbiter data furnished by the Johnson Space Center for a comprehensive analysis.

With the monitor instrumentation, contaminant sources are identified for possible elimination. The experiment provides data on the interaction of the induced and natural environments, and provides critical data for planning of future Shuttle payloads.

The unit will also be used to monitor the induced atmosphere during Spacelab missions one and two.

A brief description of the objectives of each of the monitor's instruments follows:

**Mass Spectrometer** -- The mass spectrometer will measure molecular return flux, from which molecular column density may be calculated. The purpose of the mass spectrometer measurement is twofold: to define the offgassing and outgassing molecules transported to surfaces in the Shuttle bay for correlation to actual deposition measurements on optical and temperature-controlled surfaces, and to define the gas cloud (induced atmosphere) through which optical experiments must look.

**Camera/Photometer** -- Of particular concern to the astronomical community is the effect on astronomical experiments of induced contamination in the form of individual particles and general background. Even a moderate particulate generation rate by the Shuttle would severely limit the performance of an infrared telescope. Two automated Camera/Photometers will make optical measurements of both the induced particulate environment and the background brightness.

**Cryogenic Quartz Crystal Microbalance** -- The objective of the cryogenic quartz crystal microbalance is to provide a record of the adsorption and desorption of molecular contamination in the Shuttle cargo bay. On specific Shuttle missions when the cargo bay is oriented so that it does not receive direct solar heating for long periods of time, the instrument will have the special objective of measuring molecular water vapor.

**Temperature-Controlled Quartz Crystal Microbalance** -- The temperature-controlled quartz crystal microbalance is designed to detect the adsorption or desorption of molecular contamination in the Shuttle cargo bay as a function of temperature. The contamination sources will be characterized as a function of direction and events. Contamination will also be grouped into categories according to desorption activation energies.

**Optical Effects Module** -- The Optical Effects Module is designed to provide the Shuttle cargo bay user community with information applicable to assessing the contamination hazards likely to be encountered by optical components of space-borne instrumentation.

The optical degradation of some typical window materials will be measured and monitored during prelaunch, orbital, and post-landing phases. Optical property changes due to deposition of particulates and molecular films will be discriminantly measured utilizing an integrated scattered light measurement in conjunction with direct, self-calibrating transmission measurements.

**Passive Sample Array** -- An array of optical samples will be exposed to the natural and induced environments of the Shuttle cargo bay for later return and analysis on the ground to evaluate the optical effects of contamination. Inclusion of the Passive Sample Array permits the greater scope and range of analysis required to assess more fully the physical mechanisms of degradation due to deposited contaminants.

The samples are measured in the laboratory prior to experiment integration. Control samples are included in these measurements and are then stored in a controlled, "clean" environment. Following retrieval of samples, whether during preflight activities or after the flight, the measurements are repeated and the analysis is based on any encountered changes.

**Cascade Impactor** -- The cascade impactor provides a determination of concentration and particle size distribution, as a function of time, of air-suspended contaminants in the spacecraft environment during ground-based, ascent, descent and post-landing phases. In addition to the cascade stages, the impactor measures the amount of airborne nonvolatile residue for molecules with sufficiently high sticking coefficient at the temperature encountered.

**Air Sampler** -- The objective of the Air Sampler is to determine the gaseous contaminants in the cargo bay area of the Shuttle during orbital missions.

Basically, the requirements can be categorized into three groups: ground-based; ascent; and descent sampling phases.

During the ground-based sampling, the presence of organic and silicone polymers (such as hydraulic fluids and lubricants) is of most concern.

During ascent, the primary interest is in hydrochloric acid from the solid rocket booster plume as well as hydrocarbons and silicones.

During descent, the gaseous sources of greatest concern are expected to be nitrogen compounds resulting from the auxiliary power unit exhaust and other products from reentry heating effects.

**Dew Point Hygrometer** -- The Dew Point Hygrometer will measure the dew point of the air surrounding the monitor.

The measurements will be made prior to launch and as long as the vehicle is within the Earth's atmosphere, including ascent, reentry and landing.

**Humidity Monitor** -- Humidity measurements will be made while the vehicle is in the Earth's atmosphere to produce a humidity/temperature profile of the environment within the cargo bay.

The humidity monitor will measure the relative humidity from 0 to 70 degrees centigrade.

The temperature measurement (0 to 100 degrees centigrade) will be made by a thermistor located within the humidity sensor mounting.

**Plume Pressure Gauge** -- The gauge is designed to measure the pressure wave of the plume created by the firing of the reaction control jets as the wave passes by the monitor.

#### Monodisperse Latex Reactor

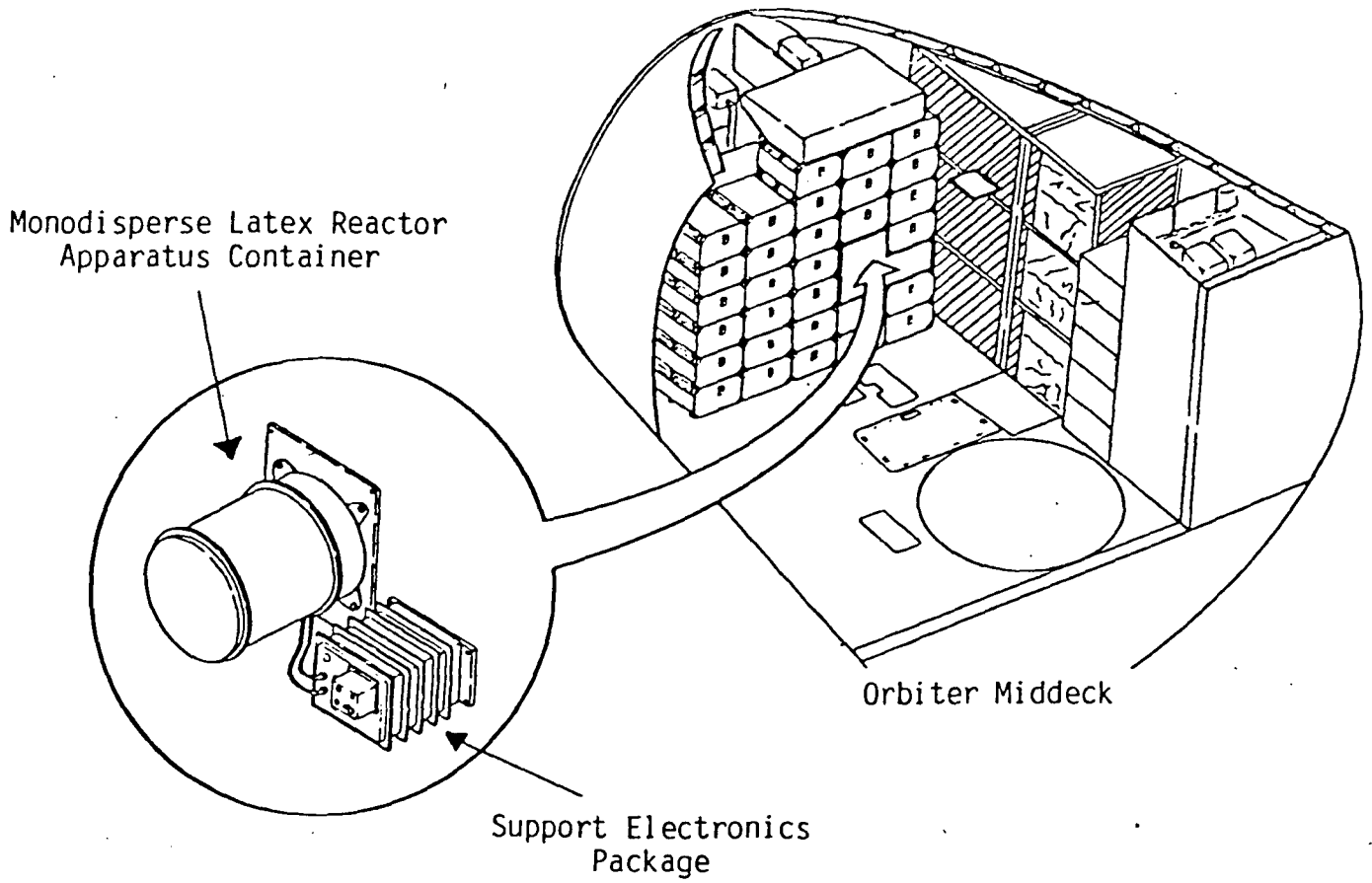
A second step experiment in the development of large, identical-sized latex particles is scheduled to be carried aboard the fourth Space Shuttle flight.

The Monodisperse Latex Reactor is a materials processing in space experiment, first carried out on STS-3, designed to study the feasibility of making monodisperse (identical size) polystyrene latex microspheres in space. The project was developed at NASA's Marshall Space Flight Center and Lehigh University in Bethlehem, Pa.

The experiment consists of four, .3-meter (1-foot)-tall reactors, each containing a chemical latex-forming recipe, housed in a .6-m (2-ft.)-tall metal cylinder. The recipe is a suspension of very tiny latex beads in water or another liquid. Latex spheres produced on the third Shuttle mission will be among the seed particles used to grow larger spheres on the fourth flight.

The latex reactor operated perfectly during STS-3, running for 14 hours and making controlled quantities of beads in sizes up to five microns. On STS-4, the experiment will be operated for 20 hours to enhance the capability of making larger monodisperse particles.

# MONODISPERSE LATEX REACTOR



On Earth, these beads can be produced only up to about three microns and still be monodisperse. The experiment which will be flown on a total of four flights will help determine if much larger (larger than 20 microns) monodisperse beads can be produced practically and economically in space.

These latex particles may have major medical and industrial research applications. Some of the proposed applications of the latex beads include measuring the size of pores in the wall of the intestine in cancer research; measuring the size of pores in the human eye in glaucoma research; and as a carrier of drugs and radioactive isotopes for treatment of cancerous tumors.

The National Bureau of Standards has also indicated its interest in routine use of the beads as calibration standards in medical and scientific equipment.

Prior to launch, each of the reactors is loaded with 100 cubic centimeters of the chemical latex-forming recipe. A small onboard computer will control the experiment after the Shuttle crew turns it on.

In orbit, the latex mixture is heated to a constant 70-degrees centigrade which initiates a chemical reaction to form the larger plastic beads.

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

The reactor will be removed from the Shuttle 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 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. Kornfeld of the Marshall Space Flight Center.

Responsibility for providing and testing the flight experiment lies with Marshall's Materials Processing in Space Projects Office, supported by the Center's Space Sciences Laboratory.

Experiment safety and interfacing requirements for the Shuttle flight are directed by Marshall's Spacelab Payload Project Office. The experiment, to be carried in the Shuttle Orbiter crew compartment locker area, is also to be conducted on Shuttle flights five and six.

Design support for the experiment was provided by General Electric Co., Valley Forge, Pa., and Rockwell International, Downey, Calif.

### Nighttime/Daytime Optical Survey of Lightning

An experiment designed to study lightning and thunderstorms from orbit is making a repeat flight on the fourth Space Shuttle mission.

The Nighttime/Daytime Optical Survey of Lightning experiment, developed and managed by NASA's Marshall Space Flight Center will record motion pictures and photo cell readings of lightning and thunderstorms as seen from orbit. The lightning survey experiment concept was conceived by Principal Investigator Dr. Bernard Vonnegut of the State University of New York, Albany.

The data and knowledge expected to result from the lightning survey may lead to the development of a better understanding of the evolution of lightning in severe storms. The experiment, which is scheduled to also be carried aboard STS-6, was first flown on the second Shuttle flight but, due to the shortened flight, produced limited results.

The experiment will be conducted from the orbiter crew compartment.

The lightning experiment equipment consists of a 16-mm data acquisition camera synchronized with a two-channel stereo cassette recorder receiving the output of a photocell optical system serving as a sensor. The camera-sensor system was built for Marshall by the Johnson Space Center.

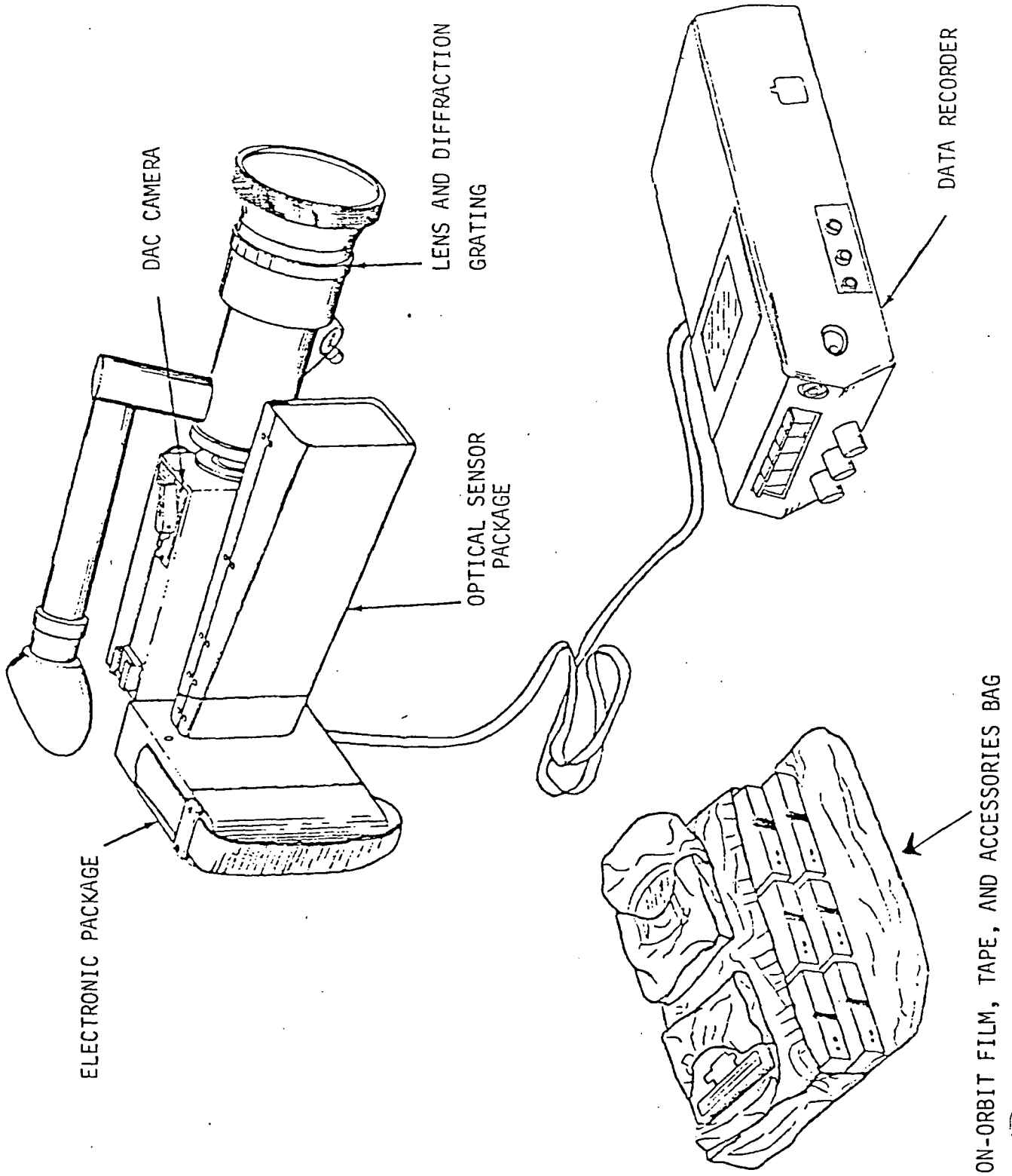
The Shuttle astronauts will use the motion picture camera to film the lightning flashes of thunderstorms. A diffraction grating will be attached to the camera lens during nighttime observations to provide lightning spectrographs. This data can be used to determine the temperature, pressure, molecular species, electron density and percent of ionization in the lightning's path.

Lightning discharges will be sensed by the photo-optical system, which creates an electronic pulse in response to the detection of a lightning flash. These pulses will be recorded on magnetic tape. A lightning event, which is visible as only one flash, is usually composed of many separate discharges, or strokes, which are detected by the photocell. Thus, the photocell will also be used during the night to record lightning strokes. And the motion picture camera will be used during the day as well to film the cloud structure and the convective circulation in the storm. These techniques may be adaptable in the development of sensors to identify severe weather situations from future meteorological satellites.

The area of the Earth's surface in the view of the orbiting Shuttle is so large that lightning storms will probably be visible on almost every orbit. Because of the high speed of the Orbiter, these storms will remain in view only a short time -- just a few seconds for storms directly beneath the flight path, somewhat longer for storms off to either side.



NIGHTTIME/DAYTIME OPTICAL SURVEY OF LIGHTNING



During passages over the dark side of the Earth, the astronaut observers will readily recognize nocturnal storms by their lightning flashes, which should be visible for hundreds of kilometers. On the sunlit side of the Earth, the crew will recognize storms through prior familiarization with the appearance of cumulonimbus clouds and associated characteristic shapes as viewed from above.

Candidate storms for this experiment will be targeted for the astronauts by a team of scientists at Marshall's Space Sciences Laboratory using a sophisticated developmental weather system called McIDAS, the Man computer Interactive Data Access System. When a potential storm is identified along the projected track path of the Orbiter, the coordinates are given to Mission Control so that the astronauts will be alerted at the appropriate time. McIDAS is a NASA and NOAA (National Oceanic and Atmospheric Administration) sponsored system based at the University of Wisconsin in Madison, which furnishes the Marshall Center team and other research groups with a mix of vast amounts of ground data and satellite weather information.

When a target is in view, a crew member will use the camera to photograph through the windows of the crew cabin. The observer will locate the storm clouds and record his observations. During the filming of the storm clouds, signals corresponding to camera shutter pulses will be recorded on one track of the stereo tape recorder and the photocell output will be recorded on the other track.

Otha H. Vaughan Jr., of Marshall's Space Sciences Laboratory, and Dr. Marx Brook, of the New Mexico Institute of Mining and Technology, Socorro, are co-investigators.

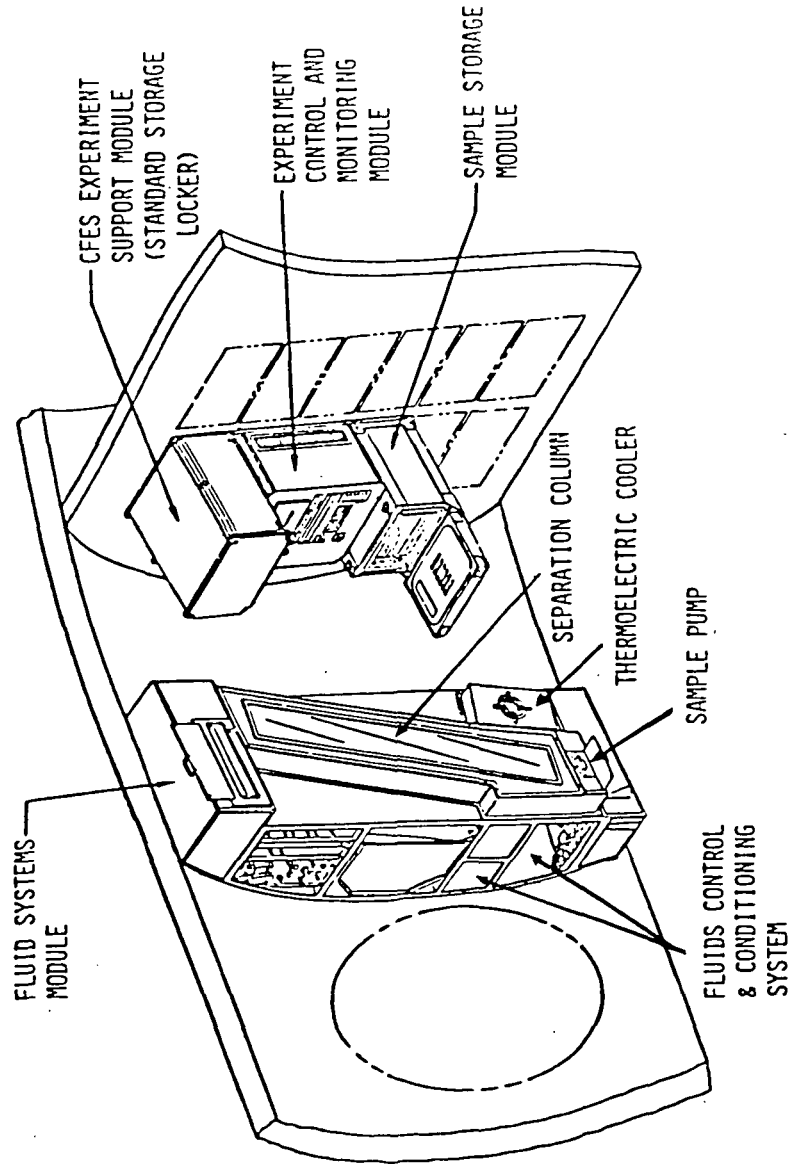
#### Continuous Flow Electrophoresis System

An experiment which marks the first use of the Space Shuttle by a commercial concern will be carried into space aboard STS-4. This flight also introduces a unique NASA concept to promote the advancement of space technology and the utilization of space through partnership arrangements with private enterprise.

The Continuous Flow Electrophoresis System, nicknamed "Eos" (Greek god of the dawn) by its developer, the McDonnell Douglas Astronautics Co., St. Louis, Mo., is designed to separate biological materials according to their surface electrical charge as they pass through an electric field. Unlike previous electrophoresis experiments in space, the system processes considerable quantities of materials carried in a continuous stream.

This flight is an initial engineering test of the electrophoresis system hardware and will process six McDonnell Douglas protein samples.

CONTINUOUS FLOW ELECTROPHORESIS SYSTEM  
MIDDECK GALLEY LOCATION



The environment of space offers advantages for electrophoresis processes over Earth-based separation. Earth's gravity limits this process in several ways.

Gravity limits the concentration of the materials in the sample being separated, which is one of the primary factors limiting the electrophoresis production of commercial quantities on Earth. On Earth, only 0.25 percent of the sample to be separated can be biological material. The rest must be carrier fluid. In space, however, the concentration can be increased to 20 percent or more of the total sample, which increases the output of the process by a factor of 80 to 100 over Earth processing.

Also on Earth, the sample stream size must be restricted to minimize gravity-induced disturbances. On Earth the stream may measure only one-half millimeter in diameter, while in space the sample stream diameter may be increased to one millimeter. This increases the output of the process by a factor of four, and when combined with the increase from higher concentrations, can result in an overall increase in output of 300 to 400 times when compared to an Earth-based unit.

Purer materials can be obtained in space.

On Earth, heat caused by the electric current used in the separation process induces convection, which reduces the purity of the separated materials. In space, the voltage may be increased without causing disturbing convective flows. Also, in space the length of time that the material being separated is in the electric field may be increased without detrimental side effects. This, in conjunction with the increased voltage, can significantly improve the purity of the separated materials.

Scientists from the Ortho Pharmaceutical Div. of Johnson & Johnson, the company collaborating with McDonnell Douglas in this effort, investigated the potential of several candidate space products. They report that a small quantity of each separated material would satisfy a reasonable share, or about 25 percent, of the available market for those products.

NASA is flying this experiment under a "joint endeavor agreement," pioneered and managed for NASA by the Materials Processing in Space Projects Office at the Marshall Space Flight Center. Under such an agreement, private enterprise and NASA work together as partners to promote the utilization of space where a technological advancement is needed and there is a potential commercial application.

Joint endeavors are designed to contribute directly to NASA's scientific objectives in the field of materials processing in low gravity and to simultaneously accelerate the benefits to the general public from this emerging technology. In this experiment, both McDonnell Douglas and NASA will benefit from the use of this equipment for space experimentation in materials science.

Under terms of the agreement with McDonnell Douglas, flight time on the Shuttle orbiter is furnished to McDonnell Douglas during the developmental phase of the electrophoresis device, starting with this mission. NASA, in turn, gets experiment opportunities using the device, and equipment performance data which will expand the base of knowledge in the field of separation sciences. McDonnell Douglas will commercialize any promising results from the work and make it available to the U.S. public on reasonable terms and conditions.

General equipment performance data and the results from NASA's experiments using the electrophoresis system device will be made public. Scientists at Marshall and Johnson Space Centers will conduct NASA's experiments on the device.

During the next two years, the electrophoresis system will be carried into space in the mid deck area of the Shuttle orbiter on six space flights. Provided these experimental operations prove successful, plans call for a larger electrophoresis unit to be carried in the cargo bay on two future Shuttle flights. According to conditions of the joint agreement, McDonnell Douglas has the option of attaching the unit to a NASA orbiting space platform in 1986 should such a platform be in operation.

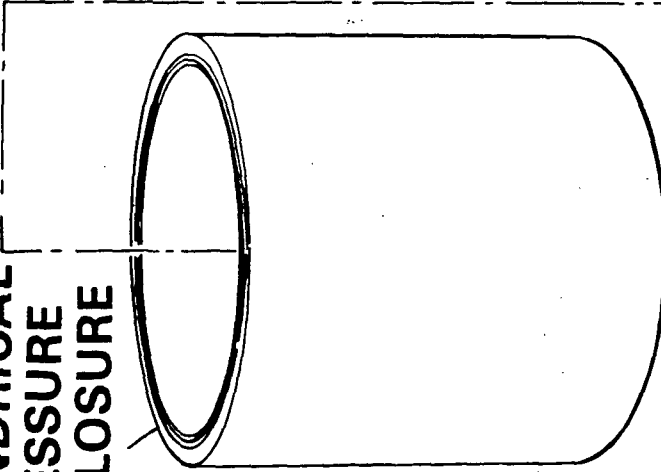
#### GETAWAY SPECIAL

Officially titled Small Self-Contained Payloads, the Getaway Special program is offered by NASA to provide anyone who wishes the opportunity to fly a small experiment aboard the Space Shuttle. The experiment must be of a scientific research and development nature.

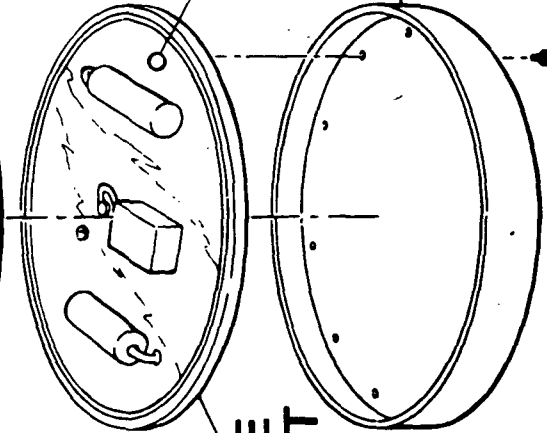
A Getaway Special Flight Verification Payload flew aboard the STS-3 mission. The test payload, a cylindrical canister .6 m (2 ft.) in diameter and .9 m (3 ft.) deep, measured the environment in the canister during flight. The data were recorded and will be analyzed for use by Getaway Special experimenters on future Shuttle missions.

The Getaway Special experiments will be flown on Shuttle missions on a space-available basis. The first private sector payload is being flown on STS-4. This payload was purchased by Gilbert Moore and donated to Utah State University where it is being used as a program for student constructed experiments. All nine experiments will be contained in the 5-cubic-foot payload canister.

**CYLINDRICAL  
PRESSURE  
ENCLOSURE**



**NASA  
INTERFACE  
EQUIPMENT  
PLATE**



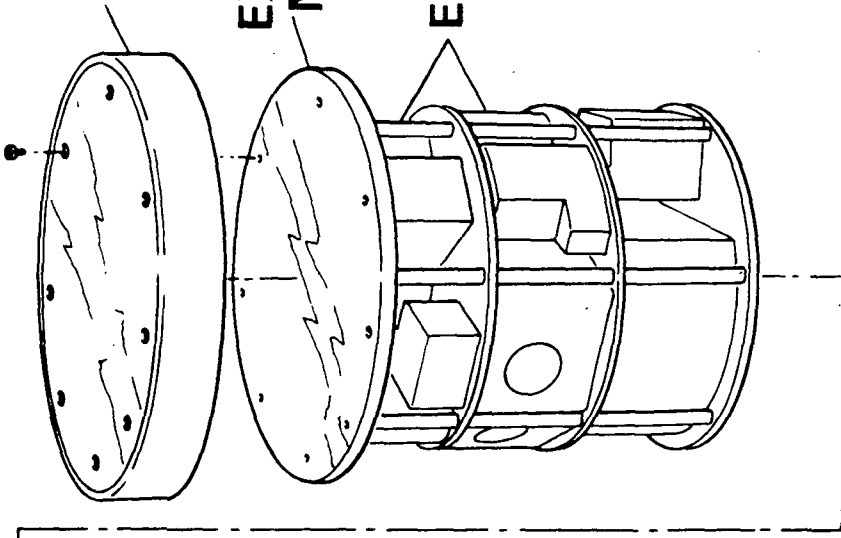
**PURGE  
PORT**

**INSULATED  
COVER**

**INSULATED  
COVER  
(AS REQUIRED)**

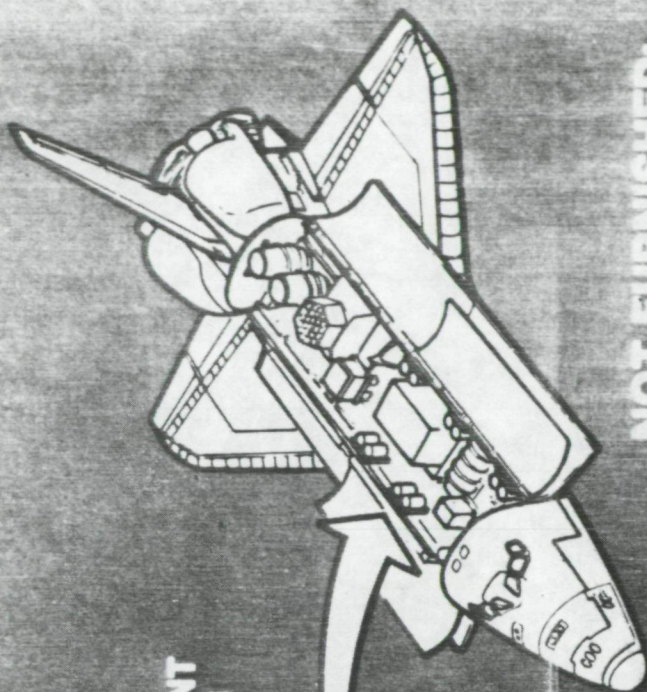
**EXPERIMENT  
MOUNTING  
PLATE**

**EXPERIMENTS AND  
RACK TO BE  
SUPPLIED BY  
EXPERIMENTER**



**GET AWAY SPECIAL  
SMALL SELF-CONTAINED  
PAYLOADS  
CONTAINER CONCEPT**

# GETAWAY SPECIAL ACCOMMODATIONS



EXPERIMENT MOUNTING HOLES

NOT FURNISHED:

- POWER
- DATA STORAGE
- EXPERIMENT CONTROL SYSTEM
- ENVIRONMENTAL CONTROL

THERMAL INSULATION

CONTROL DECODER

SHIELDED TWISTED WIRE PAIR FOR ON/OFF COMMANDS



SEAL

CYLINDER 20 IN. DIA X 31 IN. HIGH

CANISTER MOUNTING HOLES

NASA INTERFACE VOLUME (3 IN. HIGH)



SEAL

FILTERED VENTS

Experiment Science Descriptions for First Getaway Special

**Drosophila Melanogaster (Fruit Fly) Growth Experiment**

Student Investigator: Walt L. Moore, HDR Sciences Co., Santa Barbara, Calif., graduate/environmental sciences.

This experiment is designed to provide a means of raising and separating succeeding generations of fruit flies, *Drosophila Melanogaster*, in orbit to study the effects of microgravity on their genetic structure. This will be a test of equipment that is proposed to be flown on the Long Duration Exposure Facility.

**Artemia (Brine Shrimp) Growth Experiment**

Student Investigator: Bruce W. Moore, Weber State College, Ogden, Utah, freshman/music.

The brine shrimp *Artemia* will be flown to determine the genetic effects of microgravity on cysts hatched in space. Cysts will be injected into a saline solution upon experiment activation. The growing shrimp, called nauplii, will be observed during the remainder of the flight with a 35mm motor-driven Nikon camera with a 55mm micro-Nikkor lens. The camera will be shared between this experiment and another experiment concerning observations of Duckweed growth in microgravity. Powdered rice hulls will be fed to the shrimp by a linear actuator. The shrimp will be studied postflight with electron microscopy.

**Surface Tension Experiment**

Student Investigator: James Elwell, Utah State University, Ogden, graduate/electrical engineering.

The goal is to study the shape of a liquid meniscus in a weightless environment. An aluminum block contains several holes filled with solder. Upon entering weightlessness, the block is heated, allowing the solder to flow and assume a meniscus shape. The block is allowed to cool, "freezing" the meniscus when the solder solidifies.

**Composite Curing Experiment**

Student Investigator: Amber M. Dalley, Utah State University, Ogden, senior/math-philosophy.

This experiment will complete the cure of a B-staged (partially cured) epoxy resin-graphite composite sample in microgravity. The composite sample will be heated to 163 degrees C and maintained at that temperature for one-half hour to allow the resin to gel.



The flight sample will be compared with samples processed in one G and post flight laboratory analysis will determine the quality of wetting between the resin and the graphite fibers and test the tensile strength of the sample.

### **Thermal Conductivity Experiment**

Student Investigator: Russel R. Laher, Utah State University, Ogden, junior/physics-geology.

An oil and water mixture in a one G environment will separate due to the density difference. The goal of the experiment is to carry oil and water into orbit and mix the two, then heat the mixture with a platinum wire. Temperatures of the heater wire, the mixture, and the air around the cylinder will be monitored. Ultimately, the thermal conductivity of the mixture will be calculated from these data.

### **Microgravity Soldering Experiment**

Student Investigator: G. Christian Alford, Utah State University, Ogden, senior/electrical engineering.

The Microgravity Soldering Experiment studies the separation of flux from solder while soldering in weightlessness. The lack of buoyancy in a non-accelerating environment could allow pockets of flux to become trapped in the solder. The experiment will melt samples of resin core and coreless solder on four heated copper foils. When the experiment is returned, the solder will be analyzed for trapped pockets of flux and compared with solder similarly processed on Earth.

### **Root Growth of Lemna Minor L. (Duckweed) in Microgravity**

Student Investigator: Kelly D. Hunt, Utah State University, Ogden, junior/physics.

Using the 35mm Nikon, shared with the experiment described earlier, this experiment will photograph the root growth patterns of Lemna Minor L. (duckweed). The investigation centers on the nutrient transport role played by sieve tubes in the plants' roots in response to the force of gravity in Earth-grown specimens. The plants will be injected with a fixing agent before experiment deactivation. Electron microscopy will be used to compare control and flight specimens.

### **Homogeneous Alloy Experiment**

Student Investigator: Terrance L. Thomas, Utah State University, Ogden, junior/electrical engineering.

An aluminum chamber containing a powdered bismuth-tin mixture will be placed into Earth orbit. The chamber will be heated, passing the melting points of the chemicals and allowing alloying to take place. The chamber will cool down and the alloy will be returned for Earth-based analysis.

### **Algal Microgravity Bioassay Experiment**

Student Investigator: Steven M. Walker, Utah State University, Ogden, senior/biology.

The goal of the experiment is to monitor the growth rate of *Chlorella vulgaris*, a unicellular green algae, in microgravity. Upon experiment activation, a freeze-dried sample of algae will be injected into the media-filled growth chamber. Over the duration of the experiment the culture optical density and temperature will be measured. Near the end of this experiment, a fixative will be injected into the chamber preserving the cells for postflight analysis.

The Getaway Specials are available to industry, educational organizations and domestic and foreign governments for legitimate scientific purposes. Since the offer for Space Shuttle space first was made in 1976, more than 320 reservations have been made by more than 191 individuals and groups from 33 states, the District of Columbia and 14 foreign nations. Although many reservations have been obtained by persons and groups having an obvious interest in space research, a large number of spaces have been reserved by persons and organizations entirely outside the space community.

Reservations are held, for example, by realtors, bankers, newspaper publishers, and school children, among others, who have an interest in conducting experiments in biology, chemistry, Earth science, physics and other disciplines. Examples include an inner city high school class in Camden, N. J., which intends to fly an ant colony in space to determine the effect of weightlessness on the ants, and a Japanese newspaper, the *Asahi Shimbun*, is planning a snow-making experiment under zero-G conditions to investigate crystallization.

There are no stringent requirements to qualify for space flight, but the payload does have to meet safety criteria. It must also have a scientific or technological objective.

For example, a manufacturer may want to test, on a priority basis, a certain type of metal-making in space for later use in his own production. This is not only permissible, but welcome. However, a person who wishes to fly items of a commemorative nature, such as medallions for later resale as "objects that have flown in space" would be refused. While payloads must be related to a technical or scientific objective, NASA will not attempt to judge their scientific merit or novelty.

Getaway Special requests must first be approved at NASA Headquarters, Washington, D.C. It is at this point that requests for Shuttle space are screened for propriety, and scientific or technical aim. These requests must be accompanied or preceded by the payment of \$500 earnest money. Requests approved by NASA are given a payload identification number and referred to the Getaway Special Team at NASA's Goddard Space Flight Center, Greenbelt, Md.

The Getaway Special Team screens the proposal for safety and provides advice and consultation for payload design. Shuttle crew members will turn on and off up to three payload switches, but there will be no opportunity for crew monitoring of Getaway Special experiments, or for any form of inflight servicing.

The Getaway Special Team must certify that the proposed payload is safe -- meaning that it will not harm or interfere with the operations of the Shuttle, its crew or other experiments on the flight.

If any physical testing must be done on the payload to answer safety questions prior to the launch, the expense of these tests must be borne by the customer.

Getaway Special spaces come in three standard sizes: 5 cu. ft., with a maximum of 91 kg (200 lb.); 2 1/2 cu. ft. and up to 45 kg (100 lb.); and 2 1/2 cu. ft. and up to 27 kg (60 lb.). The prices for flying these are \$10,000, \$5,000 and \$3,000 respectively. These prices will remain fixed for the first three years of Shuttle operations.

The Getaway Special program is managed by the Goddard Space Flight Center. Project Manager is James S. Barrowman. Clarke Prouty, also of Goddard, is technical liaison officer. Program Manager at NASA Headquarters, Washington, D.C. is Donna S. Miller.

#### SHUTTLE STUDENT INVOLVEMENT PROJECT

The Shuttle Student Involvement Project is a joint venture of NASA and the National Science Teachers Association. The project is designed to stimulate the study of science and engineering by engaging students in grades 9 through 12 in a competition to develop proposals suitable for flight aboard the Shuttle.

The 10 winners of the first competition were announced in May 1981. NASA then paired each student with a corporate sponsor and a NASA consultant to assist the student in turning the proposal into a flight ready project. The 20 winners of the second competition were announced in May 1982 and the third competition will begin in September of this year.

Two winning entries from the first competition will fly aboard STS-4. Both experiments are medical in nature and required no hardware preparation.

"The Effects of Diet, Exercise, and Zero Gravity on Lipoprotein Profiles," was proposed by Amy Kusske, 16, Wilson High School, Long Beach, Calif. This project will document the diet and exercise program for the astronauts pre and postflight.

There are several types of lipoproteins in the blood. The ratio between these -- particularly high density lipoproteins (HDL) and low density lipoproteins (LDL) -- can be used to predict the likelihood of someone developing atherosclerosis. Atherosclerosis and coronary disease are diseases of epidemic proportions in the United States. Exercise increases the HDL/LDL ratio, decreasing the risk factor for atherosclerosis and coronary artery disease.

The goal of Amy's research is to determine whether any alterations occur in lipoprotein profiles during space flight. During the mission, the astronauts will record on log cards what is and what is not consumed in their diet. The astronauts will keep a similar diary of their exercise performance and how that exercise is maintained.

To measure the crew's lipoprotein profiles, blood samples will be collected during scheduled physical examinations approximately seven and two days before flight and upon touchdown. Analysis of these samples will be done at Johnson Space Center's Biochemical Laboratories. The results will be provided to Amy for interpretation.

Corporate sponsor for this experiment has been McDonnell Douglas Astronautics Co. Dr. William Douglas of McDonnell's Huntington Beach facility has worked with Amy. The NASA consultant for this experiment is Dr. Carolyn Huntoon, of Johnson's Biomedical Laboratories. Mrs. Linda Sanders of Lakewood High School is Amy's teacher-advisor.

A second student project on STS-4 is "The Effects of Space Travel on Levels of Trivalent Chromium in the Body." Developed by Karla Hauersperger, 17, from East Mecklenburg High School, Charlotte, N.C., this project hopes to determine whether any alterations occur in chromium metabolism during space flight.

Serum levels of insulin are known to change slightly during space flight, and insulin helps control body use of carbohydrates. Chromium is a cofactor (that is, a substance which must be present in low quantities for an enzyme to work) for insulin.

To carry out the project the food which the crew eats will be recorded, and the chromium content determined by use of U.S. Department of Agriculture computer-feed reference values.

During flight, the crew will record on log cards how much they eat of what foods (these will be same cards for the other student project).

To measure crew levels of serum glucose, insulin, chromium and urine chromium, blood and urine samples will be collected during scheduled physical examinations approximately seven and two days before flight and upon touchdown.

Analysis of these samples will be done by Johnson's Biomedical Laboratories and results will be provided to Karla for interpretation. Levels of trivalent chromium will be determined by atomic absorption spectrophotometry.

Karla's corporate sponsor was the Explorer's Club of New York City. Dr. Huntoon of Johnson helped Karla develop the project. Mrs. Wilma Collins, East Mecklenburg High School, was Karla's teacher-advisor.

#### ORBITER EXPERIMENTS PROGRAM

A complete and accurate assessment of Shuttle performance during the launch, boost, orbit, atmospheric entry and landing phases of a mission requires precise data collection to document the Shuttle's response to these conditions.

The NASA Office of Aeronautics and Space Technology (OAST), through its Orbiter Experiments Program, is providing research experiments onboard the Shuttle orbiter to record specific, research-quality data. The data will verify the accuracy of wind tunnel and other ground-based simulations made prior to flight; verify ground-to-flight extrapolation methods, and verify theoretical computational methods. The data also will be useful to the Office of Space Transportation Systems to further certify Shuttle and expand its operational envelope.

The primary objective of the Orbiter Experiments Program is to increase the technology reservoir for development of future (21st Century) space transportation systems.

The following experiments are currently included in the program and are slated to fly on early Shuttle flights.

#### Aerodynamic Coefficient Identification Package (ACIP)

The primary objectives of the Aerodynamic Coefficient Identification Package are:

- To collect aerodynamic data during the launch, entry and landing phases of the Shuttle;

- To establish an extensive aerodynamic data base for verification of the Shuttle's aerodynamic performance and the verification and correlation with ground-based data, including assessments of the uncertainties of such data;

- To provide flight dynamics data in support of other technology areas, such as aerothermal and structural dynamics.

The ACIP system has now flown on STS-1, 2 and 3. It will fly again on STS-4 and current plans call for continued operation on future Shuttle flights, including the operation of a second ACIP unit on OVO99.

Instruments in this package include dual-range linear accelerometers and rate gyros. Also included are the power conditioner for the gyros, the power control system and the housekeeping components. The package is installed colinearly with the geometric axes of the orbiter and post-installation measurements made to establish the position within 10 arc minutes. The instruments continuously sense the dynamic X, Y and Z attitudes and performance characteristics of the orbiter through these critical flight phases. The Aerodynamic Coefficient Identification Package also provides high rate sampling of the positions of orbiter control surfaces for recording with the package's attitude data.

Principal technologist is D.B. Howes of Johnson Space Center, Houston.

#### Infrared Imagery of Shuttle (IRIS)

This experiment will obtain high-resolution infrared imagery of the orbiter lower (windward) and side surfaces during reentry from which surface temperatures and hence aerodynamic heating may be inferred. The imagery will be obtained utilizing a 91.5-cm (36-in.) telescope mounted in the NASA C-141 Gerard P. Kuiper Airborne Observatory positioned appropriately at an altitude of 13,700 m (45,000 ft.) along the entry ground track of the orbiter. A single image will be obtained during each flight.

On the STS-3 mission the IRIS experiment successfully obtained an image of the Shuttle during the transition phase of the entry. The image was obtained at 16.5 minutes after Entry Interface, when the Shuttle was at an altitude of 54,860 m (180,000 ft.) and flying at a Mach 15. During the STS-4 mission, the Kuiper Airborne Observatory will be deployed from Hickam Air Force Base, Hawaii, to image the Shuttle during the peak heating phase. This will occur at an altitude of approximately 64,000 m (210,000 ft.), while flying at Mach 21.

The primary technology objective is to decrease the current level of uncertainty associated with various reentry aerothermodynamic phenomena affecting thermal protection system design. The phenomena include boundary layer transition, flow separation and reattachment, flow/surface interactions and surface catalyses to flow chemistry.

These data will provide for improved computational procedures and lead to development of advanced thermal protection systems.

The infrared imagery system consists of the C-141 aircraft and its optical system, a 6-cm (2-in.) aperture acquisition telescope focal plane system with detector array, and a high-speed data handling and storage system. The aircraft will operate from Ames Research Center, Mountain View, Calif., and will be stationed along the orbiter entry ground track about one hour prior to reentry. As the orbiter passes through the field of view of the telescope, the orbiter windward or side surface will be observed by the detector system and the data recorded on tape. After the flight, these data will be supplemented by orbiter-derived data of velocity, altitude, angle-of-attack, yaw and roll conditions existing during the period of infrared imagery observation. Analysis involves computer arrangement of this data into a two-dimensional image format, radiometric analysis and detailed comparisons of the aerodynamic heating rates with analytical predictions and ground-based experimental data.

Principal technologist is W.C. Davy, Ames Research Center.

#### Tile Gap Heating Effects (TGH) Experiment

Analyses and ground tests have shown that the gaps between the tiles of the thermal protection system generate turbulent airflow, which will cause increased heating during the reentry phase of flight. Tests have also shown that the heating effect may be reduced by optimum design of the gaps and by altering the radii at the edges of the tiles. The tile gap experiment was devised to further the investigations of heating phenomena. The results will enable improvements in reusable element thermal protection systems to reduce the convective heating caused by gaps and other discontinuities.

The orbiter will be instrumented with a removable panel 45.7 cm (18 in.) square, which will carry 11 tiles of baseline material and size. The panel will be fitted to the underside of the orbiter fuselage. The gaps between tiles will be carefully calculated and controlled during fitting to ensure that the heating rates generated during entry will be no higher than those of the baseline tile array. The aim will be to produce a design that will result in heating rates lower than those of the baseline system.

In addition to gap spacing, the gap depth will also be controlled through the use of fillers fitted at the bottom of certain gaps; i.e., at the junction of the tiles and the orbiter fuselage skin. The radii at the outer edges of the tiles will be controlled during fabrication to conform to calculations that show the reduced effects in combination with the spacing. Thermocouples will be fitted to the tile surfaces and at various depths in the gaps to measure temperatures during reentry.

The output of the thermocouples will be recorded on the orbiter's development flight instrumentation system. To assist in evaluation, Tile Gap Heating Effects data will be compared to development flight instrumentation data obtained from earlier missions.

This will be the third flight of the experiment which successfully flew on STS-2 and 3. On STS-4 it will be modified to investigate the effect of tile gap geometry on gap filler bar heating. The STS-4 test configuration is co-sponsored by the Orbiter Experiments Project and the Orbiter Project. Information provided by this test will aid the Orbiter Project in the evaluation filler bar heating experienced on STS-1, 2 and 3.

Principal technologist is W. Pitts, Ames Research Center.

#### Catalytic Surface Effects (CSE) Experiment

A strong shockwave will encompass the Shuttle orbiter during the atmospheric reentry maneuver. The shock wave severely compresses and heats the air flowing through it, causing the molecules to dissociate and react chemically with each other.

Computations show that as the dissociated atomic oxygen approaches the cooler regions of flow adjacent to the orbiter, the atomic oxygen fails to recombine into molecular oxygen.

This experiment will investigate the chemical reaction caused by impingement of atomic oxygen on the Shuttle thermal protection system which was designed under the assumption that the atomic oxygen would recombine at the thermal protection system wall.

This chemical reaction releases additional heat which results in higher thermal protection system temperatures. In this case, the surface is referred to as being a catalytic surface, that is, it allows the chemical reaction to take place.

If the thermal protection system surface is non-catalytic, then atomic oxygen will not recombine into molecular oxygen and the heating rates will be lowered. Thus, the temperature of the orbiter during reentry will be lower. With lower temperatures, orbiter thermal protection system weight could be reduced, its flight envelope could be expanded, or greater reusability could result.

The technology objective is to verify analytical predictions which could not be adequately simulated in ground-based facilities. The results will provide data and improved computational techniques for future thermal protection system designs.



The Catalytic Surface Effects will use baseline tiles, selected from those having development flight instrumentation thermocouples, located on or near the orbiter lower fuselage centerline. The five tiles will be sprayed with an overcoating mixture of chrome-iron-spinel, a highly efficient catalytic material and a vinyl acetate binder which will protect the overcoat during ground operations. The mixture is compatible with the existing tile and coating and will not alter the thermal or mechanical properties of the uncoated portions of the thermal protection system. During orbiter ascent, the vinyl acetate will burn off the tile surface, leaving the chrome-iron-spinel exposed.

Thermocouple measurements recorded during reentry will be used to determine Catalytic Surface Effects performance. Comparison of this experiment's data with data taken on previous flights from uncoated tiles will aid in the performance evaluation.

This will be the third flight of the experiment. Data collected on the STS-2 and 3 has been useful in verifying the preflight predictions that the tile surfaces are non-catalytic.

At the end of each mission, the overcoat will be removed from the six tiles, leaving the thermal protection system in its original condition.

Principal technologist is D. Stewart, Ames Research Center.

#### Dynamic, Acoustic and Thermal Environment (DATE) Experiment

To fully and economically exploit the benefits of the orbiter's large cargo-carrying capability, it is necessary to predict payload environments with accuracy and dispatch.

Such predictions will facilitate payload development and reduce the need for ultraconservative design and test. The Dynamic, Acoustic and Thermal Environment experiment will collect information for use in making credible predictions of cargo-bay environments. These environments are neither constant nor consistent throughout the bay and are influenced by interactions between cargo elements.

The instrumentation includes accelerometers, microphones, thermocouples and strain gages on payloads and in the cargo bay. Sensor outputs will be recorded for post-flight interpretation. DATE instrumentation has successfully flown on STS-1, 2 and 3.

The Goddard Space Flight Center, Greenbelt, Md., will be responsible for the data reduction.

Principal technologist is W. Bangs of Goddard.

ORBITER'S ROBOT "ARM"

(Remote Manipulator System)

Columbia is fitted with a Canadian-built remote manipulator system which was tested during STS-2 and STS-3. Part of the payload deployment and retrieval system, the mechanical arm will be used in operational flights to deploy satellites and other payloads or to grapple payloads for stowing in the payload bay and subsequent return to Earth.

Designed as an analog to the human arm, the manipulator system has shoulder, elbow and wrist joints driven by DC electric motors controlled by the flight crew using a combination of direct observation and television cameras on the elbow and wrist joints. The arm may be operated in five different modes ranging from full manual to computer-controlled through hand controls and keyboard at the payload station on the flight deck.

The manipulator system is installed on the left payload bay longeron for STS-4. A second one can be installed on the right longeron for specific payload tasks, although both arms could not operate simultaneously.

The arm, built of a light-weight carbon composite tubing 38 cm (15 in.) in diameter, is 15.3 m (50.25 ft.) long, and weighs 408 kg (900 lb.). A thermal blanket and heater provide temperature control for protecting joint-drive mechanisms and electronics. Brushless electric motors and gear trains drive the joints for pitch up/down, yaw left/right and wrist roll motions. The "hand," called an end effector, has snare wires that engage a grapple fixture on the payload.

Operator hand controllers are similar to those for spacecraft maneuvers -- a rotational hand controller for roll, pitch and yaw motions, and translational hand controller for up/down, left/right and fore/aft motions. When deactivated, the arm is latched into three cradle pedestals along the left longeron. If the drive mechanisms jam and the arm cannot be moved to its stowed position, and if contingency spacewalks are unsuccessful in restowing, the arm can be amputated with a pyrotechnic device.

The five arm operating modes are as follows:

- Automatic -- Operators select autosequence loaded into general purpose computer software which then moves arm through sequence; or, operator enters desired position coordinates into computer with keyboard at operator's station.
- Manual augmented -- Operator drives arm end effector with hand controllers without controlling individual joint motions.

- Manual single joint drive -- Operator drives arm through control panel switches on a joint-by-joint basis.
- Direct drive -- Operator controls motion through hard-wired command from control panel that bypasses the general purpose computer.
- Backup drive control -- Essentially same as direct drive, only commands pass through backup electronics and wiring.

The arm was developed and built under a cooperative agreement between NASA and the National Research Council of Canada. Spar Aerospace Ltd. is system prime contractor. Canada has absorbed the costs of research and development of the first arm installed aboard Columbia.

The ability of the arm to handle payloads in orbital flight can be tested on the ground only to a limited degree. Before full-scale heavy mass and large-volume payloads can be moved in and out of the payload bay, smaller, lighter objects are being handled to gain confidence in the design and to gain experience in operating the arm. The induced environment contamination monitor serves as a simulated payload during STS-4 arm testing.

Systems testing of the remote arm are aimed toward verifying that the arm, its computer software, closed-circuit television and crew visual cues all mesh for smooth and reliable operation. STS-4 arm tests are grouped under five basic test objectives:

- Deploy and berth the contamination monitor with the remote arm.
- Grapple, rigidize and release the contamination monitor grapple fixture with the arm's end effector, or hand.
- Verify that the software will bring an arm joint to stop before its travel limit is reached.
- Demonstrate the arm's ability to hold position during reactor control system thruster activity.
- Test the software's ability to move the arm elbow joint in manual control mode.

#### HUNTSVILLE OPERATIONS SUPPORT CENTER

The Huntsville Operations Support Center is a facility at the Marshall Space Flight Center in Huntsville, Ala., which provides launch support to Kennedy Space Center and payload operation support to Johnson Space Center.

During premission, countdown, launch and powered flight toward orbit, Marshall and contractor engineers, development project managers and their contractors are on consoles in the support center to monitor realtime data being transmitted from the Shuttle. Their purpose is to evaluate and help solve problems that might crop up with Marshall-developed Shuttle elements, including the Space Shuttle main engines, external tank and solid rocket boosters. They also are concerned with problems in the overall main propulsion system and range safety system.

The data, which provide information on the "health" of these systems, are gathered by sensors aboard the Shuttle and are instantaneously transmitted from the launch site to the support center. There the information is processed by computers and displayed on screens and other instruments at 12 stations in the engineering console room. More than 3,000 temperature, pressure, electrical voltage and other measurements are made every second. During the 10 hours of peak activity before and during launch, more than 11 million measurements are assessed by teams of experts.

Support center personnel will view the Shuttle on the launch pad via two closed circuit television lines. They also have access to more than 25 direct communications lines that link them with the launch site at Kennedy Space Center, Mission Control Center at Johnson and with responsible contractor plants.

In addition to launch support, payload services will be provided by teams of scientists operating out of specially equipped payload support rooms.

During this flight, two co-investigators on the Monodisperse Latex Reactor will operate in the support center to evaluate the function of the experiment and monitor the astronautic-experiment operations during televised hardware use. The Induced Environment Contamination Monitor scientific team will monitor and evaluate the electrical function of the instrument package during its normal operation. The team will also monitor contamination mapping of the cargo bay and a plume pressure test.

Other payload assistance is provided for the Nighttime/Daytime Optical Survey of Lightning. Scientists in the Huntsville center will monitor flight crew voice transmissions to coordinate on-orbit use of experiment hardware with the principal investigator, located at Johnson.

#### SPACEFLIGHT TRACKING AND DATA NETWORK (STDN)

One of the key elements in the Shuttle mission is the capability to track the spacecraft, to communicate with the astronauts and to obtain the telemetry data that informs ground controllers of the condition of the spacecraft and its astronauts.

The heart of this complex network is located at the Goddard Space Flight Center, Greenbelt, Md., just outside Washington, D.C. where the Spaceflight Tracking and Data Network (STDN) and the NASA Communications Network (NASCOM) is located.

With the exception of very brief periods during the launch, flight and recovery of STS-4. Goddard serves as the communications hub of the mission, receiving all telemetry, radar and air-to-ground communications and relaying that information to Johnson in Houston, and to other NASA and Department of Defense facilities participating in the mission. Most video (TV) transmission facilities used during the mission are provided by and monitored for quality by Goddard personnel. At Goddard, the network operations managers and systems specialists keep the entire NASA/DOD network tuned for the mission support.

### Spaceflight Tracking and Data Network

The Spaceflight Tracking and Data Network is a complex NASA worldwide system that provides reliable, realtime communications with the Space Shuttle orbiter and crew. The network is maintained and operated by Goddard. Approximately 2,500 personnel are required to operate the worldwide network.

The network for the Orbital Flight Test Program consists of 15 ground stations equipped with 4.3-, 9-, 12- and 26-m (14-, 30-, 40- and 85-ft.) S-band antenna systems and C-band radar systems, augmented by 15 Department of Defense geographical locations providing C-band support and one Department of Defense 18.3-m (60-ft.) S-band antenna system. In addition, there are six major computing interfaces located at the Network Operations Control Center (NOCC) and the Operations Support Computing Facility (OSCF), both at Goddard; Western Space Missile Center, Calif.; Air Force Satellite Control Facility, Colo.; White Sands Missile Range, N.M.; and Eastern Space and Missile Center, Fla., providing realtime network computational support.

The network has support agreements with the governments of Australia, Spain, Senegal, Botswana, Chile, United Kingdom and Bermuda to provide NASA tracking stations support to the Space Transportation System program.

In the Spaceflight Tracking and Data Network Operations Control Center at Goddard, the network director and a team of operations managers and network systems specialists, keep the entire network tuned for mission support. Should the Johnson Mission Control Center be seriously impaired for an extended time, facilities serving the Network Operations Control Center would become an emergency mission control center manned by Johnson personnel, with the responsibility of safely returning the Space Shuttle orbiter to a landing field.

The Merritt Island, Fla., S-band station provides the appropriate data to the Launch Control Center at Kennedy Space Center and the Mission Control Center at Johnson during prelaunch testing and the terminal countdown. During the first minutes of launch and during the ascent phase, the Merritt Island and Ponce de Leon, Fla., S-band and Bermuda S-band stations, as well as the C-band stations located at Bermuda; Wallops Island, Va.; Grand Bahama; Grand Turk; Antigua; Cape Canaveral; and Patrick Air Force Base, Fla., will provide appropriate tracking data, both high speed and low speed, to the Kennedy and Johnson Control Centers.

The Madrid, Spain; Indian Ocean Station Seychelles; Orroal and Yarragadee, Australia; and Guam stations provide critical support to the orbital maneuvering system 1 and 2 burns on the first revolution. During the orbital phase, all S-band and some of the C-band stations that see the Space Shuttle orbiter at 3 degrees above the horizon will support and provide appropriate tracking, telemetry, air-to-ground and command support to the Johnson Mission Control Center through Goddard.

During the nominal reentry and landing phase planned for Edwards Air Force Base, Calif.; the Goldstone and Buckhorn, Calif.; S-band stations and C-band stations at the Pacific Missile Test Center, Vandenberg Air Force Base, Edwards Air Force Base and Dryden Flight Research Facility will provide highly critical tracking, telemetry, command and air-ground support to the orbiter and send appropriate data to the Johnson and Kennedy Control Centers.

NASA TRACKING STATIONS

<u>Location</u>	<u>Equipment</u>
Ascension Island (ACN)	S-Band, UHF A/G
Bermuda (BDA)	S-Band, C-Band, UHF A/G
Buckhorn (BUC)	S-Band, C-Band
Goldstone (GDS)	S-Band, UHF A/G
Guam (GWM)	S-Band, UHF A/G
Hawaii (HAW)	S-Band, UHF A/G
Merritt Island (MIL)	S-Band, UHF A/G
Santiago (AGO)	S-Band
Madrid (MAD)	S-Band, UHF A/G
Orroral (ORR)	S-Band
Botswana (BOT)	UHF A/G
Dakar (DKR)	UHF A/G
Yarragadee (YAR)	UHF A/G

Personnel:

Tracking Stations - 1,110\*  
Goddard Space Flight Center - 1,400

\*More than 500 of whom are local residents.

STS-4 FREQUENCIES

Uplink

2106 MHZ	}	COMMAND VOICE AND RANGING
1831 MHZ		
2041 MHZ		

296.8 MHZ	}	UHF A/G VOICE
259.4 MHZ		

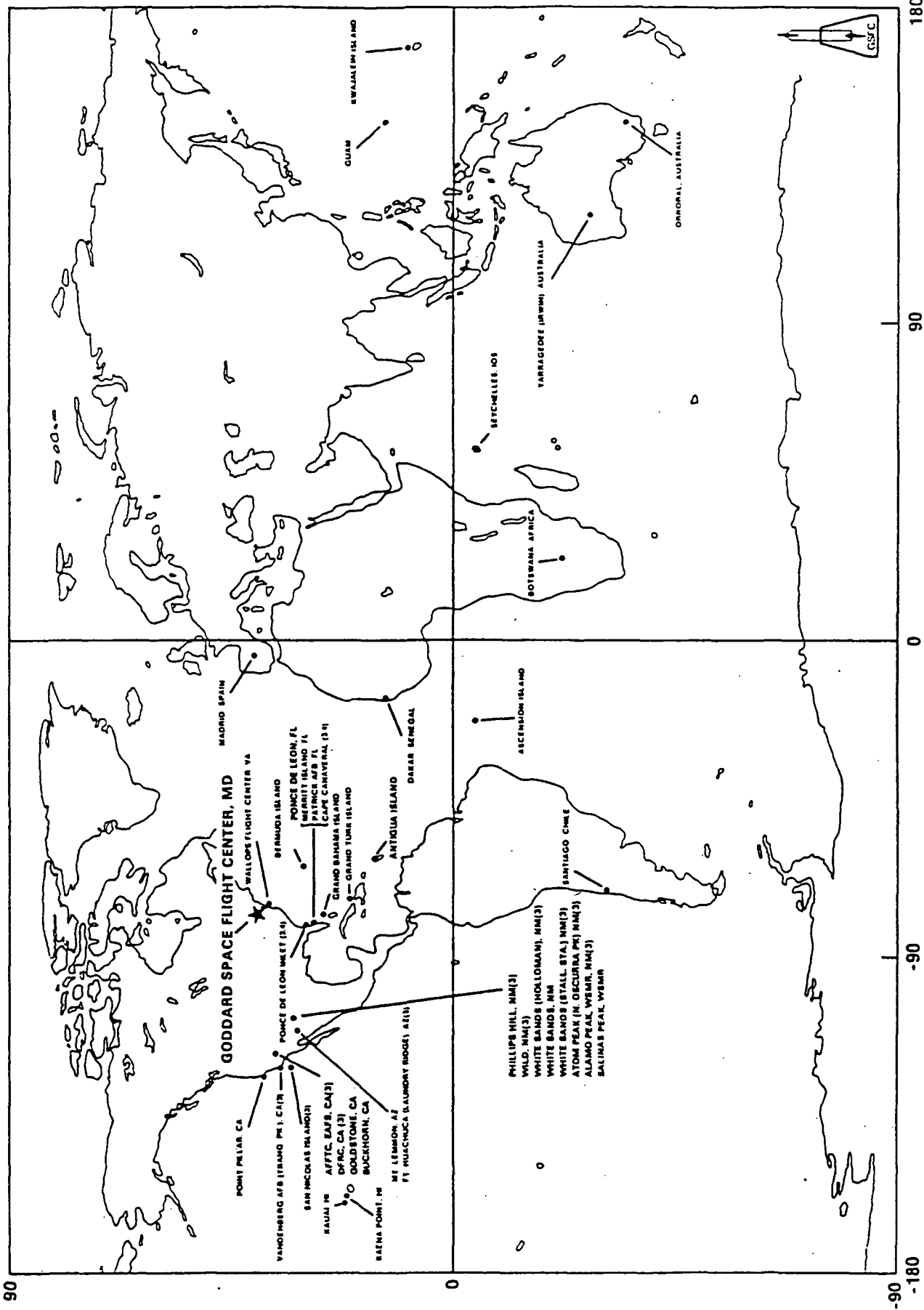
Downlink

2205 MHZ	}	TELEMETRY
2217 MHZ		
2287 MHZ		
2250 MHZ		

296.8 MHZ	UHF A/G
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259.4 MHZ	VOICE
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SPACEFLIGHT TRACKING AND DATA NETWORK (STDN)

SHUTTLE STANDARD OFT MENU

Day 1\*, 5    Day 2, 6    Day 3, 7

Day 4

Meal A				
Peaches	(T) Applesauce	(T) Dried Peaches	(IM) Dried Apricots	(IM)
Beef Pattie	(R) Dried Beef	(NF) Sausage	(R) Breakfast Roll	(I)(NF)
Scrambled Eggs	(R) Granola	(R) Scrambled Eggs	(R) Granola w/Blueberries	(R)
Bran Flakes	(R) Breakfast Roll(I)	(NF) Cornflakes	(R) Vanilla Inst.Brkfst.	(B)
Cocoa	(B) Choc.Inst. Brkfst.	(B) Cocoa	(B) Grapefruit Drink	(B)
Orange Drink	(B) Orange-Grapefruit Drink	(B) Orange-Pineapple Drink		

Meal B				
Frankfurters	(T) Corned Beef	(T)(I) Ham	(T) Ground Beef w/Pickle Sauce	(T)
Turkey Tetrazzini	(R) Asparagus	(R) Cheese Spread	(T) Noodles & Chicken	(R)
Bread (2X)(I)	(NF) Bread (2X)	(I)(NF) Bread (2X)	(I)(NF) Stewed Tomatoes	(T)
Bananas	(FD) Pears	(T) Gr.Beans & Broccoli	(R) Pears	(FD)
Almond Crunch Bar	(NF) Peanuts	(NF) Crushed Pineapple	(T) Almonds	(NF)
Apple Drink (2X)	(B) Lemonade (2X)	(B) Shortbread Cookies	(NF) Strawberry Drink	(B)
		Cashews		
		Tea w/Lemon & Sugar (2X)		

Meal C				
Shrimp Cocktail	(R) Beef w/BBQ Sauce	(T) Cr. Mushroom Soup	(R) Tuna	(T)
Beef Steak(T)	(I) Cauliflower w/Cheese	(R) Smoked Turkey	(IM) Macaroni & Cheese	(R)
Rice Pilaf	(R) Gr.Beans w/Mushrooms	(R) Mixed Italian Veg.	(R) Peas w/Butter Sauce	(R)
Broccoli au Gratin	(R) Lemon Pudding	(T) Vanilla Pudding	(R) Peach Ambrosia	(R)
Fruit Cocktail	(T) Pecan Cookies	(NF) Strawberries	(R) Chocolate Pudding	(T)
Butterscotch Pud.	(T) Cocoa	(B) Tropical Punch	(B) Lemonade	(B)
Grape Drink	(B)			

NOTE: \*Day 1 (launch day) consists of Meal B and C only.

Abbreviations

T - Thermostabilized	I - Irradiated
IM - Intermediate Moisture	FD - Freeze Dried
R - Rehydratable	NF - Natural Form
B - Beverage (Rehydratable)	X - Serving

BIOGRAPHICAL DATA

NAME: Thomas K. Mattingly II (Captain, USN). STS-4 Commander,  
NASA Astronaut

BIRTHPLACE AND DATE: Born in Chicago, Ill., March 17, 1936. His  
parents, Mr. and Mrs. Thomas K. Mattingly, now reside in  
Hialeah, Fla.

PHYSICAL DESCRIPTION: Brown hair; blue eyes; height: 5 feet 10  
inches; weight: 140 pounds.

EDUCATION: Attended Florida elementary and secondary schools and  
is a graduate of Miami Edison High School, Fla.; received  
a bachelor of science degree in Aeronautical Engineering  
from Auburn University in 1958.

MARITAL STATUS: Single.

CHILDREN: Thomas K. III, May 13, 1972.

ORGANIZATIONS: Associate Fellow, American Institute of Aero-  
nautics and Astronautics; Fellow, American Astronautical  
Society; and member, Society of Experimental Test Pilots,  
and the U.S. Naval Institute.

SPECIAL HONORS: Presented the NASA Distinguished Service Medal,  
the JSC Certificate of Commendation (1970), the JSC Group  
Achievement Award (1972), the Navy Distinguished Service  
Medal and Navy Astronaut Wings, the Society of Experimen-  
tal Test Pilots Iven C. Kincheloe Award (1972), the Delta  
Tau Delta Achievement Award (1972), the Auburn Alumni  
Engineers Council Outstanding Achievement Award (1972),  
the AAS Flight Achievement Award for 1972, the AIAA Haley  
Astronautics Award for 1973, and the Federation Aero-  
nautique Internationale V. M. Komarov Diploma in 1973.

EXPERIENCE: Prior to reporting for duty at the Lyndon B. Johnson  
Space Center, he was a student at the Air Force Aerospace  
Research Pilot School.

Mattingly began his Naval career as an ensign in 1958 and  
received his wings in 1960. He was then assigned to VA-35  
and flew AlH aircraft aboard the USS Saratoga from 1960 to  
1963. In July 1963, he served in VAH-11 deployed aboard  
the USS Franklin D. Roosevelt where he flew the A3B,  
aircraft for two years.

He has logged 6,300 hours of flight time -- 4,130 hours in  
jet aircraft.

**NASA EXPERIENCE:** Mattingly is one of 19 astronauts selected by NASA in April 1966. He served as a member of the astronaut support crews for the Apollo 8 and 11 missions and was the astronaut representative in development and testing of the Apollo spacesuit and backpack (EMU).

He was designated command module pilot for the Apollo 13 flight but was removed from flight status 72 hours prior to the scheduled launch due to exposure to the German measles.

Mattingly subsequently served as command module pilot of Apollo 16, April 16-27, 1972. He was accompanied on the fifth manned lunar landing mission by John W. Young (spacecraft commander) and Charles M. Duke, Jr., (lunar module pilot). The mission assigned to Apollo 16 was to collect samples from the lunar highlands at a location near the crater Descartes. While in lunar orbit the scientific instruments aboard the command and service module "Casper" extended the photographic and geochemical mapping of a belt around the lunar equator. Twenty-six separate scientific experiments were conducted both in lunar orbit and during cislunar coast. Major emphasis was placed on using man as an orbital observer capitalizing on the human eye's unique capabilities and man's inherent curiosity. Although the mission of Apollo 16 was terminated one day early, due to concern over several spacecraft malfunctions, all major objectives were accomplished through the efforts of the mission support team and made possible by the most rigorous preflight planning associated with an Apollo mission.

Mattingly has logged 265 hours and 51 minutes in space--1 hour and 13 minutes of which were spent in extravehicular activity (EVA).

Mattingly worked as head of astronaut office support to the Space Transportation System program from January 1973 to March 1978. He was next assigned as technical assistant for flight test to the manager of the Orbital Flight Test Program. From December 1979 to April 1981, he headed the astronaut office ascent/entry group. He subsequently served as backup commander for STS-2 and STS-3, Columbia's second and third orbital test flights.

**CURRENT ASSIGNMENT:** Mattingly is commander for STS-4, the fourth flight of the Shuttle orbiter Columbia.

NAME: Henry W. Hartsfield Jr., STS-4 Pilot  
NASA Astronaut

BIRTHPLACE AND DATE: Born in Birmingham, Ala., on Nov. 21, 1933. His mother, Mrs. Norma Hartsfield, resides in Birmingham, Ala.

PHYSICAL DESCRIPTION: Brown hair; hazel eyes; height: 5 feet 10 inches; weight: 165 pounds.

EDUCATION: Graduated from West End High School, Birmingham, Ala.; received a bachelor's degree in physics at Auburn University in 1954; did graduate work in physics at Duke University and in astronautics at the Air Force Institute of Technology; and received a master's degree in engineering science from the University of Tennessee in 1971.

MARITAL STATUS: Married to the former Judy Frances Massey of Princeton, N.C. Her mother, Mrs. Marguerite Hales, resides in Goldsboro, N.C.

CHILDREN: Two daughters: Judy Lynn, May 29, 1958; Keely Warren, May 14, 1959.

SPECIAL HONORS: Awarded the Air Force Meritorious Service Medal; the General Thomas D. White Space Trophy for 1973 (1974).

EXPERIENCE: Hartsfield received his commission through the Reserve Officer Training Program (ROTC) at Auburn University. He entered the Air Force in 1955, and his assignments have included a tour with the 53rd Tactical Fighter Squadron in Bitburg, Germany. He is also a graduate of the USAF Test Pilot School at Edwards Air Force Base, Calif., and was an instructor there prior to his assignment in 1966 to the USAF Manned Orbiting Laboratory (MOL) Program as an astronaut. After cancellation of the Air Force program in June 1969, he was reassigned to NASA.

He has logged over 5,500 hours flying time--of which more than 4,900 hours are in the following jet aircraft: F-86, F-100, F-104, F-105, F-106, T-33, and T-38.

NASA EXPERIENCE: Hartsfield became a NASA astronaut in September 1969. He was a member of the astronaut support crew for Apollo 16 and served as a member of the astronaut support crew for the Skylab 2, 3 and 4 missions.

Hartsfield retired in August 1977 from the United States Air Force with more than 22 years of active service but continues his assignment as a NASA astronaut in a civilian capacity. He was a member of the orbital 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 interfaces.

Hartsfield served as backup pilot for STS-2 and STS-3, Columbia's second and third orbital flight tests.

**CURRENT ASSIGNMENT:** Hartsfield is pilot for STS-4, the fourth flight of the Space Shuttle Orbiter Columbia.

SPACE SHUTTLE PROGRAM MANAGEMENT

NASA Headquarters

James M. Beggs	Administrator
Dr. Hans Mark	Deputy Administrator
Maj. General J.A. Abrahamson	Associate Administrator for Space Transportation Systems
L. Michael Weeks	Deputy Associate Administrator for Space Transportation Systems
Joe H. Engle	Deputy Associate Administrator for Space Flight
David R. Braunstein	Deputy Associate Administrator for Space Transportation Systems (Management)
Walter F. Dankoff	Director, Engine Programs
Edward P. Andrews	Director, Ground Systems and Flight Test
Frank Van Rensselear	Director, Upper Stages
Jerry J. Fitts	Director, Solid Rocket Booster and External Tank
Robert E. Smylie	Associate Administrator for Space Tracking and Data Systems

Johnson Space Center

Christopher C. Kraft Jr.	Director
Henry E. Clements	Associate Director
Clifford E. Charlesworth	Deputy Director
Glynn S. Lunney	Manager, Space Shuttle Program
Aaron Cohen	Manager, Space Shuttle Orbiter Project Office
George W. S. Abbey	Director of Flight Operations
Robert O. Piland	Director of Engineering and Development
Lynwood C. Dunseith	Director of Data Systems and Analysis

Kennedy Space Center

Richard G. Smith	Director
Dr. Robert H. Gray	Manager, Shuttle Projects Office
John J. Neilon	Manager, Cargo Projects
George F. Page	Director, Shuttle Operations
Alfred D. O'Hara	Director, STS Processing
Thomas S. Walton	Manager, Cargo Operations

Marshall Space Flight Center

Dr. William R. Lucas	Director
Thomas J. Lee	Deputy Director
Robert E. Lindstrom	Manager, MSFC Shuttle Project Office
James E. Kingsbury	Director, Science and Engineering Directorate
James B. Odom	Manager, External Tank Project
George B. Hardy	Manager, Solid Rocket Booster Project
James M. Sisson	Manager, Engineering and Major Test Management Office
Judson A. Lovingood	Acting Manager, Space Shuttle Main Engine Project

Dryden Flight Research Facility

John A. Manke	Facility Manager
Gary Layton	Shuttle Project Manager

Goddard Space Flight Center

Dr. Noel Hinners	Director
Richard S. Sade	Director of Networks Directorate Space Tracking and Data Network



Goddard Center (cont'd)

Walter LaFleur

Deputy Director of Networks  
Directorate (STDN)

William B. Dickinson

Division Chief, NASA  
Communications Network

Donald D. Wilson

Assistant Chief, NASA  
Communications Network

Daniel Spintman

Chief, Network Operations  
Division

James M. Stevens

Shuttle Network Support Manager

ABBREVIATIONS/ACRONYMS

AA	Accelerometer Assembly, Angular Accelerometer
A/A	Air-to-Air
ACCEL	Accelerometer
ACCU	Audio Center Control Unit
ACIP	Aerodynamic Coefficients Identification Package
ACN	Ascension Island (STDN site)
ADI	Attitude Directional Indicator
AGO	Santiago, Chile (STDN site)
ANG	Angle
ANT	Antenna
AOA	Abort Once Around
AOS	Acquisition of Signal
APU	Auxiliary Power Unit
ATO	Abort to Orbit
AUD	Audio
AUTO	Automatic
BDA	Bermuda Island (STDN site)
BOT	Botswana (STDN site)
BRT	Bright
BUC	Buckhorn, Calif. (STDN site)
CAL	Calibration
CAMR	Camera
CCTV	Close Circuit Television
CCU	Crewman Communications Umbilical
CDR	Commander
CNSL	Console

CNTRLR	Controller
C/O	Checkout
COAS	Crewman Optical Alignment Sight
CONT	Continuous
CRT	Cathode Ray Tube
CTR	Center
C/W	Caution and Warning
DAP	Digital Auto Pilot
DB	Deadband
DFI	Development Flight Instrumentation
DISC	Discrete
DKR	Dakar, Senegal (STDN site)
DTO	Detailed Test Objective
ECLS	Environmental Control Life Support
EDW	Edwards AFB, Calif. (Deorb OPT site)
EES	Emergency Ejection Suits
EET	Entry Elapsed Time
EI	Entry/Interface
ET	External Tank
FCS	Flight Control System
FDF	Flight Data File
FM	Frequency Modulation
FRD	Flight Requirements Document
FSO	Functional Supplementary Objective
FTO	Functional Test Objective
GDS	Goldstone, Calif. (STDN site, 1st antenna)
GDX	Goldstone, Calif. (STDN site, 2nd antenna)

GLRSHLD	Glareshield
GMT	Greenwich Mean Time
GNC	Guidance Navigation and Control
GPC	General Purpose Computer
GWM	Guam Island, U.S. (STDN site)
H2	Hawaii (Kauai, STDN site)
HIC	Hickam AFB, Hawaii (Deorb OPT site)
HTR	Heater
IECM	Induced Environmental Contamination Monitor
IMU	Inertial Measurement Unit
INRTL	Inertial
IOS	Indian Ocean (STDN site)
ITS	Interim Teleprinter System
KAD	Kadena AB, Ryuku Islands (Deorb OPT site)
KSC	Kennedy Space Center, Fla. (Deorb OPT site)
L	Left
LH2	Liquid Hydrogen
LON	Longitude
LOS	Loss of Signal
LOX	Liquid Oxygen
LTG	Lighting
LVLH	Local Vertical Local Horizontal
MAD	Madrid, Spain (STDN site, 1st antenna)
MAN	Manual
MAX	Madrid, Spain (STDN site, 2nd antenna)
MECO	Main Engine Cutoff
MET	Mission Elapsed Time

MIL	Merritt Island, Fla. (STDN site, 1st antenna)
MLX	Merritt Island, Fla. (STDN site, 2nd antenna)
MNVR	Maneuver
NOR	Northrup FLT Strip, N.M. (Deorb OPT site)
NOZ	Nozzle
O2	Oxygen
OFI	Operational Flight Instrumentation
OI	Operational Instrumentation
OMS	Orbital Maneuvering System
OPR	Operator
OPS	Operations, Operational Sequence
ORB	Orbiter
ORR	Orroral Valley, Australia (STDN site)
OVHD	Overhead
PA	Power Amplifier
PCM	Pulse-Code Modulation
PL	Payload
PLBD	Payload Bay Doors
PLT	Pilot
PM	Phase Modulation
PMC	Private Medical Communication
PNL	Panel
POS	Position
PRO	Proceed
PTC	Passive Thermal Control
PWR	Power
QTY	Quantity

QUI Quito, Ecuador (STDN site)  
R Right  
RCDR Recorder  
RCS Reaction Control System  
REF Reference  
REFSMMAT Reference Stable Member Matrix  
RELMAT Relative Matrix  
RGA Rate Gyro Assembly  
ROS Regulated Oxygen System  
ROT Rota, Spain (Deorb OPT site), Rotation  
RT Rotation Discrete Rate  
SAA South Atlantic Anomaly  
SEL Select  
SEP Separation  
SGLS Space Ground Link System  
SPKR Speaker  
SPLY Supply  
STBY Standby  
SV State Vector  
SYS Systems  
TB Talkback  
TDRS Tracking and Data Relay Satellite  
TK Tank  
T/L Timeline  
TRKR Tracker  
TUL Tula Peak, N.M. (STDN site)  
TV Television

UHF	Ultra High Frequency
VAC	Vacuum
VLV	Valve
VTR	Video Tape Recorder
WCS	Waste Collection System
WIN	Irwin, Australia (STDN site)
WMC	Waste Management Compartment
XFER	Transfer
X-POP	X Body Axis Perpendicular to Orbit Plane
Y-POP	Y Body Axis Perpendicular to Orbit Plane
-ZLV	-Z Local Vertical (-Z Body Axis Towards Earth)

-end-