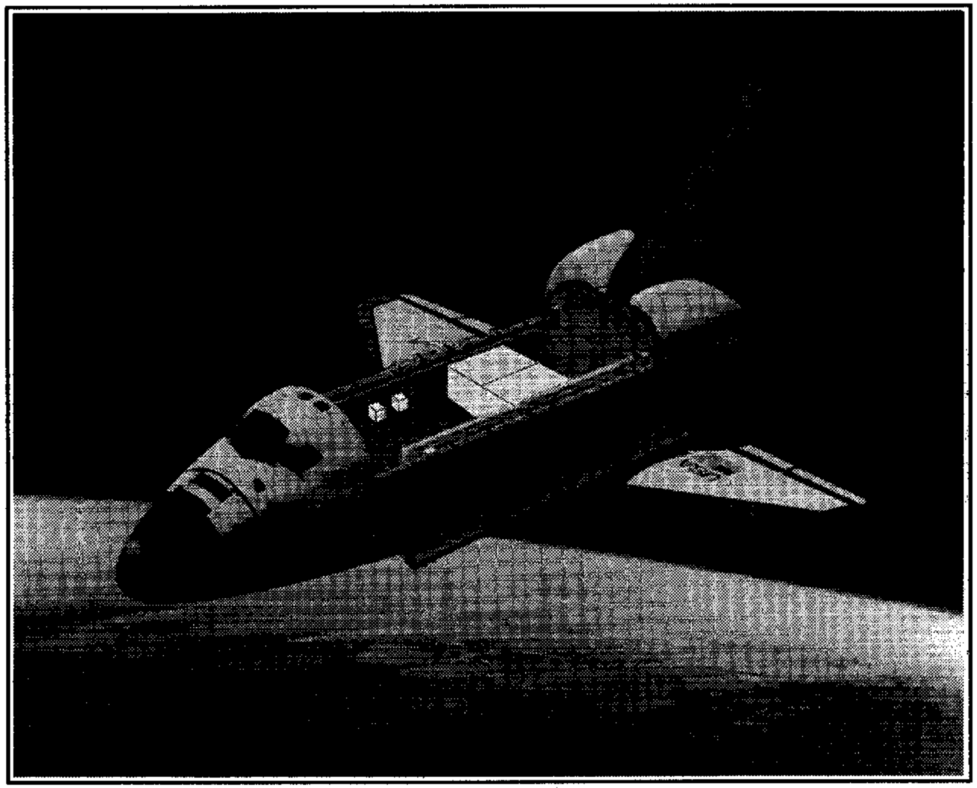

STS-53

PRESS INFORMATION

December 1992

Rockwell International
Space Systems Division

Office of External Communications &
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CONTENTS

MISSION OVERVIEW

This is the 15th flight of Discovery and the 52nd for the space shuttle.

The flight crew for the seven-day STS-53 mission is commander David (Dave) M. Walker; pilot Robert (Bob) D. Cabana; and mission specialists Guion (Guy) S. Bluford, James (Jim) S. Voss, and Michael Richard (Rich) U. Clifford.

STS-53 is the ninth dedicated Department of Defense mission of the shuttle program. Its primary objective is to successfully deploy the Department of Defense 1 satellite, the last major classified military payload currently planned for the shuttle fleet. The all-military STS-53 crew includes personnel from the Army, Navy, Air Force, and Marine Corps.

The classified DOD-1 cargo element consists of a deployable spacecraft and associated airborne support equipment, which contains the spacecraft's deployment system. DOD-1 is scheduled to be deployed into a 57-degree trajectory, 200-nautical-mile circular orbit on orbit 5 at a mission elapsed time of six hours and nine minutes.

STS-53 secondary objectives include the Glow Experiment/Cryogenic Heat Pipe Experiment Payload (GCP); Hand-held, Earth-oriented, Real-time, Cooperative, User-friendly, Location-targeting, and Environmental System (HERCULES); Space Tissue Loss (STL); Battlefield Laser Acquisition Sensor Test (BLAST); Radiation Monitoring Equipment (RME) III; Visual Function Tester (VFT) 2; Microencapsulation in Space (MIS) 1; Cloud Logic To Optimize Use of Defense Systems (CLOUDS) 1A; Cosmic Radiation Effects and Activation Monitor (CREAM); Fluid Acquisition and Resupply Equipment (FARE); and Orbital Debris Radar Calibration System (ODERACS).

GCP is a two-part experiment. GLO, the Phillips Laboratory Geophysics Directorate's shuttle glow experiment, contains an extreme ultraviolet imager and spectrograph for recording shuttle/environment interaction measurements in the 115- to 1,150-nanometer spectral range. The sensors will observe orbiter atomic oxygen surface glow (as seen on the shuttle's tail and other surfaces facing in the direction of travel), contaminating events, and air glow. The CRYOHP, sponsored by Wright Aeronautical Laboratories, will measure the zero-gravity performance of two liquid oxygen heat pipes and contains mechanical cryo coolers enclosed in a vented hitchhiker canister. CRYOHP has uses in cooling infrared sensors in space. The GCP payload is mounted on the starboard side of Discovery's payload bay using getaway special-type attach fittings and two adapter beams.

HERCULES is a Naval Research Laboratory-sponsored middeck payload that will enable the space shuttle crew members to point an electronic still camera at a feature on Earth, record the image, and automatically determine, in real time, the latitude and longitude of the ground target to within one nautical mile. HERCULES is designed to provide a valuable Earth observation system for military, environmental, oceanographic, and meteorological applications. The hardware configuration consists of a playback/downlink unit (PDU), electronic still camera (ESC) and ESC electronics box, the HERCULES attitude processor (HAP), and the HERCULES inertial measurement unit (HIMU). Configuration B, which allows data to be viewed and downlinked, will be flown on STS-53.

STL, sponsored by the Walter Reed Army Institute of Research in conjunction with NASA's Life Sciences Division, is a middeck experiment that will study the effects of weightlessness on bone tissue, muscles, and blood. The data will be used to improve the recovery of soldiers whose injuries require lengthy bed rest. Drugs to prevent tissue loss will be tested to determine their effectiveness.

Configuration A will be flown on STS-53. The experiment operates continuously from before launch through landing.

BLAST's objective is to evaluate the concept of using a space-borne laser receiver to detect laser energy and to provide a laser communication uplink for transmitting Global Positioning System information from specific ground-based test locations. The BLAST receiver is mounted in the crew compartment starboard window. The hardware configuration consists of the system optical head assembly (SOHA), system electronics assembly (SEA), orbiter CCTV video interface unit (VIU/C), and a payload general-support computer (PGSC). Configuration B will be flown on STS-53. BLAST is jointly sponsored by the Army Space Command, Army Space Technology Research Office, and Night Vision Electro-Optics Directorate project.

RME-III is a joint NASA/Armstrong Laboratory experiment that will measure ionizing radiation levels at different locations in the orbiter crew compartment to update and refine models of the space radiation environment in low Earth orbit. It consists of a hand-held radiation monitor, a pocket REM meter, and two solid-state recorders. The equipment contains a liquid crystal display for real-time data display and a keyboard for controlling its functions. Four 55-minute data takes are required. Only five minutes of crew-attended activity is required.

VFT-2 is an Air Force Armstrong Laboratory middeck experiment that will study the effects of weightlessness on human vision to determine if change in vision occurs in space and, if so, whether the changes are clinically significant and how quickly the individual recovers. The crew will look into a hand-held, battery-powered device that will measure the sensitivity of the eye to image contrast changes.

The objective of MIS-1, sponsored by the U.S. Army Medical Research and Development Command's Institute of Dental Research and the U.S. Army Laboratory Command, is to demonstrate the feasibility of producing timed-release antibiotic pharmaceutical microcapsules in microgravity. Scientists have reason to believe that microcapsules produced in space will have uniformity and timed-release properties vastly superior to those made on Earth. Ampicillin anhydrate will be the drug microencapsulated in space. The system consists of hardening chambers, a delivery system for the polymer/drug solution, ultrasonic spray nozzles with power supply, electric field generators, a video recorder, and a control module. The experiment will be mounted on a double adapter plate and housed in the orbiter middeck.

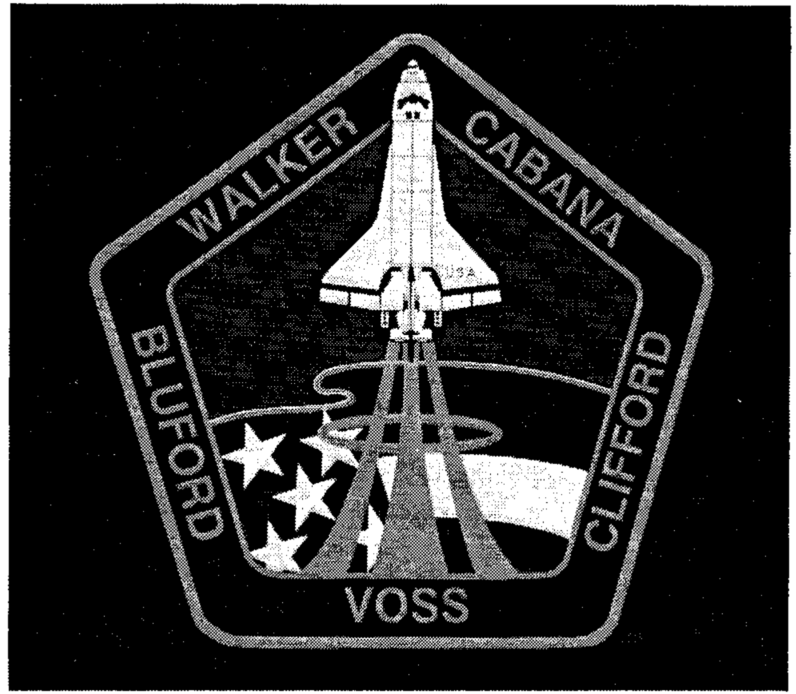
CLOUDS-1A is a DOD-sponsored middeck payload that will quantify variations in apparent cloud cover as a function of the angle at which clouds of various types are viewed and will develop meteorological observation models for various cloud formations. The data will be stored in a high-resolution data base for use by the meteorological community and various Defense Meteorological Satellite Program initiatives in developing and evaluating future electro-optical sensors for DOD systems through the generation of standard scenes for model evaluation and the study of high-incidence-angle effects. The payload consists of a 35mm camera assembled with a battery-powered motor drive, data recording system, 105mm lens, and infrared filter.

CREAM is designed to measure cosmic ray energy loss spectra, neutron fluxes, and induced radioactivity as a function of time and location within the orbiter. CREAM occupies half of a middeck locker and includes active and passive monitors placed at specific locations throughout the orbiter's crew compartment. CREAM is sponsored by the Department of Defense.

FARE, sponsored by NASA, will investigate the filling, refilling, and emptying of simulated propellant tanks and the behavior of liquid motion in a low-gravity environment. The FARE configuration consists of a spherical receiver tank, a spherical supply tank, a pressurization system, a vent system, structure and adapter plates, lights, a ballast assembly (power control box), a flowmeter, a fire hazard blanket, and airborne support equipment. The tanks are made of clear acrylic plastic to enable video recording of the fluid's behavior. The test fluid is treated water. This middeck payload will be operated manually and uses hardware from the Storage Fluid Management Demonstration experiment flown on STS 51-C in January 1985.

NASA Johnson Space Center's ODERACS payload will eject six spheres ranging in size from 2 to 6 inches in diameter from Discovery's payload bay to test ground-based capability to detect potentially dangerous debris in low Earth orbit. The spheres will be observed, tracked, and recorded by ground-based radars and optical telescopes, enabling end-to-end calibration of radar imaging facilities and data analysis systems. In addition, the radar signatures of the spheres will be compared to signatures detected from current orbital debris. ODERACS is contained in a getaway special canister mounted on an adapter beam in Discovery's payload bay. It will be deployed on orbit 31.

STS-53 marks Discovery's return to flight following a six-month orbiter maintenance down period at NASA's Kennedy Space Center, Fla. Discovery underwent structural inspections, servicing of its Freon service loop, installation of a drag chute identical to those already installed on Columbia and Endeavour, and nearly 80 other avionics, subsystems, and structures/thermal protection system upgrades to improve its performance. The changes were designed to maintain Discovery's structural integrity, keep the fleet uniform and technologically up-to-date, and enhance vehicle turnaround time. Among the significant upgrades during the down period were an improved nose wheel steering system, middeck accommodations rack, middeck utility panel, repackaged galley,



STS-53 Crew Insignia

improved main landing gear tires, redundant weight-on-wheels sensing, improved auxiliary power units, a tire pressure decay monitoring system, various thermal protection system improvements, and structural modifications to improve wing strength.

Thirteen detailed test objectives and 12 detailed supplementary objectives are scheduled to be flown on STS-53.

MISSION STATISTICS

Vehicle: Discovery (OV-103), 15th flight

Launch Date/Time:

12/2/92	6:59 a.m., EST
	5:59 a.m., CST
	3:59 a.m., PST

Launch Site: Kennedy Space Center (KSC), Fla.—Launch Pad 39A

Launch Window: 2-1/2 hours (crew-on-back constraint)

Mission Duration: 7 days, 5 hours, 54 minutes

Landing: Nominal end-of-mission landing on orbit 115

12/9/92	12:53 p.m., EST
	11:53 a.m., CST
	9:53 a.m., PST

Runway: Nominal end-of-mission landing on concrete runway 15, Kennedy Space Center (KSC), Fla. Weather alternates are Edwards Air Force Base (EAFB), Calif., and Northrup Strip (NOR), White Sands, N.M.

Transatlantic Abort Landing: Zaragoza, Spain; alternates: Moron, Spain; Ben Guerir, Morocco

Return to Launch Site: KSC

Abort-Once-Around: EAFB; alternates: KSC, NOR

Inclination: 57 degrees

Ascent: The ascent profile for this mission is a direct insertion. Only one orbital maneuvering system thrusting maneuver, referred to as OMS-2, is used to achieve insertion into orbit. This direct-insertion profile lofts the trajectory to provide the earliest opportunity for orbit in the event of a problem with a space shuttle main engine.

The OMS-1 thrusting maneuver after main engine cutoff plus approximately two minutes is eliminated in this direct-insertion ascent profile. The OMS-1 thrusting maneuver is replaced by a 5-foot-per-second reaction control system maneuver to facilitate the main propulsion system propellant dump.

Altitude: 200 nautical miles (230 statute miles) circular orbit (DOD-1 deployment), then 175 nautical miles (202 statute miles) circular orbit (ODERACS deployment)

Space Shuttle Main Engine Thrust Level During Ascent: 104 percent

Space Shuttle Main Engine Locations:

No. 1 position: Engine 2024
No. 2 position: Engine 2012
No. 3 position: Engine 2017

External Tank: ET-49

Solid Rocket Boosters: BI-055

Editor's note: The following weight data are current as of November 11, 1992.

Total Lift-off Weight: Approximately 4,506,642 pounds

Orbiter Weight, Including Cargo, at Lift-off: Approximately 243,952 pounds

Orbiter (Discovery) Empty and 3 SSMEs: Approximately 173,597 pounds

Payload Weight Up: Approximately 26,166 pounds

Payload Weight Down: Approximately 5,151 pounds

Orbiter Weight at Landing: Approximately 193,215 pounds

Payloads—Payload Bay (*denotes primary payload): Department of Defense (DOD) 1*, Glow Experiment/Cryogenic Heat Pipe Experiment Payload (GCP), Orbital Debris Radar Calibration System (ODERACS)

Payloads—Middeck: Battlefield Laser Acquisition Sensor Test (BLAST); Cloud Logic To Optimize Use of Defense Systems (CLOUDS) 1A; Cosmic Radiation Effects and Activation Monitor (CREAM); Fluid Acquisition and Resupply Equipment (FARE); Hand-held, Earth-oriented, Real-time, Cooperative, User-friendly, Location-targeting, and Environmental System (HERCULES); Microencapsulation in Space (MIS) 1; Radiation Monitoring Equipment (RME) III; Space Tissue Loss (STL); Visual Function Tester (VFT) 2

Flight Crew Members:

Commander: David M. Walker, third space shuttle flight
Pilot: Robert D. Cabana, second space shuttle flight
Mission Specialist 1: Guion S. Bluford, fourth space shuttle flight
Mission Specialist 2: James S. Voss, second space shuttle flight
Mission Specialist 3: Michael Richard (Rich) U. Clifford, first space shuttle flight

Ascent Seating:

Flight deck, front left seat, David M. Walker
Flight deck, front right seat, Robert D. Cabana
Flight deck, aft center seat, James S. Voss
Flight deck, aft right seat, Guion S. Bluford
Middeck, Michael Richard (Rich) U. Clifford

Entry Seating:

Flight deck, front left seat, David M. Walker
Flight deck, front right seat, Robert D. Cabana
Flight deck, aft center seat, James S. Voss
Flight deck, aft right seat, Michael Richard (Rich) U. Clifford
Middeck, Guion S. Bluford

Extravehicular Activity Crew Members, If Required:

Extravehicular (EV) astronaut 1: James S. Voss
EV-2: Michael Richard (Rich) U. Clifford

STS-53 Flight Directors:

Ascent, Entry: N.W. (Wayne) Hale
Orbit 1 Team: J.M. (Milt) Heflin
Orbit 2 Team/Lead: R.M. (Rob) Kelso
Planning Team: L.J. (Linda) Ham

Entry: Automatic mode until subsonic, then control stick steering

Notes:

- The remote manipulator system is not installed in Discovery's payload bay for this mission.

- The shuttle orbiter repackaged galley is installed in Discovery's middeck.

- Due to the classified nature of the DOD-1 payload, the flight control room will operate in a classified mode from launch minus five hours until DOD-1 payload operations have been completed, at which time it will be transitioned to an unclassified mode. Normal NASA Public Affairs Office commentary will be broadcast through "go for orbit operations" (MET: 0/01:36). During DOD-1 payload operations, commentary will be restricted to orbiter/crew status reports, with normal PAO commentary resuming afterwards. NASA Select coverage will be normal before the launch; however, from lift-off through completion of DOD-1 operations, only a wide-angle view of the Mission Control Center will be available. Normal NASA Select coverage will resume after the completion of the DOD-1 payload operations. Downlink of video outside the orbiter crew cabin is prohibited; downlink of video inside the crew cabin is allowed if specified precautions are taken.

MISSION OBJECTIVES

- Primary objective
  - — Department of Defense (DOD) 1 deployment
- Secondary objectives
  - — Payload bay
    - Glow Experiment/Cryogenic Heat Pipe Experiment Payload (GCP)
    - Orbital Debris Radar Calibration System (ODERACS)
  - — Middeck
    - Hand-held, Earth-oriented, Real-time, Cooperative, User-friendly, Location-targeting, and Environmental System (HERCULES)
    - Space Tissue Loss (STL)
    - Battlefield Laser Acquisition Sensor Test (BLAST)
    - Radiation Monitoring Equipment (RME) III
    - Visual Function Tester (VFT) 2
    - Cosmic Radiation Effects and Activation Monitor (CREAM)
    - Microencapsulation in Space (MIS) 1
    - Cloud Logic To Optimize Use of Defense Systems (CLOUDS) 1A
    - Fluid Acquisition and Resupply Equipment (FARE)
- 13 development test objectives/12 detailed supplementary objectives

CREW ASSIGNMENTS

Commander (David [Dave] M. Walker):

Overall mission decisions

Payload—DOD-1, VFT-2

Pilot (Robert [Bob] D. Cabana):

Payload—GCP, MIS-1

Mission Specialist 1 (Guion [Guy] S. Bluford):

Payload—DOD-1, STL-1, CLOUDS-1A

Other—Earth observations

Mission Specialist 2 (James [Jim] S. Voss):

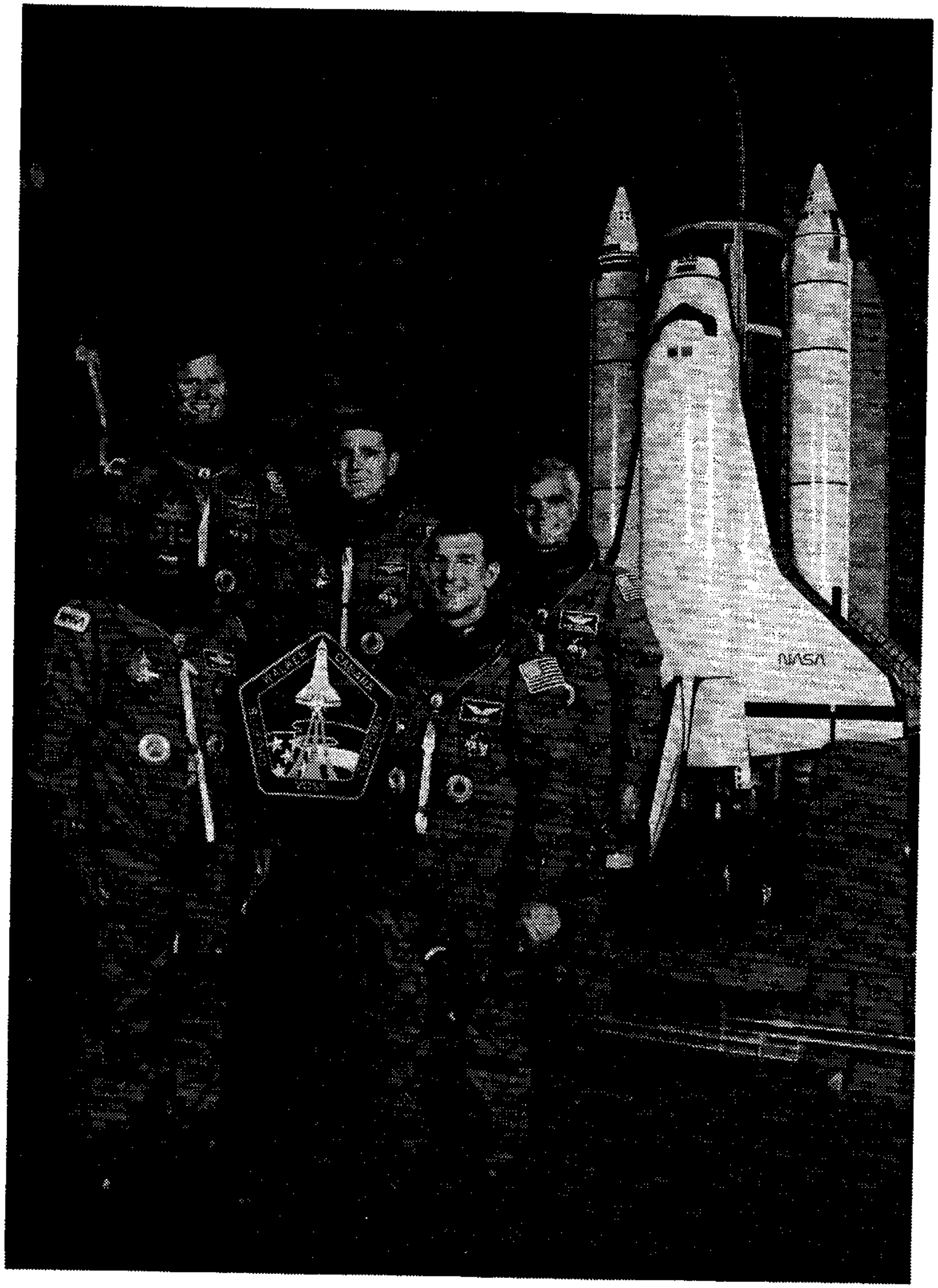
Payload—HERCULES, VFT-2

Medical DSO lead

Mission Specialist 3 (Michael Richard [Rich] U. Clifford):

Payload—FARE, BLAST, ODERACS

Other—Earth observations



STS-53 crew members are (front, left to right) Guion S. Bluford and James S. Voss, mission specialists. In the rear (left to right) are David M. Walker, mission commander; Robert D. Cabana, pilot; and Michael R.U. Clifford, mission specialist.

FLIGHT ACTIVITIES OVERVIEW

Flight Day 1

Launch
OMS-2
Unstow cabin
DOD-1 deploy (MET 0/06:09)
RCS separation burn
CREAM activation
RME activation
GCP activation

Flight Day 2

GCP operations
HERCULES operations
VFT-2 operations
BLAST operations
FARE tests 1 and 2
Orbit adjust burns (OMS-3 and -4)

Flight Day 3

ODERACS deployment
RCS separation burn
GCP/GLO tests (orbits 31-36)
HERCULES operations
FARE test 3
BLAST operations

Flight Day 4

HERCULES operations
BLAST operations
GCP/GLO tests (orbits 50-54)
FARE test 4

Flight Day 5

HERCULES operations
BLAST operations
GCP/GLO tests (orbits 65-70)
FARE tests 5, 6, and 7

Flight Day 6

HERCULES operations
BLAST operations
MIS operations
FARE test 8
GCP/GLO operations (orbits 85-87)

Flight Day 7

GCP operations
FCS checkout
RCS hot-fire test
Cabin stow

Flight Day 8

Deorbit preparation
Deorbit burn
Landing

Notes:

- Each flight day includes a number of scheduled housekeeping activities. These include inertial measurement unit alignment, supply water dumps (as required), waste water dumps (as required), fuel cell purge, Ku-band antenna cable repositioning, and a daily private medical conference.

DEVELOPMENT TEST OBJECTIVES/DETAILED SUPPLEMENTARY OBJECTIVES

DTOs

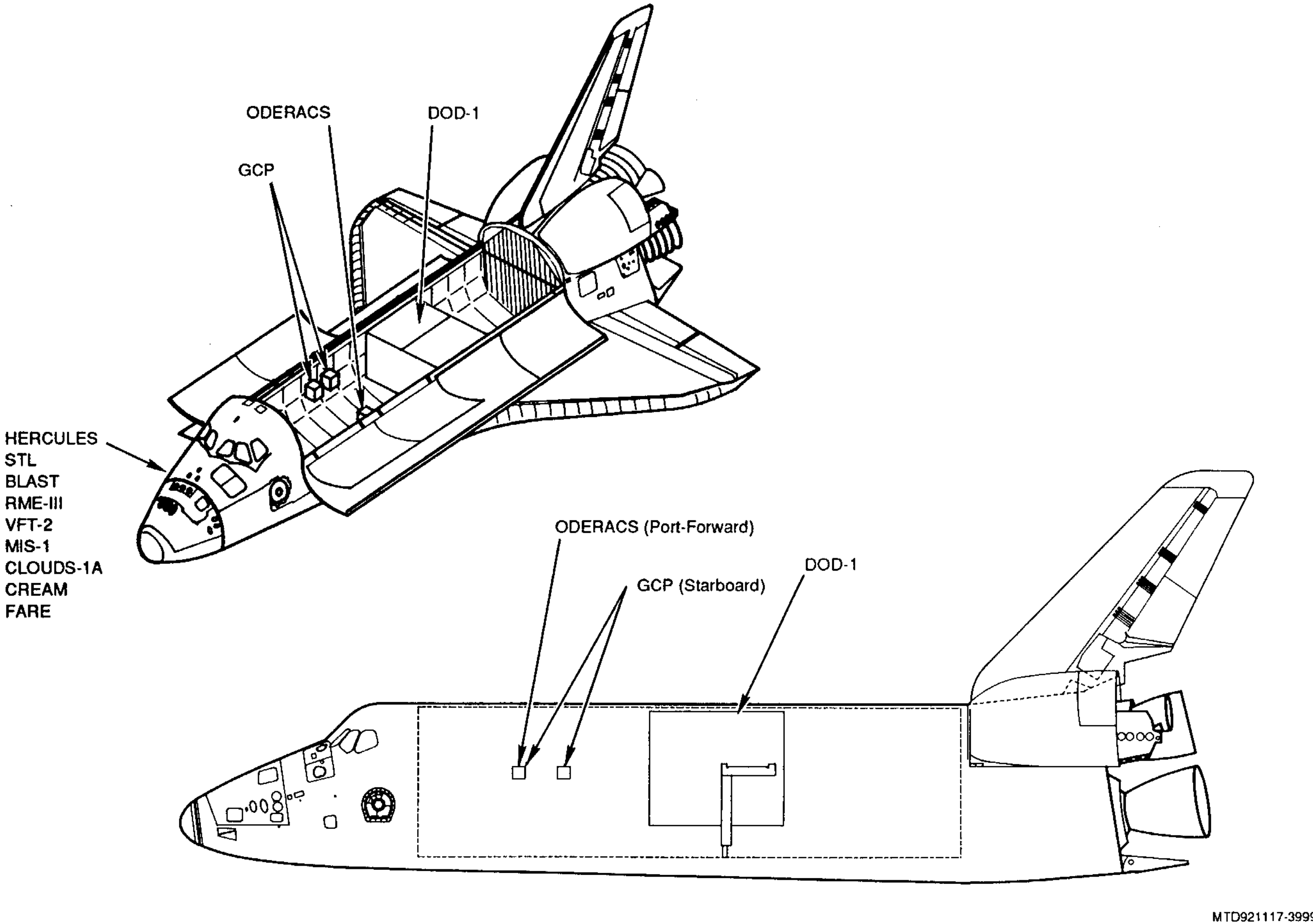
- Ascent structural capability evaluation (DTO 301D)
- Ascent compartment venting evaluation (DTO 305D)
- Descent compartment venting evaluation (DTO 306D)
- Entry structural capability evaluation (DTO 307D)
- Vibration and acoustic evaluation (DTO 308D)
- ET TPS performance (DTO 312)
- Orbiter/payload acceleration and acoustics environment data (DTO 319D)
- Edwards lakebed runway bearing strength assessment for orbiter landings (DTO 520)
- Orbiter drag chute system (DTO 521)
- Evaluation of MK I rowing machine (DTO 653)
- PGSC single-event upset monitoring (DTO 656)
- Acoustical noise dosimeter data (DTO 663)
- Crosswind landing performance (DTO 805)

DSOs

- In-flight radiation dose distribution (TEPC only) (DSO 469)
- Intraocular pressure (DSO 472*)
- Retinal photography (DSO 474*)
- Hyperosmotic fluid countermeasure (DSO 479*)
- Orthostatic function during entry, landing, and egress (DSO 603B*)
- Visual-vestibular integration as a function of adaptation (DSO 604*)
- Posture equilibrium control during landing and egress (DSO 605*)
- Effects of space flight on aerobic and anaerobic metabolism at rest and during exercise (DSO 608*)
- The effect of prolonged space flight on head and gaze stability during locomotion (DSO 614*)
- Documentary television (DSO 901)
- Documentary motion picture photography (DSO 902)
- Documentary still photography (DSO 903)

*Extended-duration orbiter buildup medical evaluation.

STS-53 PAYLOAD CONFIGURATION



DEPARTMENT OF DEFENSE 1

DOD-1 is the primary payload for STS-53 and the last major military payload scheduled to be flown aboard the shuttle. The identity and purpose of DOD-1 are classified.

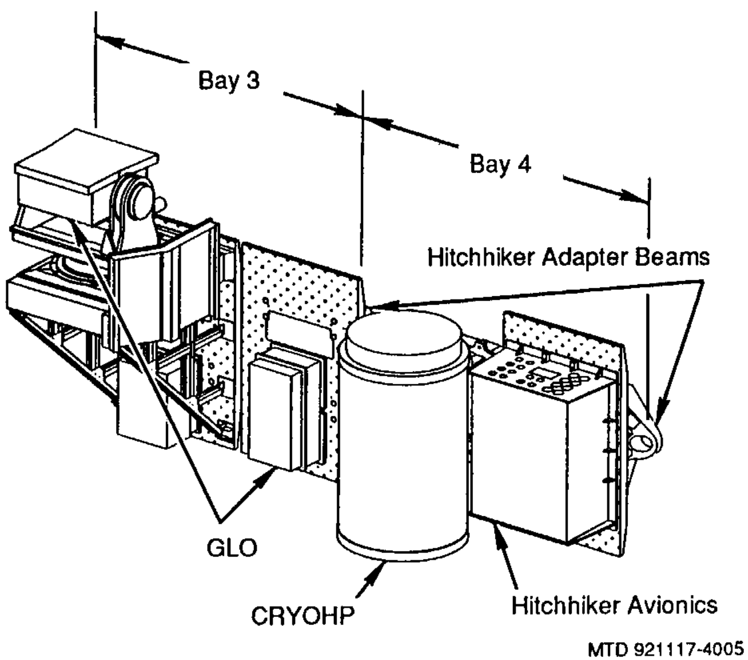
DOD-1 consists of a deployable spacecraft and associated airborne support equipment. It is launched unpowered and is activated after payload bay door operations. Three radio frequency checks will be performed between DOD-1 and remote tracking stations in England and California on orbits 2 through 4.

DOD-1 is scheduled to be deployed into a 57-degree, 200-nautical-mile circular orbit on orbit 5 at a mission elapsed time of six hours and nine minutes. An orbiter separation burn will be performed at MET 0/06:29. The DOD-1 deployment window is 20 minutes.

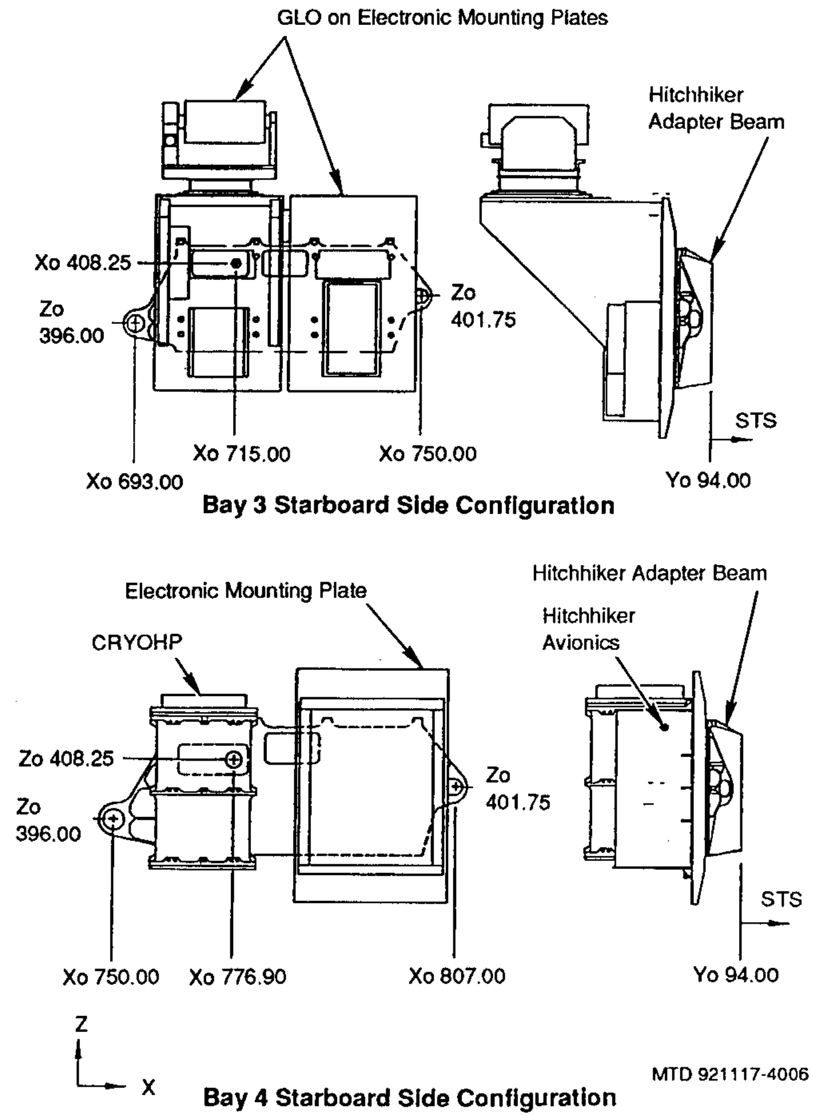
GLOW EXPERIMENT/CRYOGENIC HEAT PIPE EXPERIMENT PAYLOAD (GCP)

The experiments that comprise the GCP will investigate surface glow on the shuttle orbiter and the use of liquid oxygen heat pipes operating at very low, or cryogenic, temperatures to cool sensors, instruments, and spacecraft. The shuttle glow (GLO) and cryogenic heat pipe (CRYOHP) experiments are mounted on a "hitchhiker" carrier that is attached to the wall of the payload bay.

NASA's Hitchhiker project provides researchers with small payloads low-cost access to space. Unlike getaway special payloads, hitchhiker payloads are able to use orbiter power and the services of crew members.



GCP

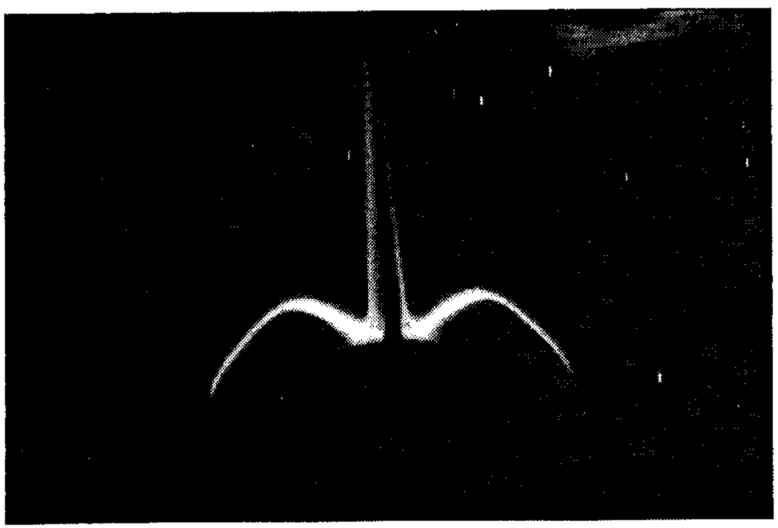


GCP Payload Configuration

GLO EXPERIMENT

Researchers will study the interaction of the shuttle's surface with the space environment as seen in such phenomena as the glow on the orbiter's tail and other surfaces. GLO experimenters will use the Arizona imaging spectrograph to photograph the orbital maneuvering system pods located near the orbiter's tail, firings of the OMS and reaction control system jets, dumps of waste water, and operations of the orbiter's flash evaporative cooler system. Spectrographs in the AIS will record images in the ultraviolet, visible, and infrared bands.

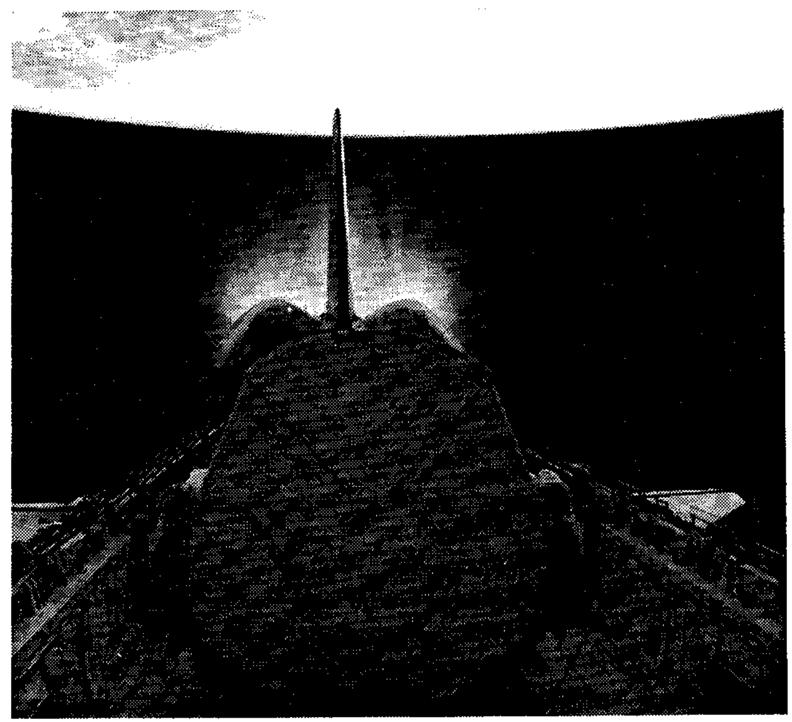
Experimenters at the Payload Operations Control Center at the Goddard Space Flight Center in Greenbelt, Md., will send commands from the ground telling the AIS what exposure time to use, how many detectors to use, etc. The crew will fire the orbiter's jets, dump waste water, and perform any other actions required for the experiment. Data from the experiment will be transmitted to the POCC for near-real-time viewing by the experimenters.



Orbiter Glow Phenomenon

GLO Imager Parameters

Imager Number	Imager Type	Wavelength Peak (hw) (nm)	Angular FOV (deg)	Photocathode
1	Narrow-UV	160 (25)	2	CsTe
2	Narrow-UV	200 (25)	2	
3	Narrow-UV	235 (25)	2	
4	Narrow-UV	260 (25)	2	
5	Wide-UV	160 (25)	25	CsTe
6	Wide-UV	200 (25)	25	
7	Wide-UV	235 (25)	25	
8	Wide-UV	260 (25)	25	
9	Medium-visible	500 (200)	5	S-20
10	Medium-visible	700 (200)	5	
11	Wide-IR	900 (400)	18	None
12	Narrow-IR	900 (400)	2	



Orbiter Jet Firings

This experiment is sponsored by the Geophysics Directorate of the Air Force's Phillips Laboratory in Albuquerque, N.M. It is being flown on this mission under the direction of the Department of Defense's Space Test Program.

CRYOHP EXPERIMENT

The purpose of this joint DOD and NASA experiment is to demonstrate the reliable start-up and operation of cryogenic heat pipes in microgravity at temperatures ranging from minus 315°F to 198°F. This advanced technology is designed to remove excess heat generated by infrared sensors, instruments, and spacecraft which could cause them to fail or return useless data.

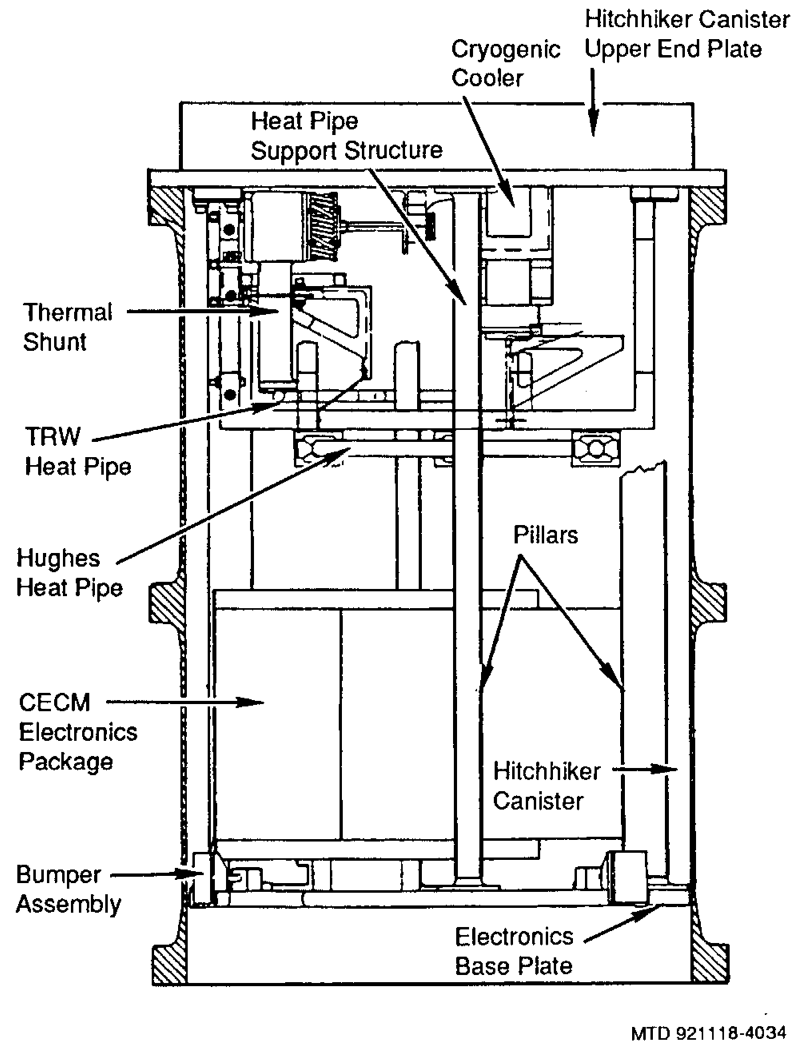
Heat pipes, which are simple but dependable devices, use evaporation and condensation to remove heat. In this experiment, waste heat evaporates supercold liquid oxygen, and the vapor condenses at the other end of the pipe, releasing the heat to space. The liquid oxygen then returns to the evaporative end to repeat the process.

This is the first time that liquid oxygen heat pipes will be operated in space. A similar experiment—the Capillary Pumped Loop Hitchhiker—was flown on STS 61-C in 1986.

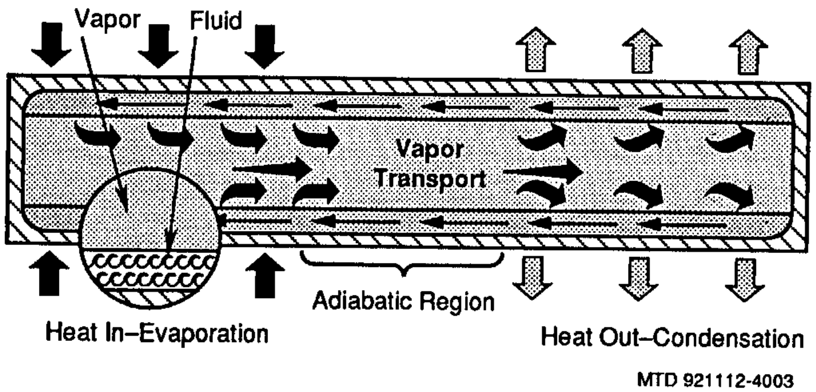
Two heat pipe designs will be tested on this mission. One of the heat pipes was made by TRW and the other was made by Hughes.

The crew will turn on the experiment, which is sealed in a getaway special canister for thermal protection, approximately eight hours after Discovery arrives on orbit. Experimenters at the POCC will command and monitor eight tests of each concept.

Mike Morgan, of the U.S. Air Force Wright Laboratory, is the principal investigator.



Cryogenic Heat Pipe Experiment



CRYOHP Flight Experiment Heat Pipe Principles

HAND-HELD, EARTH-ORIENTED, REAL-TIME, COOPERATIVE, USER-FRIENDLY, LOCATION-TARGETING, AND ENVIRONMENTAL SYSTEM (HERCULES)

HERCULES is a new device that makes it simple for shuttle crew members to take pictures of Earth: they just point and shoot any interesting feature, whose latitude and longitude are automatically determined in real time within two nautical miles. After this first flight, the camera system is scheduled to fly again on STS-56.

Astronauts Point HERCULES Camera Through Orbiter's Overhead Window To Obtain Bearings and Photograph Earth

The system components—HERCULES attitude processor (HAP); alignment, geolocation, and human interface software; and ring-laser gyro—are attached to a modified Nikon F-4 electronic still camera (ESC). To activate the system in space, a crew member points the camera, with its attached gyro, at two known stars to obtain the bearing and enters state vectors, star identifications, and commands into a portable computer connected to the HAP. Then pictures are taken in the normal way, by aiming at Earth and operating the shutter.

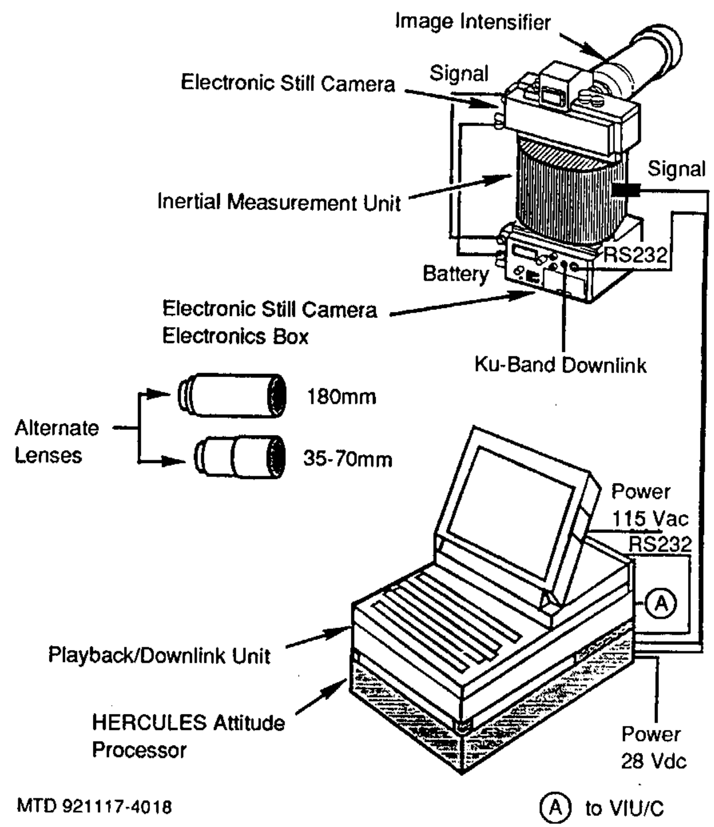
The HAP processes the data from the gyro, determines the image's absolute orientation in space, and passes this pointing information to software operating on the portable computer, which calculates the latitude and longitude. The HAP sends this geolocation information back to the camera, which appends it to the image data.

The camera system can be operated in two configurations. Configuration A allows the crew to store image and geolocation data in the ESC for postmission analysis. In configuration B, the crew can view the electronic image aboard the shuttle and downlink it to Earth through the orbiter's Ku-band communication system. Configuration B will be used on this mission.

HERCULES will greatly simplify picture-taking on board the shuttle. It is a big improvement over the previous system, which required the crew to take multiple shots of the same subject while keeping the edge of the Earth in view. With HERCULES, the crew can use any Nikon-compatible lens for daytime photography and an image intensifier at night. Even areas of the Earth that have no distinguishing topographical features can be photographed and geolocated at any magnification. Since the images are captured digitally, computers can analyze them and disseminate the data—an important improvement over the previous system.

One hundred forty cities, islands, bodies of water, mountains and volcanos, and other topographic features around the world have been selected as sites of interest. These sites include San Francisco Bay and Tokyo Bay; Long Island, N.Y., and Zanzibar; Mount Etna, Sicily, and Mt. Kilimanjaro in Tanzania, East Africa.

The Naval Research Laboratory (NRL) in Washington, D.C., developed HERCULES under a joint Navy, Army, and NASA project. Already, NRL scientists are working on future improvements for HERCULES, such as the addition of Global Positioning System hardware to enhance geolocation accuracy to less than a nautical mile and a gimbal system that would allow the camera to track points on Earth automatically.



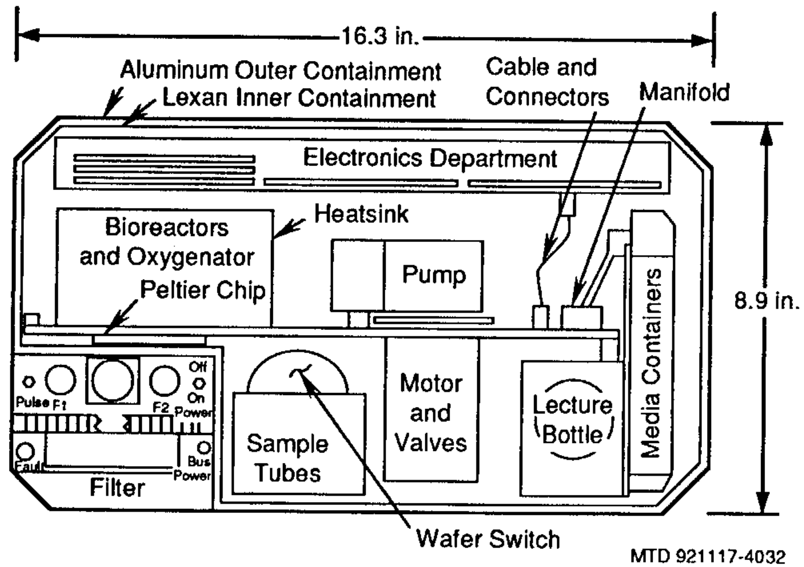
HERCULES Configuration B

When gravity is reduced or eliminated, as it is in space travel, life systems degrade at a remarkable rate. The Space Tissue Loss (STL) 1 life sciences payload will study cell growth during space flight. Specifically, STL-1 will study the response of muscle, bone, and endothelial and white blood cells to microgravity by evaluating various parameters, including shape, cytoskeleton, membrane integrity and metabolism, activity of enzymes that inactivate proteins, and the effects or change of response to various stimulants, hormones, and drugs on these parameters. STL will help scientists understand more about how white cells respond to antigens from infectious agents and tumors. It will also show how space flight can cause a tremendous loss of calcium and minerals from bones and find ways to prevent or minimize bone failure in space and on Earth. Findings from tests of muscle disintegration could yield more information about similar muscle failure that occurs in forms of muscular dystrophy and the loss of muscle mass after severe injury, prolonged bed rest, and aging. Findings from this and other studies will be used to develop pharmaceutical products and physical treatment regimens to limit the extent of muscle tissue loss after fractures/cast immobilization and surgery. Anticipated benefits include savings from the reduced need for physical therapy and more rapid return to activity following injury.

The payload, a cell culture device that replaces a standard locker double tray inside one standard middeck locker, has a large tray assembly that can be refurbished and replaced. A triply contained, hermetically sealed fluid path assembly holds the cells under study, all media for sustained growth, and automated drug delivery provisions for testing candidate pharmaceuticals. A self-contained computer system is preprogrammed for medium and gas delivery to the cells, environmental monitoring of temperature and other important parameters, timed collection of medium and/or cells, and cell fixation. For STS-53, STL-1 will operate in configuration A, which uses orbiter power.

The crew will activate the payload shortly after orbital insertion. Before operations begin, the crew will enter a reference time tag using a push-button input on the front panel of the payload. Throughout the remainder of the flight, the crew will periodically check the equipment. Analysis of the samples will be performed immediately after landing.

STL-1 was last flown on STS-45.



Space Tissue Loss 1 Assembly

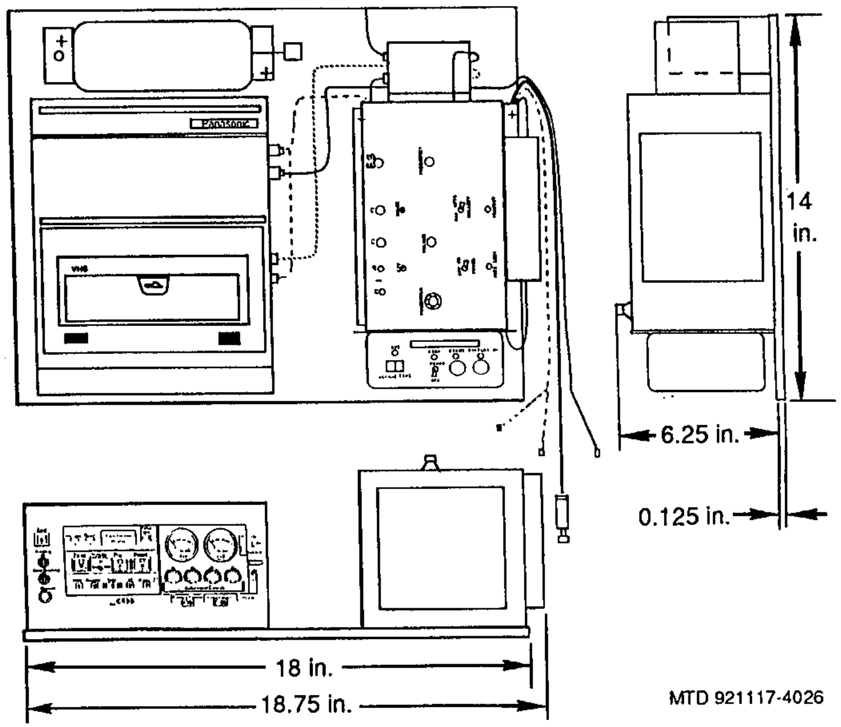
The STL-1 experiment is sponsored by the Department of Space Biosciences at the Walter Reed Army Institute of Research, Washington, D.C., in conjunction with NASA's Life Sciences

Division. It is being integrated with and flown on the shuttle under the direction of the DOD's Space Test Program.

Dr. George Kearney, research scientist at Walter Reed Army Institute of Research, is the principal investigator. Col. Bill Wiesmann, M.D., director of the Division of Surgery at WRAIR, is the program manager. Tom Cannon, of the WRAIR Department of Space Biosciences, is the project manager. The three are supported by collaborative partners at WRAIR, the Armed Forces Institute of Pathology, NASA's Ames Research Center, the University of Louisville Medical School, and a DOD Space Test Program team of personnel from the Air Force, Aerospace Corporation, and Rockwell International.

BATTLEFIELD LASER ACQUISITION SENSOR TEST

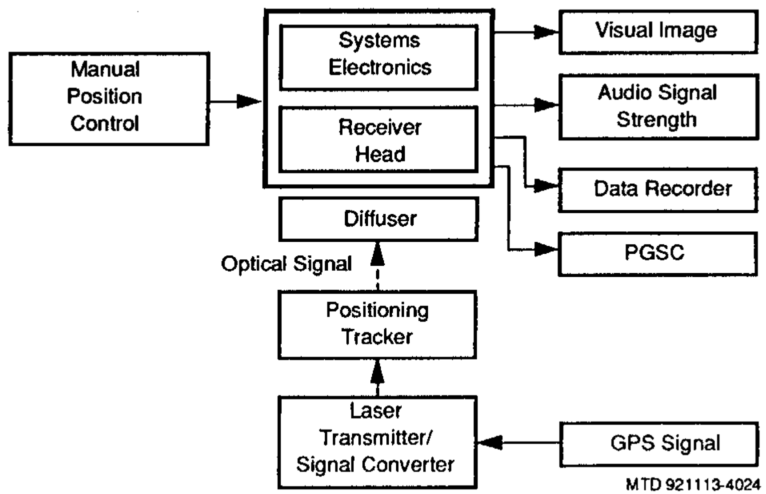
BLAST, an Army space project to develop DOD sensor technology, will evaluate the concept of using a spaceborne laser receiver to detect laser energy and provide a laser communication uplink for transmitting Global Positioning System (GPS) data from specific ground-based test locations. Two fixed optical tracking facilities—the Air Force Maui Optical Site in Hawaii and the Air Force Malabar Test Facility in Palm Bay, Fla.—and portable tracking sites set up at various DOD field locations will be used.



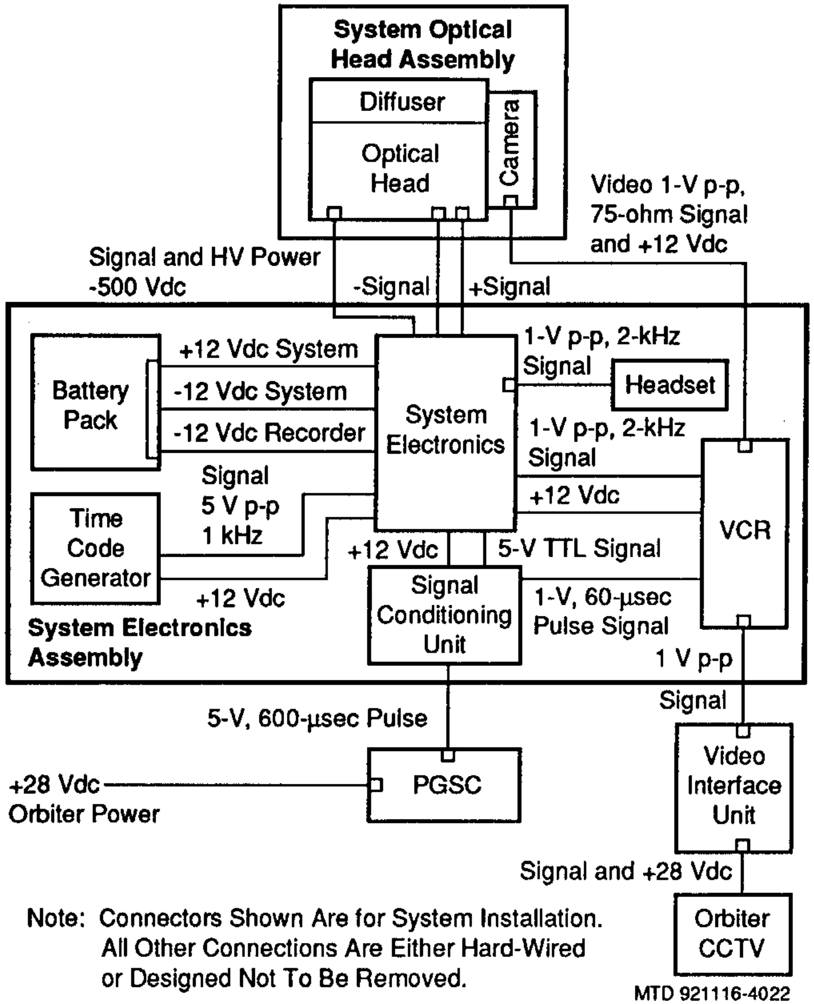
BLAST Payload

Two BLAST configurations are available: A and B. Configuration B will be used on STS-53. The system consists of four subsystems: the system optical head assembly (SOHA), system electronics assembly (SEA), orbiter closed-circuit television (CCTV) with video interface unit (VIU/C), and a payload general-support computer (PGSC).

A low-power visible laser mounted on a ground-based gimbaled tracking system will track the shuttle, using the most recent orbiter location provided by NASA. The optical signal from the tracking facilities will be captured by an on-board laser receiver mounted in Discovery's flight deck overhead window. The optical signal will be processed and displayed to the flight crew in real time and recorded for analysis after the mission.



BLAST Design Concept



BLAST System Configuration B

The table on the next page lists the fixed and portable tracking sites that will participate in this experiment.

BLAST is jointly sponsored by the Army Space Command, Colorado Springs, Colo.; the Army Space Technology Research Office, Adelphi, Md.; and the Night Vision Electro-Optics Directorate, Ft. Belvoir, Va. It is under the direction of the DOD's Space Test Program.

BLAST Tracking Sites

Sites	Lat. (deg)	Long. (deg)	Alt. (ft)	Sites	Lat. (deg)	Long. (deg)	Alt. (ft)
Ft. Drum, N.Y.	44.02	–75.62	680	Twenty-nine Palms MAB, Calif.	34.57	–115.90	2,055
White Sands Missile Range (Adam Peak), N.M.*	33.73	–106.37	7,999	Macdill AFB, Fla.	27.85	–82.52	14
Patuxent River NAS, Md.	38.35	–76.23	40	Ft. Gordon, Ga.	33.37	–81.93	145
Ft. Devens, Mass.	42.52	–71.60	269	Hanscom AFB, Mass.	42.47	–71.29	133
Ft. AP Hill, Va.	38.07	–77.30	70	Brunswick NAS, Maine	43.88	–69.93	75
Ft. Indiantown Gap, Pa.	40.45	–76.73	488	Bangor ANGB, Maine	44.80	–68.82	192
Ft. Campbell, Ky.*	36.55	–87.60	707	Wright-Patterson AFB, Ohio	39.82	–84.03	824
Ft. Bragg (Graddy Mountain), N.C.*	35.12	–79.19	404	Ft. Knox, Ky.	37.90	–85.97	740
Redstone Arsenal, Ala.	34.63	–86.72	685	Duluth ANGB, Minn.	46.83	–92.18	1,430
Ft. Stewart, Ga.	32.07	–81.43	50	Cheyenne Mountain AFB, Colo.	TBD	TBD	TBD
Ft. Benning, Ga.	32.52	–84.85	232	Roosevelt Roads NAS, P.R.	18.20	–65.60	TBD
Eglin AFB, Calif.*	30.53	–86.64	85	Vieques Island, P.R.	18.12	–65.43	TBD
Malabar AFS, Fla.	28.02	–79.30	10	Vandenberg AFB, Calif.	34.72	–120.57	367
Key West NAS, Fla.	24.57	–81.69	6	Nellis AFB, Nev.	36.23	–115.03	1,869
Ft. Leonard Wood, Mo.	37.67	–92.27	1,159	Yakima Firing Range, Wash.	46.85	–120.00	TBD
Ft. Sill, Okla.	34.63	–98.28	1,188	Fallon NAS, Nev.	39.42	–118.70	3,934
Ft. Hood, Texas	31.15	–97.75	1,015	NWSTF Boadman, Wash.	TBD	TBD	TBD
Corpus Christi NAS, Texas*	27.70	–97.28	19	Vacapes Complex, Va.	TBD	TBD	TBD
Ft. Bliss, Texas	31.85	–106.36	3,950	Bermuda NAS, Bermuda	32.40	–65.00	TBD
Yuma APG, Ariz.	33.00	–114.50	422	Luke AFB, Ariz.	33.53	–112.38	1,090
Ft. Huachuca (Scott Peak), Ariz.*	31.55	–110.43	5,981	Davis-Monthan AFB, Ariz.	32.15	–110.88	2,705
Dugway Proving Ground, Utah	40.42	–112.93	4,349	Loring AFB, Maine	46.95	–67.88	746
Ft. Carson (Steven's Pt.), Colo.*	38.50	–104.87	6,454	Keesler AFB, Miss.	30.41	–88.92	34
Ft. Lewis, Wash.	46.97	–122.62	301	Pease ANGB, N.H.	43.07	–70.82	101
Edwards AFB, Calif.	34.90	–117.88	2,302	Alexander Hamilton A/P, St. Croix, V.I.	18.30	–65.50	TBD
China Lake NAS, Calif.*	36.20	–117.72	7,841	Ellsworth AFB, S.D.	44.13	–103.01	3,278
Ft. Erwin (Tiefort Mountain), Calif.*	35.27	–116.60	3,573	Charleston AFB, S.C.	32.90	–80.03	46
AMOS AFS, Hawaii	20.70	–156.25	10,000	Minot AFB, N.D.	48.40	–101.35	1,668
Cherry Pt. MAB, N.C.	34.90	–76.87	29	Wallops Flight Facility, Va.	37.94	–75.45	41

*Designates confirmed site coordinates

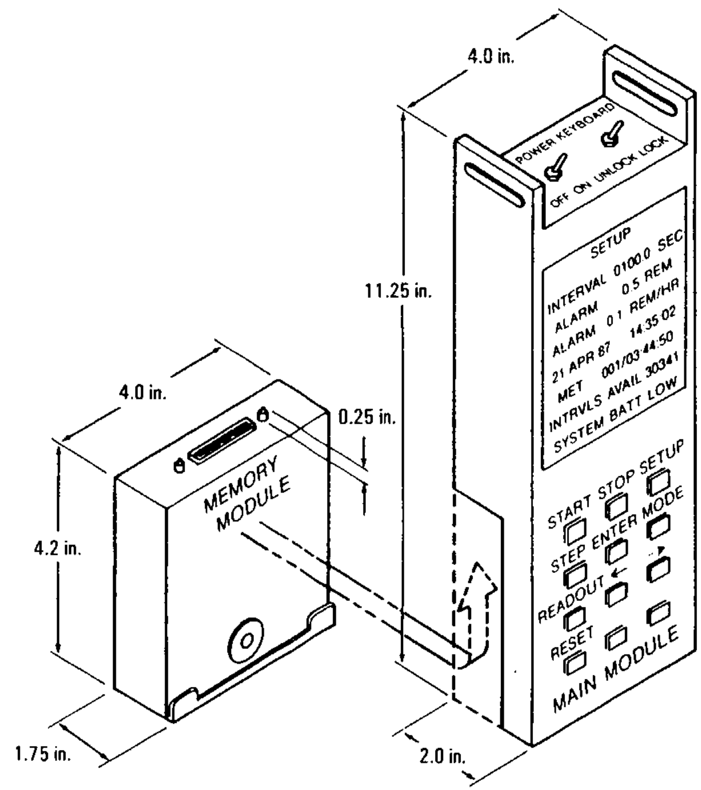
The Radiation Monitoring Equipment (RME) III microdosimeter will display and record the dose rate and total accumulated dosage of the STS-53 crew's exposure to ionizing radiation at different locations in Discovery's crew compartment. RME-III measures gamma ray, electron, neutron, and proton radiation and uses a tissue-equivalent proportional counter spatial ionization chamber radiation detector, which effectively simulates a target size of a few microns of tissue (the dimensions of a typical human cell) and calculates, in real time, exposure in RADS-tissue equivalent. RME-III data is being archived and used to update and refine models of the space radiation environment in low Earth orbit. This will help space mission planners to more accurately assess risk and safety factors for future long-term space missions, such as space station Freedom. Next-generation instruments will be flown on Freedom and on future manned and unmanned missions to the moon, Mars, and beyond. RME-III is also being used to measure radiation exposure in high-altitude aircraft, such as the Concorde.

RME-III consists of a hand-held instrument with replaceable memory modules. The equipment contains a liquid crystal display for real-time data presentation and a keyboard for controlling its functions. The self-contained experiment has four zinc-air and five AA batteries in each memory module and four zinc-air batteries in the main module. RME weighs approximately 23 pounds.

RME-III will be stored in a middeck locker during flight except when it is activated and when memory modules are being replaced. It will be activated as soon as possible following orbit insertion and programmed to operate throughout the entire mission. A crew member will be required only to enter the correct mission elapsed time upon activation and to change the memory module every two days. The equipment takes measurements of the radiation environment at a specified sample rate. All data stored in the memory modules will be analyzed upon return.

RME-III has been flown on 12 shuttle missions since STS-26. It replaces two earlier configurations. It has been flown in conjunction with other radiation experiments, such as the CREAM and SAM. RME will be flown on several future shuttle missions.

RME-III is under the direction of the Department of Defense's Space Test Program. It is sponsored by the DOD in cooperation with the Human Systems Division of NASA's Space Radiation Advisory Group.



RME Configuration

VISUAL FUNCTION TESTER 2

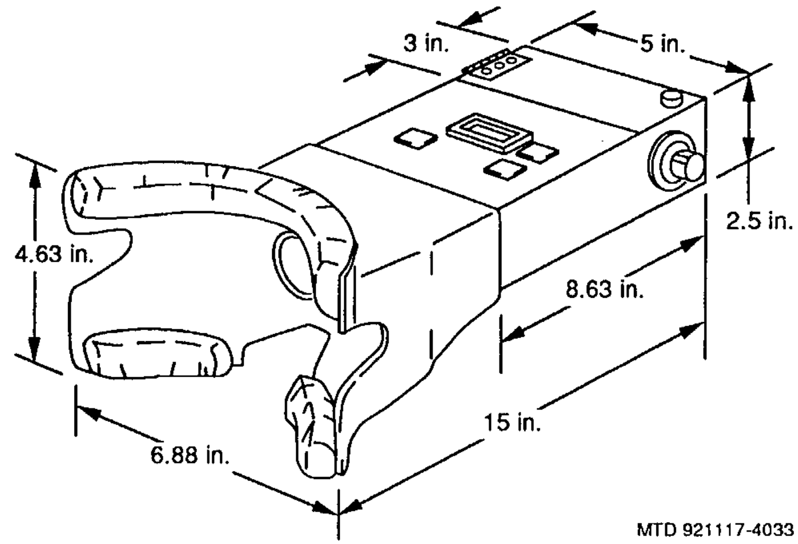
The Visual Function Tester (VFT) 2 experiment will examine whether any change in human vision occurs in space and, if so, will determine whether the changes are clinically significant and how quickly recovery occurs. It consists of a hand-held, battery-powered device with a binocular eyepiece that uses controlled illumination to present three types of visual targets that are used to test visual acuity and eye interaction effects, such as stereopsis and eye dominance.

Two STS-53 crew members will be tested two weeks and one week before the flight, every day during the flight, after the landing, on the day of landing, and two and seven days after the landing. Testing will be performed at the same time in the morning, when the subjects' eyes are rested. The procedure takes about 30 minutes and may be performed anywhere in the crew cabin during the mission.

Test data are read on device displays and recorded on data sheets. The experiment is stowed in one middeck locker.

VFT-2 has been flown previously on five shuttle missions.

The VFT is a DOD Space Test Program secondary experiment and is sponsored by the Armstrong Laboratory at Wright-Patterson Air Force Base, Ohio. Dr. Lee Task, research physicist, and Dr. (Lt. Col.) Mel O'Neal, research optometrist, of the Human Engineering Division, are the principal investigators. They are assisted by Air Force and Rockwell International personnel located at NASA's Johnson Space Center, Texas.



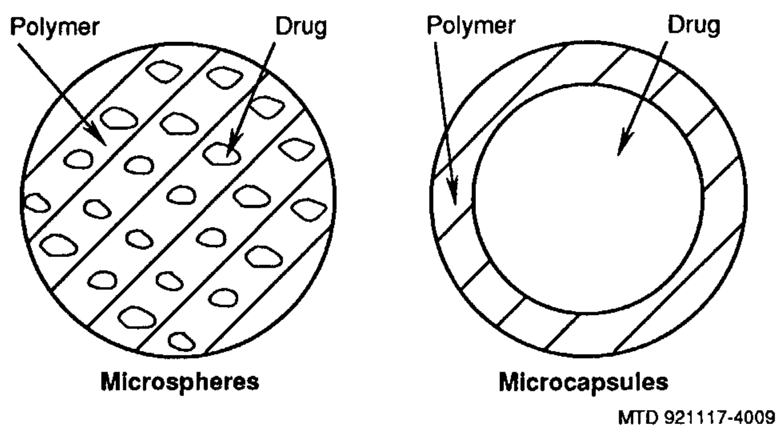
Visual Function Tester Configuration

MICROENCAPSULATION IN SPACE (MIS)

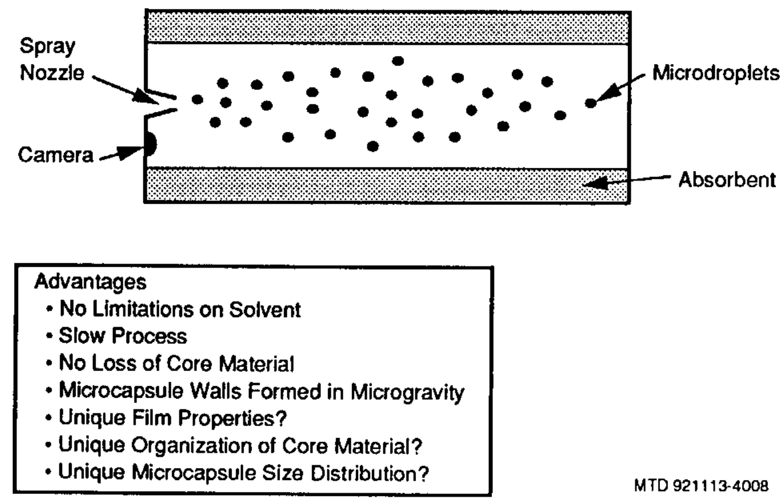
MIS is an Army project aimed at improving the understanding of microencapsulated drug technology. Microcapsules are tiny spheres about 50 to 100 micrometers in diameter (roughly the thickness of a strand of human hair) that have been used to develop high-performance chemical products and innovative pharmaceuticals like taste-masked formulas and time-released prescriptions.

On this first of several planned MIS flights, the shuttle crew will perform two experiments to produce time-released antibiotic microcapsules. An antibiotic, ampicillin, will be microencapsulated with a biodegradable polymer. Experimenters expect the properties of microcapsules made in space to be vastly superior to those made on Earth. If so, they may offer new approaches for future pharmaceutical products, which could be manufactured on space station Freedom.

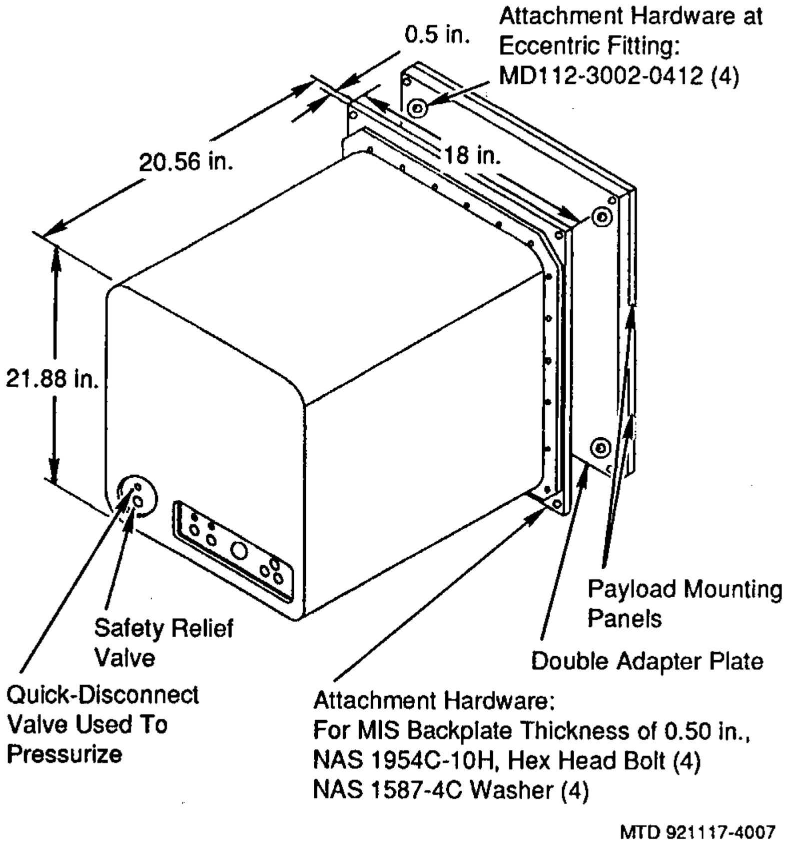
MIS was conceived, designed, and constructed by the Controlled Release Division of Southern Research Institute. Dr. Thomas R. Tice is principal investigator. It is sponsored by the U.S. Army Institute of Dental Research and U.S. Army Medical Research and Development Command with partial funding from the U.S. Army Laboratory Command.



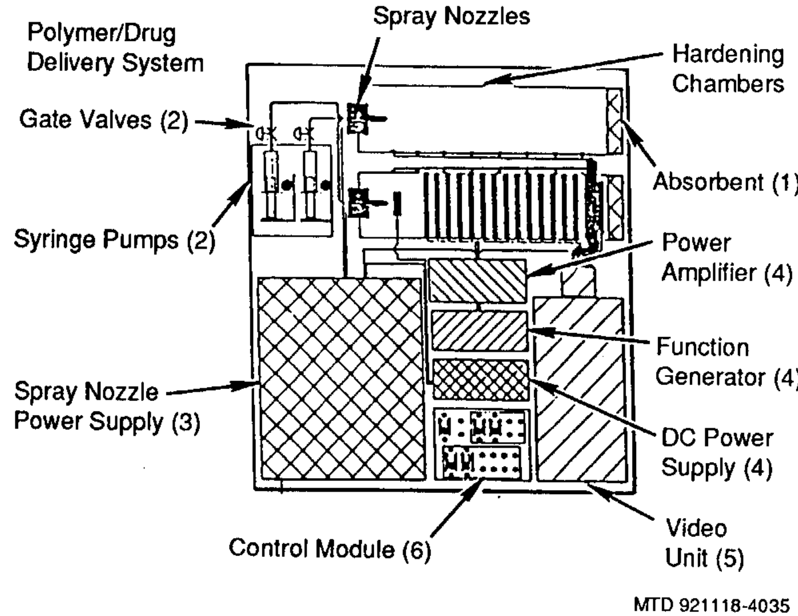
Microspheres and Microcapsules



Microencapsulation in Space



MIS Middeck Configuration



MIS Component Configuration

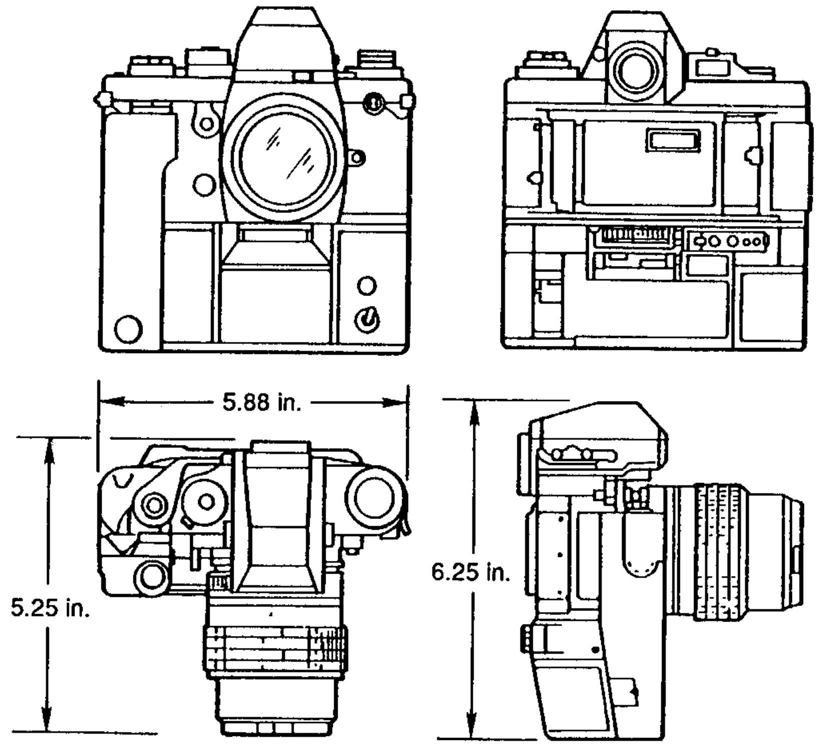
CLOUD LOGIC TO OPTIMIZE USE OF DEFENSE SYSTEMS 1A

Cloud Logic To Optimize Use of Defense Systems (CLOUDS) 1A is a DOD-sponsored Military-Man-in-Space payload whose objectives are to quantify variations in apparent cloud cover as a function of the angle at which clouds of various types are viewed and to develop meteorological observation models for various cloud formations. Photographic sequences of cloud fields over various ground sites (targets of opportunity) will be obtained. The data will be used by the meteorological community and various Defense Meteorological Satellite Program (DMSP) initiatives to provide a more efficient assessment of relevant cloud characteristics that impact DOD systems. The DMSP office will use the data for the development and evaluation of future electro-optical sensors through the generation of standard scenes for model evaluation and the study of high-incidence-angle effects.

On orbit, a crew member will take a series of high-resolution photographs of individual cloud scenes. Each CLOUDS mission emphasizes a specific meteorological or cloud feature of interest. For STS-53, the emphasis will be on severe weather, including thunderstorms and tropical storms. Photos will be taken from a wide range of viewing angles. The scenes of interest are identified by meteorologists on the ground and relayed to the shuttle crew members.

The CLOUDS-1A experiment is stowed in a middeck locker and consists of a Nikon F3/T 35mm camera assembly with a 105mm f/2.5 lens, data recording system, motor drive, and infrared filter. Ten packs of 36-exposure Kodacolor Gold 100 film will be used during the flight.

CLOUDS has been flown on several shuttle missions since 1984. It is under the direction of the DOD's Space Test Program.



CLOUDS-1A Camera Configuration

COSMIC RADIATION EFFECTS AND ACTIVATION MONITOR (CREAM)

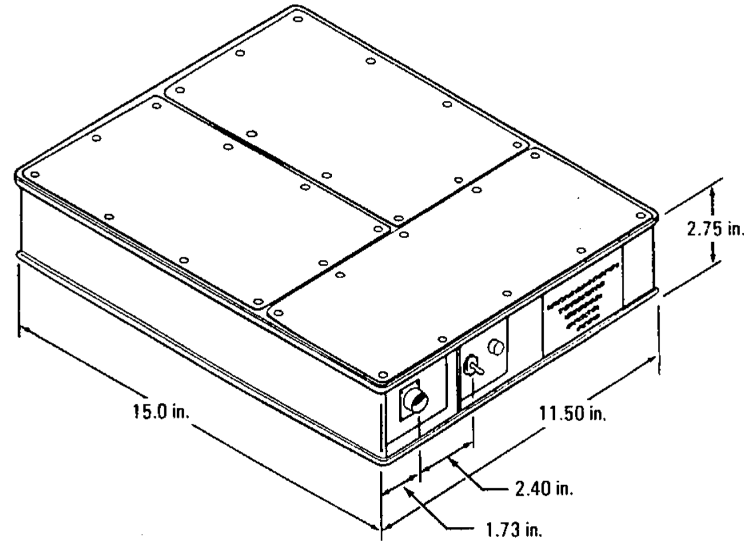
CREAM is designed to collect data on cosmic ray energy loss spectra, neutron fluxes, and induced radioactivity. The data is collected as a function of geomagnetic coordinates and detector location within the orbiter.

The CREAM data will be collected by active and passive monitors placed throughout the orbiter's cabin. CREAM data will be obtained from the same locations that will be used to gather data for the Radiation Monitoring Equipment experiment in an attempt to correlate the two experiments' data.

On two previous flights, STS-44 and STS-48, CREAM provided important information on the buildup of secondary radiation with increased shielding and identified a new region of trapped radiation over the South Atlantic.

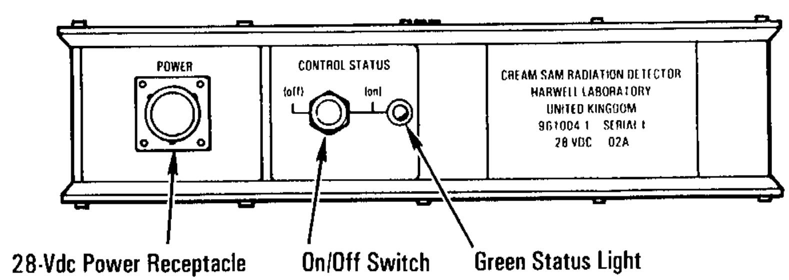
The CREAM payload flight hardware consists of an active cosmic ray monitor, a passive sodium iodide detector, and up to five passive foil detector packages. The active monitor will obtain real-time spectral data, and the passive monitors will obtain data integrated over the duration of the mission to be analyzed after the flight. A passive sodium iodide detector will be used as a control to obtain background data before launch. It will accompany the flight packages until the CREAM locker is installed in the middeck. The control package will rejoin the flight detector packages as soon as possible after the landing.

The CREAM active monitor is a box containing sensors, electrical power interface, and associated electronics and solid-state memory.



Active Monitor

CREAM Payload Configuration

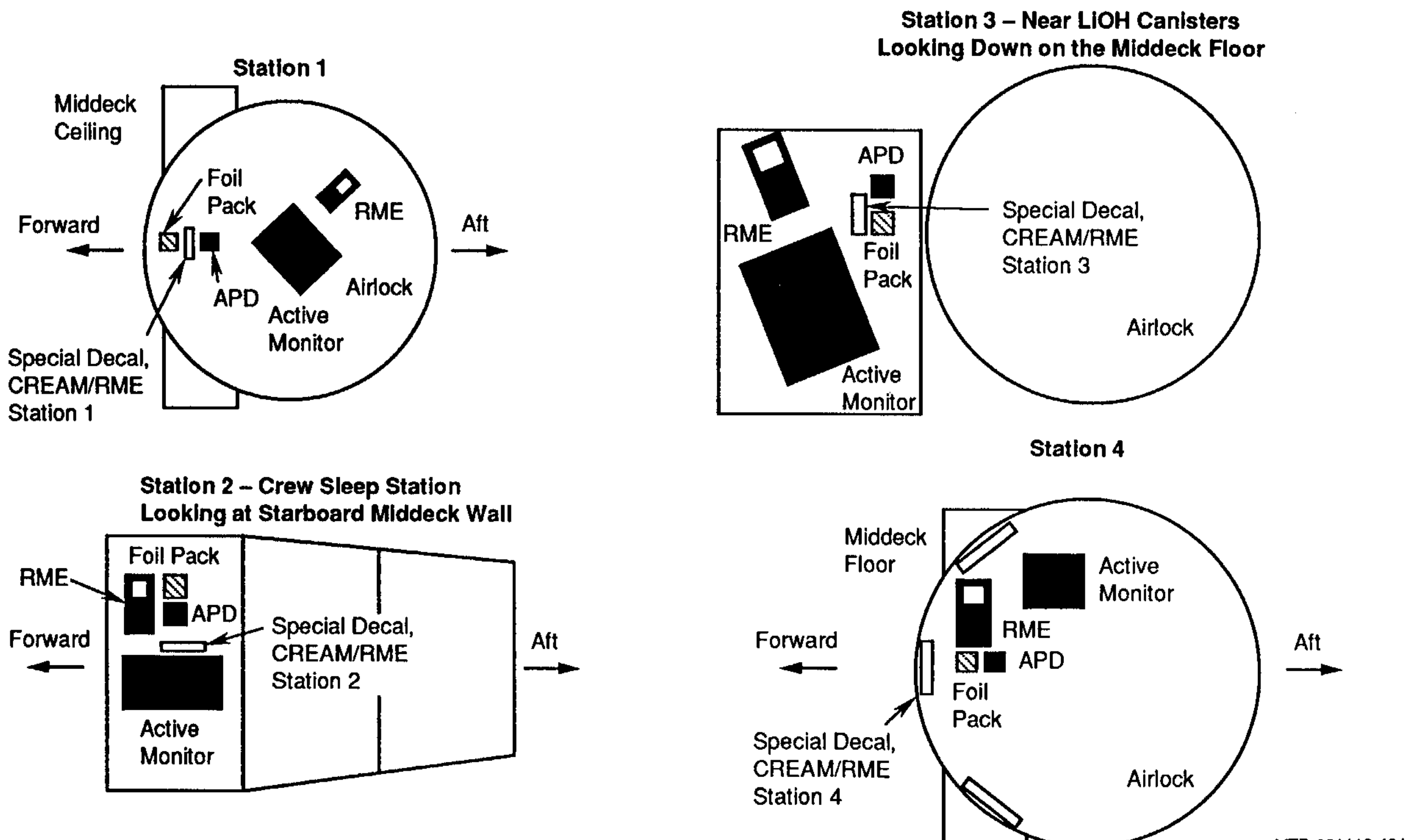


Detail of CREAM Active Monitor Front Panel

CREAM operates on 28-Vdc power from the shuttle orbiter, weighs approximately 48 pounds, and is stowed in one middeck locker.

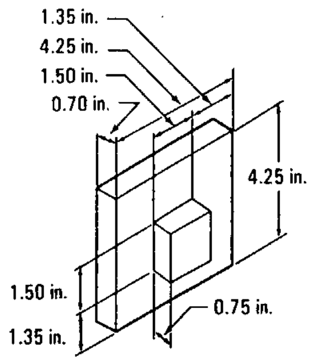
The payload will be unstowed and operated by the crew approximately 2-1/2 hours after launch. A crew member will be available at regular intervals to monitor the payload/experiment. The crew will be required to document the placement and setup of the payload in each monitoring location with 35mm still photography.

CREAM is sponsored by the Department of Defense. The experiment is provided by the United Kingdom Defense Research Agency, Farnborough, England. CREAM is being integrated with and flown on the space shuttle under the direction of the DOD's Space Test Program.

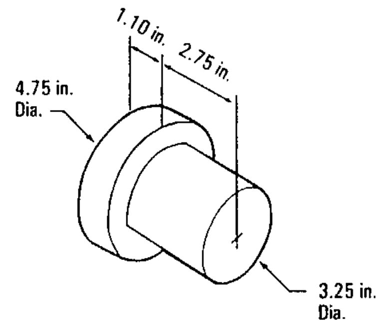


Note: Not to Scale

CREAM Detector Decal Locations



Passive Dosimetry Package



Sodium Iodide Crystal
Passive Detector

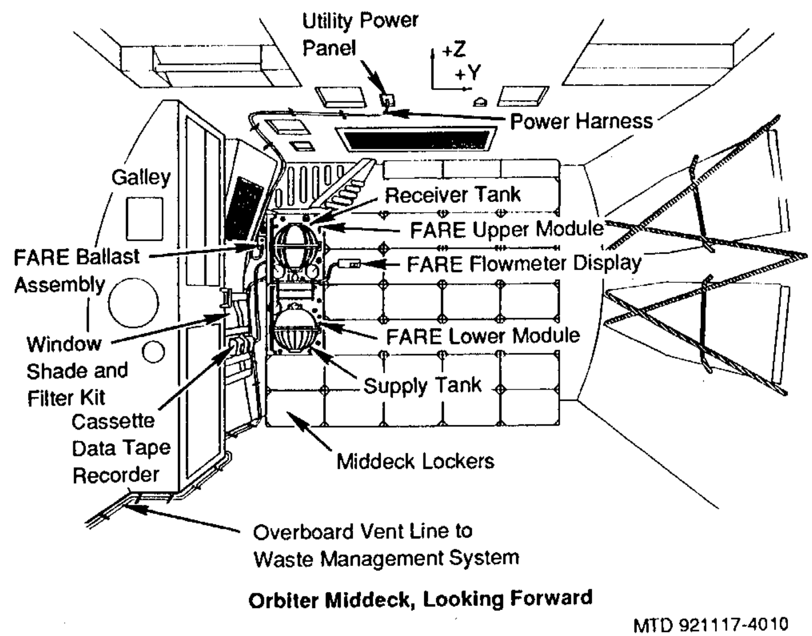
FLUID ACQUISITION AND RESUPPLY EQUIPMENT (FARE)

The purpose of FARE is to investigate the dynamics of fluid transfer in microgravity and develop methods for transferring vapor-free propellants and other liquids that must be replenished in long-term space systems like satellites, extended-duration orbiters, and space station Freedom.

FARE hardware consists of two 12.5-inch spherical tanks made of transparent acrylic, one to supply and one to receive fluids. There are also liquid transfer lines, two pressurized air bottles, a calibrated cylinder, and the necessary valves, lines, fittings, pressure gauges, and flowmeter display. The experiment is self-contained except for the water-fill port, air-fill port, and an overboard vent connected to the orbiter waste management system.

Eight times over an eight-hour test period, mission specialists will conduct the FARE experiment. A sequence of manual valve operations causes pressurized air from the bottles to force fluid (water with iodine, blue food coloring, a wetting solution, and an antifoaming agent) from the supply tank to the receiver tank and back again to the supply tank. Baffles in the receiver tank control fluid motion during transfer, a fine-mesh screen filters vapor from the fluid, and the overboard vent removes vapor from the receiver tank as the liquid rises.

Crew members will control and monitor the experiment from the FARE control panel, which has four pressure gauges and one temperature control gauge. During the transfer operations, they will tape the process with a video camcorder and take 35mm photographs. If necessary, they can also consult with the principal

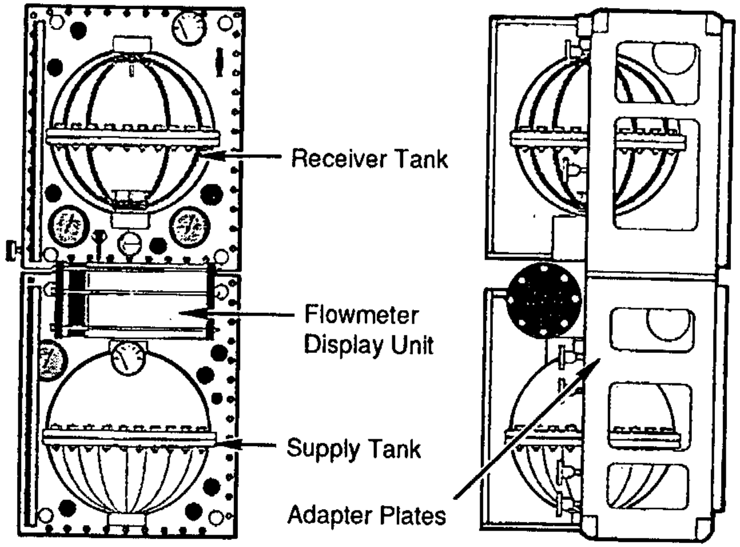


FARE Configuration

investigator through air-to-ground communications. (There is no real-time data downlink during the experiment.)

After the mission, analysts will evaluate the experiment equipment and review the videotape and photographs.

The FARE hardware is lighter, simpler, cheaper, and less likely to leak than the collapsible tanks that have previously been used in



- Envelope: 45 in. x 22 in. x 19 in.
- Tanks
  - Material: Acrylic
  - Diameter: 12.5 in.
  - Volume: 1,022 $in.^3$
- Test Fluid:
  - Water and Additives
  - Amount: 5.4 Gallons

MTD 921117-4011

FARE Configuration

space. Experimenters are hoping FARE will be more effective as well.

FARE is managed by NASA's Marshall Space Flight Center in Huntsville, Ala. The basic equipment was developed by Martin Marietta for the Storable Fluid Management Demonstration, a configuration different from FARE that flew on STS 51-C in 1985. Susan L. Driscoll is the principal investigator.

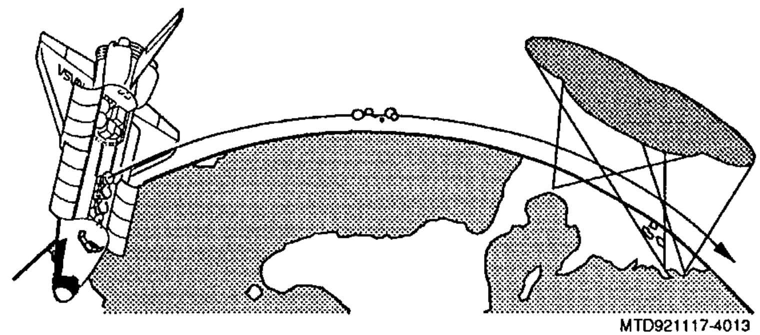
ORBITAL DEBRIS RADAR CALIBRATION SYSTEM (ODERACS) EXPERIMENT

The primary purpose of this experiment is to enable scientists to fine tune Earth-based radar and optical instruments so they can keep better tabs on the thousands of pieces of man-made space junk orbiting the Earth. Of the approximately 6,500 artificial objects in space catalogued by the U.S. Air Force, only 6 percent are functional satellites; the rest is debris, some of it as small as 10 centimeters in diameter.

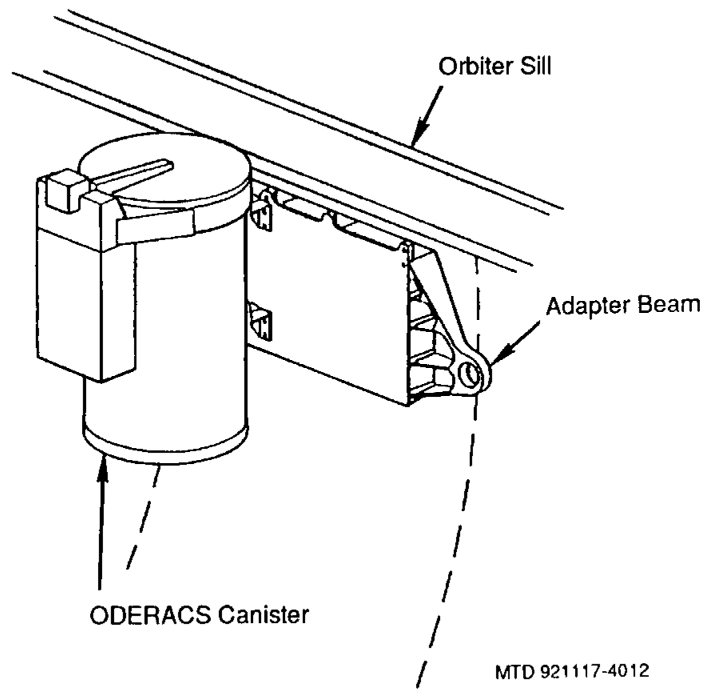
Since objects smaller than 10 centimeters can damage spacecraft, NASA would like to be able to locate, characterize, and track accurately space debris as small as 1 millimeter so that adequate shielding can be designed for the U.S. space station, which is planned to be assembled in low Earth orbit later in this decade. More accurate information about the size of orbital debris and its distribution would also mean the station would have to make fewer maneuvers to avoid any debris that its shielding cannot protect it against. This experiment is expected to give NASA greater confidence in its ability to characterize the orbital debris environment.

For this experiment, six metal spheres—two 6 inches in diameter, two 4 inches in diameter, and two 2 inches in diameter—will be ejected from the payload bay of the shuttle Discovery on its 31st orbit of the Earth at an altitude of 175 nautical miles. The spheres will pass over several radars and telescopes located around the world. These facilities will detect and analyze the spheres, and the data gathered will be used to verify the accuracy of the debris-tracking instruments and their data collection and analysis systems.

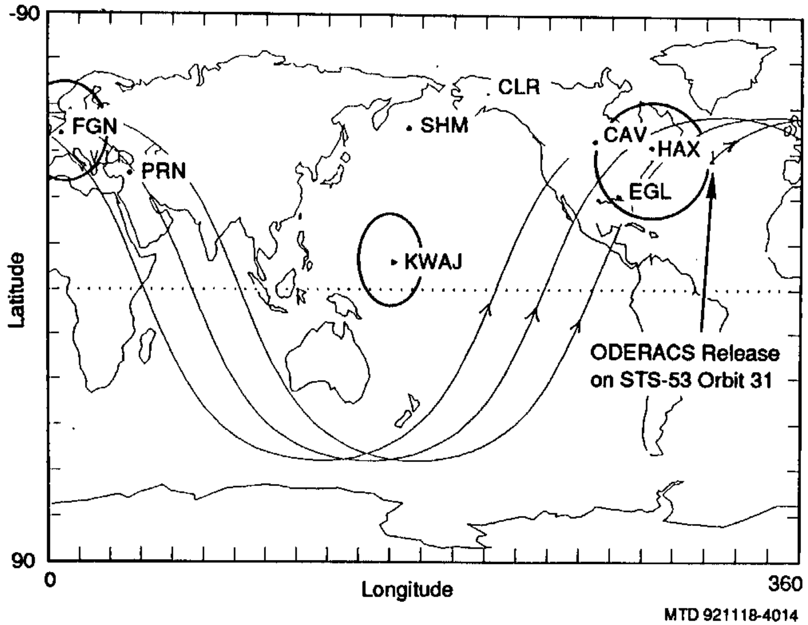
The ODERACS ejection system fits inside a 5-cubic-foot getaway special (GAS) canister that is mounted on the wall of the shuttle's payload bay. The spheres are held in cylinders by cam-operated retainer pins. Springs eject the spheres from the cylinders when the retainer pins are retracted by rotating the cam.



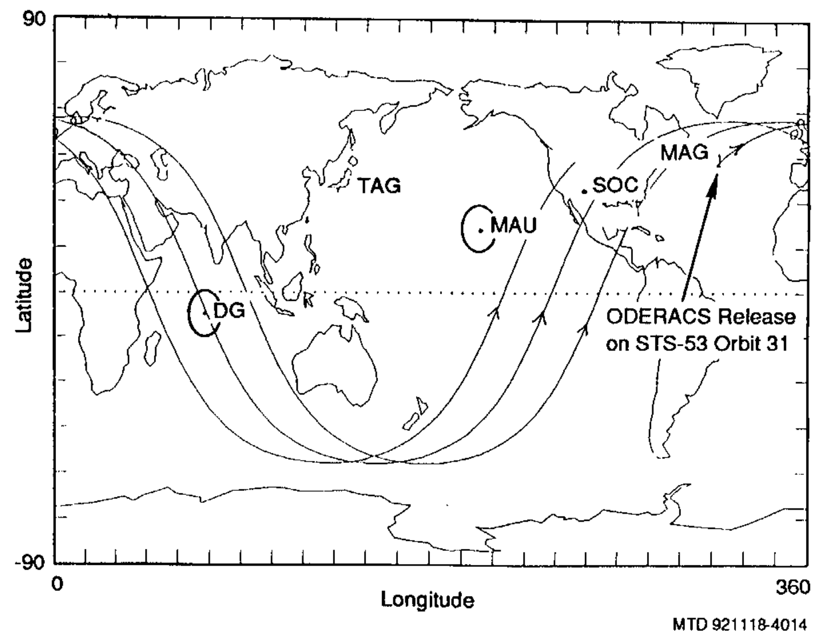
Deployment of ODERACS Calibration Spheres



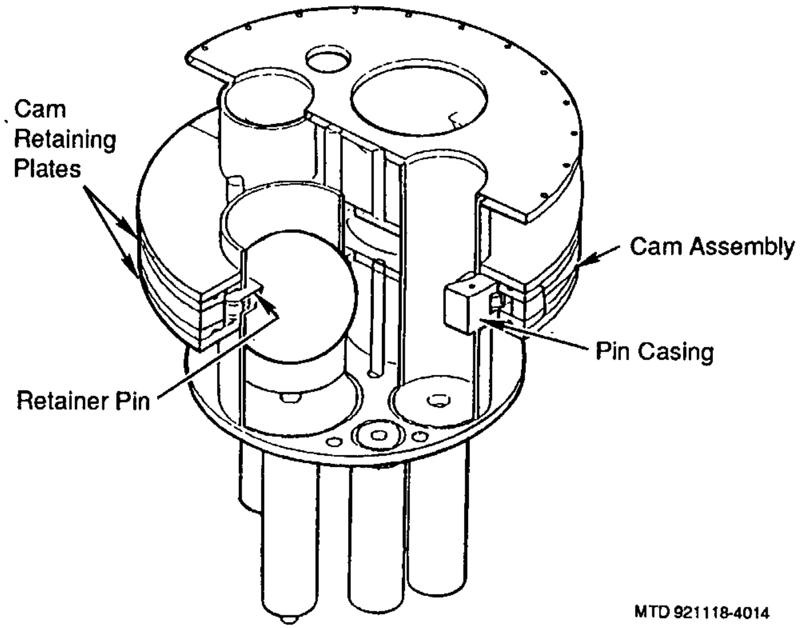
ODERACS Payload Configuration



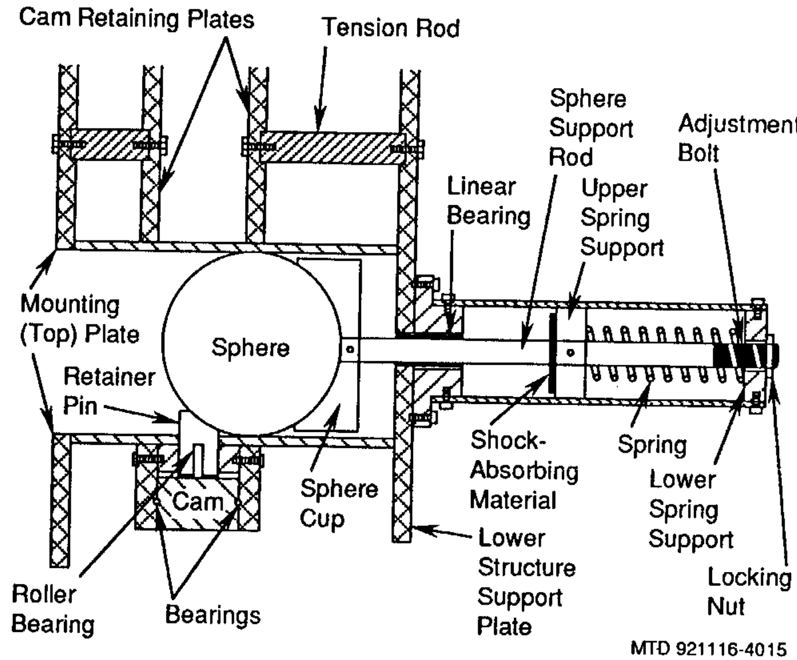
Radar Sites' Fields of View



Optical Sites' Fields of View



ODERACS Ejection System



ODERACS Ejection System Mechanism

From the aft flight deck of the orbiter, mission specialist Michael Clifford, using a hand-held encoder, will open the door of the GAS canister, release the spheres, and close the door. The ejection sequence will be videotaped and observed on radar to determine the velocity of the spheres. This data will be used to help the telescopes and radars locate the spheres on their first pass.

Scientists will calibrate their instruments by comparing the known dimensions, compositions, reflectivity, and electromagnetic scattering properties of the six spheres to empirical optical and radar debris signatures.

The 2- and 4-inch spheres are made of solid stainless steel and have a polished finish. The smaller sphere weighs 1.17 pounds and the larger one weighs 9.36 pounds. The 6-inch spheres are made of solid aluminum and weigh 11 pounds. The surface of the 6-inch spheres has been sandblasted to a matte finish to allow scientists to make reflectivity and phase function comparisons.

The useful life of the 2- and 6-inch spheres is about 45 days. After about 65 days in orbit, they will reenter the atmosphere and burn up. The 4-inch spheres are expected to have a longer useful life of about 70 days. They will reenter the Earth's atmosphere after about 120 days in space and burn up.

The Haystack radar, operated by Lincoln Laboratory at the Massachusetts Institute of Technology for the Air Force in Tyngsboro, Mass., is the primary target for this experiment. This radar's 120-foot antenna can track objects in space as small as 1 centimeter in diameter at distances of up to 620 nautical miles. Information from the Haystack radar is used by NASA to help determine the amount of debris in orbit around the Earth.

The small metal spheres will be used to verify the accuracy of the Haystack radar's measurements and its data collection and analysis systems. Data collected during each observation session will be transferred to digital tape and transmitted to the Johnson Space Center in Houston at the end of the session for postmission processing by Haystack's orbital debris analysis system. The ODAS identifies the locations of the observed objects, estimates the size of the objects, and correlates each object with objects that have already been catalogued.

Radars in the Kwajalein Atoll in the South Pacific, in Florida, and in Germany will also track and observe the spheres.

Optical telescopes have been useful in identifying and characterizing space debris, but they must be accurately calibrated in order to determine the size of orbiting objects and their population. Telescopes that will be used in this experiment include those that are part of the worldwide GEODDS network, NASA's telescope at JSC, and the Super-RADOT telescope in the South Pacific.

The imaging telescope at JSC has already improved NASA's understanding of the orbital debris environment. Its highly advanced electro-optical sensor is 50 times more sensitive than photographic film and processes data digitally, which facilitates the analysis and storage of data. This telescope will correlate measurements of the ODERACS spheres with the known reflectance of the telescope.

The ODERACS experiment is a joint project involving NASA's JSC and Goddard Space Flight Center, North Carolina State University and the University of Colorado, and the Army and Air Force. Students at North Carolina State designed the ejection system and built the preliminary hardware. The flight hardware was built and integrated at JSC. The optical characteristics of the spheres were determined at the University of Colorado.

The ODERACS experiment is under the direction of John F. Stanley, deputy chief of the Space Science Branch of the Solar System Explorations Division at JSC.

Ascent wing structural capability evaluation (DTO 301D). The purpose of this DTO is to collect data to expand the data base of ascent dynamics for various weights.

Ascent compartment venting evaluation (DTO 305D). This DTO is intended solely to collect data to expand the data base for vent model verification.

Descent compartment venting evaluation (DTO 306D). The purpose of this DTO is to expand the data base to verify vent models.

Entry structural capability evaluation (DTO 307D). This DTO will collect structure loads data for different payload weights and configurations to expand the data base of flight loads during entry.

Vibration and acoustic evaluation (DTO 308D). This DTO is for the collection of data to expand the data base for vibration and acoustic data during ascent.

ET TPS performance (DTO 312). This DTO will photograph the external tank after separation to determine TPS charring patterns, identify regions of TPS material spallation, and evaluate overall TPS performance.

Orbiter/payload acceleration and acoustics environment data (DTO 319D). The purpose of this DTO is to obtain low-frequency (0 to 50 Hz) payload/orbiter interface data to develop computer prediction techniques to validate math models and forcing functions.

Edwards lakebed runway bearing strength and rolling friction assessment for orbiter landing (DTO 520). The purpose of this DTO is to obtain data to better understand the rolling friction of orbiters on Edwards dry lakebeds as this data relates to heavyweight orbiters with a forward center of gravity.

Orbiter drag chute system (DTO 521). This DTO will evaluate the performance of the orbiter drag chute system through a series of landings with increasing speeds. The DTO will be performed on vehicles equipped to measure drag forces imposed by the drag chute system. This DTO has two phases. Phase I will consist of three flights: with the drag chute deployed at or after nose gear touchdown on the first flight, at nose gear touchdown (incorporating delayed load relief) on the second flight, and at derotation on the third flight. Upon completion of Phase I, the deceleration parachute will be operational for all vehicles. Phase II will consist of seven additional flights of gradually increasing landing speed, beginning with initiation of deployment at derotation of 185 knots equivalent air speed (KEAS) through initiation at 205 KEAS.

Evaluation of the MK I rowing machine (DTO 653). This DTO will evaluate the use of the MK I rowing machine as an alternative to the shuttle treadmill. Noise and vibration associated with the MK I are anticipated to be significantly less than for the treadmill. In-flight simulated rowing is anticipated to provide total body exercise, including aerobic and anaerobic conditioning. Heart rate will be recorded to determine the effectiveness of changes in the resistive settings of the device.

PGSC single-event upset monitoring (DTO 656). The objective of this DTO is to determine payload general-support computer (PGSC) random-access memory susceptibility to single-event upset caused by cosmic radiation. The information could lead to improved procedures, hardware, or software to reduce radiation effects.

Acoustical noise dosimeter data (DTO 663). This DTO will use an audio dosimeter to gather baseline data on the time-averaged acoustical noise levels for the middeck during daytime and nighttime operations. Noise levels are a concern from crew operations, performance, and health standpoints. Data is sought on middeck payloads, intermittent equipment noises, voice/communications, the new RCRS, the WCS, manned laboratory data, the three or four-tier sleep station, and the middeck during sleep periods when no "hard" sleep station is flown. This data will provide information to help determine new specification levels for intermittent noises as well as a maximum 24-hour exposure level.

Crosswind landing performance (DTO 805). This DTO will continue to gather data for a manually controlled landing with a crosswind.

In-flight radiation dose distribution (DSO 469). This DSO will measure the radiation in a thinly shielded region of the orbiter. The crew will fasten a passive proton spectrometer to the right mid-deck wall soon after attaining orbit and stow the hardware as late as possible. The objective is to evaluate and verify methods for assessing and managing health risks from space radiation exposure.

Intraocular pressure (DSO 472*). The purpose of this DSO is to establish a data base of changes in intraocular pressures that can be used to evaluate crew health. The hand-held tonometer will be validated as a tool for diagnostic and scientific data collection on orbit.

Retinal photography (DSO 474*). The purpose of this DSO is to analyze retinal photography taken on orbit and determine if microgravity-induced cephalad fluid shifts elevate intracranial pressure. It will also certify equipment that will provide retinal images for diagnostic and investigative purposes.

Hyperosmotic fluid countermeasure (DSO 479*). The hypothesis of this test is that if a hyperosmotic saline countermeasure is ingested before return to 1-g, the crew member will experience decreased loss of plasma volume and longer-lasting protection against orthostatic intolerance than if an isosmotic countermeasure were ingested. Further, crew members who ingest a salt water solution will have better resistance to orthostatic stress than crew members who consume salt tablets and water of the same osmolality. The objective of this test is to compare different combinations of salt and water.

Orthostatic function during entry, landing, and egress (DSO 603B*). Heart rate and rhythm, blood pressure, cardiac output, and peripheral resistance of crew members will be monitored during entry, landing, seat egress, and orbiter egress in order to develop and assess countermeasures designed to improve orthostatic tolerance upon return to Earth. This data will be used to determine whether precautions and countermeasures are needed to protect crew members in the event of an emergency egress. It will also be used to determine the effectiveness of proposed in-flight countermeasures. Crew members will don equipment prior to donning the LES during deorbit preparation and will wear the equipment and record verbal comments throughout entry. Equipment consists of a blood pressure monitor, accelerometers, an impedance cardiograph, and transcranial Doppler hardware.

Visual-vestibular integration as a function of adaptation (DSO 604*). The objective of this DSO is to investigate visual-vestibular and perceptual adaptive responses as a function of mission duration. The operational impact of these responses on crew members' ability to conduct entry, landing, and egress procedures will also be investigated.

Posture equilibrium control during landing/egress (DSO 605*). Posture control as a function of mission duration will be assessed using a posture platform test performed before and after flight only. Results from this study will be used to develop countermeasures to assure postural stability during landing and egress.

Effects of space flight on aerobic and anaerobic metabolism at rest and during exercise (DSO 608*). Changes in energy metabolism, shifts in fuel utilization, and decreases in muscle mass after extended-duration space flight may limit a crew member's ability to

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*Extended-duration orbiter buildup medical evaluation.

do physical work, both in flight and after flight. The crew members will keep a daily log of their fluid intake and may be given prescribed exercise protocols.

The effect of prolonged space flight on head and gaze stability during locomotion (DSO 614*). The purpose of this DSO is to characterize preflight and postflight head and body movement and gaze stability during walking, running, and jumping, all of which are relevant to egress from the shuttle. Changes in these parameters due to the microgravity environment could impair a crew member's ability to perform an emergency egress from the vehicle. There are no on-orbit activities for this DSO.

Documentary television (DSO 901). The purpose of DSO 901 is to provide live television transmissions or VTR dumps of crew activities and spacecraft functions, including payload bay views, STS and payload bay activities, crew activities, in-flight crew press conference, and unscheduled TV activities.

Documentary motion picture photography (DSO 902). This DSO requires documentary and public affairs motion picture photography of significant activities that best depict the basic capabilities of the space shuttle and key flight objectives. This DSO includes photography of payload bay activities, flight deck activities, and middeck activities and any unscheduled motion picture photography. This photography provides a historical record of the flight as well as material for release to the news media, independent publishers, and film producers.

Documentary still photography (DSO 903). This DSO requires still photography of crew activities in the orbiter and mission-related scenes of general public and historical interest.

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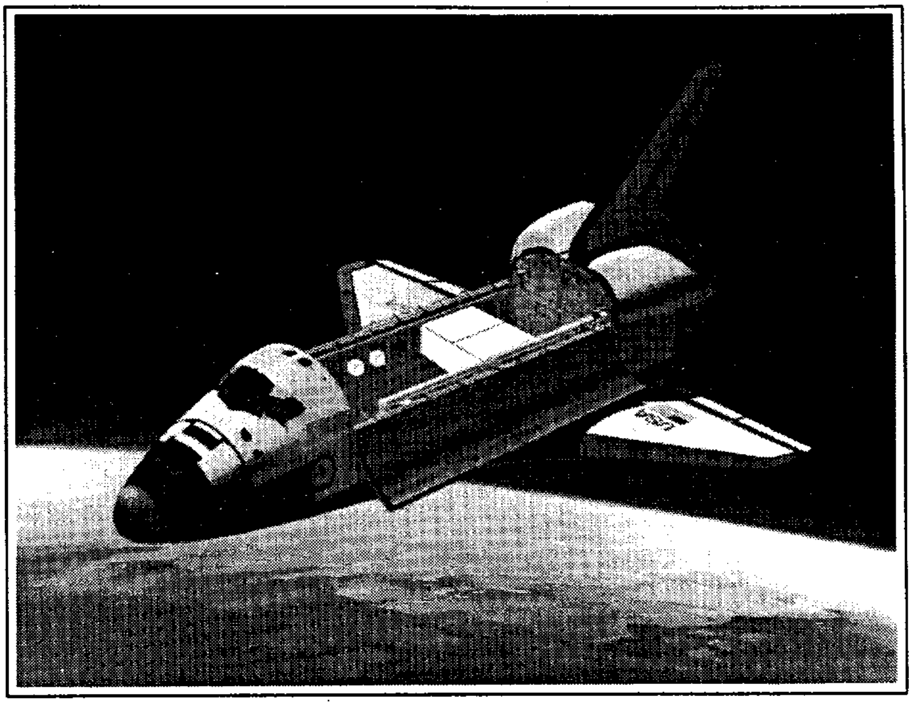
*Extended-duration orbiter buildup medical evaluation.



STS-53

MISSION STATISTICS

PRELAUNCH COUNTDOWN TIMELINE

MISSION TIMELINE

December 1992

Rockwell International
Space Systems Division

Office of External Communications &
Media Relations

CONTENTS

MISSION OVERVIEW

This is the 15th flight of Discovery and the 52nd for the space shuttle.

The flight crew for the seven-day STS-53 mission is commander David (Dave) M. Walker; pilot Robert (Bob) D. Cabana; and mission specialists Guion (Guy) S. Bluford, James (Jim) S. Voss, and Michael Richard (Rich) U. Clifford.

STS-53 is the ninth dedicated Department of Defense mission of the shuttle program. Its primary objective is to successfully deploy the Department of Defense 1 satellite, the last major classified military payload currently planned for the shuttle fleet. The all-military STS-53 crew includes personnel from the Army, Navy, Air Force, and Marine Corps.

The classified DOD-1 cargo element consists of a deployable spacecraft and associated airborne support equipment, which contains the spacecraft's deployment system. DOD-1 is scheduled to be deployed into a 57-degree trajectory, 200-nautical-mile circular orbit on Orbit 5 at a mission elapsed time of 6 hours and 15 minutes.

STS-53 secondary objectives include the Glow Experiment/Cryogenic Heat Pipe Experiment Payload (GCP); Hand-held, Earth-oriented, Real-time, Cooperative, User-friendly, Location-targeting, and Environmental System (HERCULES); Space Tissue Loss (STL); Battlefield Laser Acquisition Sensor Test (BLAST); Radiation Monitoring Equipment (RME) III; Visual Function Tester (VFT) 2; Microcapsulation in Space (MIS) 1; Cloud Logic To Optimize Use of Defense Systems (CLOUDS) 1A; Cosmic Radiation Effects and Activation Monitor (CREAM); Fluid Acquisition and Resupply Equipment (FARE); and Orbital Debris Radar Calibration System (ODERACS).

GCP is a two-part experiment. GLO, the Phillips Laboratory Geophysics Directorate's shuttle glow experiment, contains an extreme ultraviolet imager and spectrograph for recording shuttle/environment interaction measurements in the 115- to 1,150-nanometer spectral range. The sensors will observe orbiter atomic oxygen surface glow (as seen on the shuttle's tail and other surfaces facing in the direction of travel), contaminating events, and air glow. The CRYOHP, sponsored by Wright Aeronautical Laboratories, will measure the zero-gravity performance of two liquid oxygen heat pipes and contains mechanical cryo coolers enclosed in a vented hitchhiker canister. CRYOHP has uses in cooling infrared sensors in space. The GCP payload is mounted on the starboard side of Discovery's payload bay using getaway special-type attach fittings and two adapter beams.

HERCULES is a Naval Research Laboratory-sponsored middeck payload that will enable the space shuttle crew members to point an electronic still camera at a feature on Earth, record the image, and automatically determine, in real time, the latitude and longitude of the ground target to within one nautical mile. HERCULES is designed to provide a valuable Earth observation system for military, environmental, oceanographic, and meteorological applications. The hardware configuration consists of a playback/ downlink unit (PDU), electronic still camera (ESC) and ESC electronics box, the HERCULES attitude processor (HAP), and the HERCULES inertial measurement unit (HIMU). Configuration B, which allows data to be viewed and downlinked, will be flown on STS-53.

STL, sponsored by the Walter Reed Army Institute of Research in conjunction with NASA's Life Sciences Division, is a middeck experiment that will study the effects of weightlessness on bone tissue, muscles, and blood. The data will be used to improve the recovery of soldiers whose injuries require lengthy bed rest. Drugs to prevent tissue loss will be tested to determine their effectiveness. Configuration A will be flown on STS-53. The experiment operates continuously from before launch through landing.

BLAST's objective is to evaluate the concept of using a spaceborne laser receiver to detect laser energy and to provide a laser communication uplink for transmitting Global Positioning System information from specific ground-based test locations. The BLAST receiver is mounted in the crew compartment starboard window. The hardware configuration consists of the system optical head assembly (SOHA), system electronics assembly (SEA), orbiter CCTV video interface unit (VIU/C), and a payload general-support computer (PGSC). Configuration B will be flown on STS-53. BLAST is jointly sponsored by the Army Space Command, Army Space Technology Research Office, and Night Vision Electro-Optics Directorate project.

RME-III is a joint NASA/Armstrong Laboratory experiment that will measure ionizing radiation levels at different locations in the orbiter crew compartment to update and refine models of the space radiation environment in low Earth orbit. It consists of a hand-held radiation monitor, a pocket REM meter, and two solid-state recorders. The equipment contains a liquid crystal display for real-time data display and a keyboard for controlling its functions. Four 55-minute data takes are required. Only five minutes of crew-attended activity is required.

VFT-2 is an Air Force Armstrong Laboratory middeck experiment that will study the effects of weightlessness on human vision to determine if change in vision occurs in space and, if so, whether the changes are clinically significant and how quickly the individual recovers. The crew will look into a hand-held, battery-powered device that will measure the sensitivity of the eye to image contrast changes.

The objective of MIS-1, sponsored by the U.S. Army Medical Research and Development Command's Institute of Dental Research and the U.S. Army Laboratory Command, is to demonstrate the feasibility of producing time-release antibiotic pharmaceutical microcapsules in microgravity. Scientists have reason to believe that microcapsules produced in space will have uniformity and timed-release properties vastly superior to those made on Earth. Ampicillin anhydrate will be the drug microencapsulated in space. The system consists of hardening chambers, a delivery system for the polymer/drug solution, ultrasonic spray nozzles with power supply, electric field generators, a video recorder, and a control module. The experiment will be mounted on a double adapter plate and housed in the orbiter middeck.

CLOUDS-1A is a DOD-sponsored middeck payload that will quantify variations in apparent cloud cover as a function of the angle at which clouds of various types are viewed and will develop meteorological observation models for various cloud formations. The data will be stored in a high-resolution data base for use by the meteorological community and various Defense Meteorological Satellite Program initiatives in developing and evaluating future electro-optical sensors for DOD systems through the generation of standard scenes for model evaluation and the study of high-incidence-angle effects. The payload consists of a 35mm camera assembled with a battery-powered motor drive, data recording system, 105mm lens, and infrared filter.

CREAM is designed to measure cosmic ray energy loss spectra, neutron fluxes, and induced radioactivity as a function of time and location within the orbiter. CREAM occupies half of a middeck locker and includes active and passive monitors placed at specific locations throughout the orbiter's crew compartment. CREAM is sponsored by the Department of Defense.

FARE, sponsored by NASA, will investigate the filling, refilling, and emptying of simulated propellant tanks and the behavior of liquid motion in a low-gravity environment. The FARE configuration consists of a spherical receiver tank, a spherical supply tank, a pressurization system, a vent system, structure and adapter plates, lights, a ballast assembly (power control box), a flowmeter, a fire hazard blanket, and airborne support equipment. The tanks are made of clear acrylic plastic to enable video recording of the fluid's behavior. The test fluid is treated water. This middeck payload will be operated manually and uses hardware from the Storage Fluid Management Demonstration experiment flown on STS 51-C in January 1985.

NASA Johnson Space Center's ODERACS payload will eject six spheres ranging in size from 2 to 6 inches in diameter from Discovery's payload bay to test ground-based capability to detect potentially dangerous debris in low Earth orbit. The spheres will be observed, tracked, and recorded by ground-based radars and optical telescopes, enabling end-to-end calibration of radar imaging facilities and data analysis systems. In addition, the radar signatures of the spheres will be compared to signatures detected from current orbital debris. ODERACS is contained in a getaway special canister mounted on an adapter beam in Discovery's payload bay. It will be deployed on orbit 31.

STS-53 marks Discovery's return to flight following a six-month orbiter maintenance down period at NASA's Kennedy Space Center, Fla. Discovery underwent structural inspections, servicing of its Freon service loop, installation of a drag chute identical to those already installed on Columbia and Endeavour, and nearly 80 other avionics, subsystems, and structures/thermal protection system upgrades to improve its performance. The changes were designed to maintain Discovery's structural integrity, keep the fleet uniform and technologically up-to-date, and enhance vehicle turnaround time. Among the significant upgrades during the down period were an improved nose wheel steering system, middeck accommodations rack, middeck utility panel, repackaged galley, improved main landing gear tires, redundant weight-on-wheels sensing, improved auxiliary power units, a tire pressure decay monitoring system, various thermal protection system improvements, and structural modifications to improve wing strength.

Thirteen detailed test objectives and 12 detailed supplementary objectives are scheduled to be flown on STS-53.

MISSION STATISTICS

Vehicle: Discovery (OV-103), 15th flight

Launch Date/Time:

12/2/92 6:59 a.m., EST
5:59 a.m., CST
3:59 a.m., PST

Launch Site: Kennedy Space Center (KSC), Fla.--Launch Pad 39A

Launch Window: 2.5 hours (crew-on-back constraint)

Mission Duration: 7 days, 5 hours, 54 minutes

Landing: Nominal end-of-mission landing on orbit 115

12/9/92 12:53 p.m., EST
11:53 a.m., CST
9:53 a.m., PST

Runway: Nominal end-of-mission landing on concrete runway 15, Kennedy Space Center (KSC), Fla. Weather alternates are Edwards Air Force Base (EAFB), Calif., and Northrup Strip (NOR), White Sands, N. M.

Transatlantic Abort Landing: Zaragoza, Spain; alternates: Moron, Spain; Ben Guerir, Morocco

Return to Launch Site: KSC

Abort-Once-Around: NOR; alternates: EAFB, KSC

Inclination: 57 degrees

Ascent: The ascent profile for this mission is a direct insertion. Only one orbital maneuvering system thrusting maneuver, referred to as OMS-2, is used to achieve insertion into orbit. This direct-insertion profile lofts the trajectory to provide the earliest opportunity for orbit in the event of a problem with a space shuttle main engine.

The OMS-1 thrusting maneuver after main engine cutoff plus approximately two minutes is eliminated in this direct-insertion ascent profile. The OMS-1 thrusting maneuver is replaced by a 5-foot-per-second reaction control system maneuver to facilitate the main propulsion system propellant dump.

Altitude: 200 nautical miles (230 statute miles) circular orbit (DOD-1 deployment), then 175 nautical miles (202 statute miles) circular orbit (ODERACS deployment)

Space Shuttle Main Engine Thrust Level During Ascent: 104 percent

Space Shuttle Main Engine Locations:

No. 1 position: Engine 2024
No. 2 position: Engine 2012
No. 3 position: Engine 2017

External Tank: ET-49

Solid Rocket Boosters: BI-055

Editor's Note: The following weight data are current as of November 24, 1992.

Total Lift-off Weight: Approximately 4,506,642 pounds

Orbiter Weight, Including Cargo, at Lift-off: Approximately 243,952 pounds

Orbiter (Discovery) Empty and 3 SSMEs: Approximately 173,597 pounds

Payload Weight Up: Approximately 26,166 pounds

Payload Weight Down: Approximately 5,151 pounds

Orbiter Weight at Landing: Approximately 193,215 pounds

Payloads--Payload Bay (* denotes primary payload): Department of Defense (DOD) 1*, Glow Experiment/Cryogenic Heat Pipe Experiment Payload (GCP), Orbital Debris Radar Calibration System (ODERACS)

Payloads--Middeck: Battlefield Laser Acquisition Sensor Test (BLAST); Cloud Logic To Optimize Use of Defense Systems (CLOUDS) 1A; Cosmic Radiation Effects and Activation Monitor (CREAM); Fluid Acquisition and Resupply Equipment (FARE); Hand-held, Earth-oriented, Real-time, Cooperative, User-friendly, Location-targeting and Environmental System (HERCULES); Microencapsulation in Space (MIS) -1; Radiation Monitoring Equipment (RME) III; Space Tissue Loss (STL); Visual Function Tester (VFT) 2

Flight Crew Members:

Commander: David M. Walker, third space shuttle flight
Pilot: Robert D. Cabana, second space shuttle flight
Mission Specialist 1: Guion S. Bluford, fourth space shuttle flight
Mission Specialist 2: James S. Voss, second space shuttle flight
Mission Specialist 3: Michael Richard (Rich) U. Clifford, first space shuttle flight

Ascent Seating:

Flight deck, front left seat, David M. Walker
Flight deck, front right seat, Robert D. Cabana
Flight deck, aft center seat, James S. Voss
Flight deck, aft right seat, Guion S. Bluford
Middeck, Michael Richard (Rich) U. Clifford

Entry Seating:

Flight deck, front left seat, David M. Walker
Flight deck, front right seat, Robert D. Cabana
Flight deck, aft center seat, James S. Voss
Flight deck, aft right seat, Michael Richard (Rich) U. Clifford
Middeck, Guion S. Bluford

Extravehicular Activity Crew Members, If Required:

Extravehicular (EV) astronaut 1: James S. Voss
EV-2: Michael Richard (Rich) U. Clifford

STS-53 Flight Directors:

Ascent, Entry: N. W. (Wayne) Hale
Orbit 1 Team: J. M. (Milt) Heflin
Orbit 2 Team/Lead: R. M. (Rob) Kelso
Planning Team: L. J. (Linda) Ham

Entry: Automatic mode until subsonic, then control stick steering

Notes:

. The remote manipulator system is not installed in Discovery's payload bay for this mission.

. The shuttle orbiter repackaged galley is installed in Discovery's middeck.

. Due to the classified nature of the DOD-1 payload, the flight control room will operate in a classified mode from launch minus five hours until DOD-1 payload operations have been completed, at which time it will be transitioned to an unclassified mode. Normal NASA Public Affairs Office commentary will be broadcast through "go for orbit operations" (MET: 0/01:36). During DOD-1 payload operations, commentary will be restricted to orbiter/crew status reports, with normal PAO commentary resuming afterwards. NASA Select coverage will be normal before the launch; however, from lift-off through completion of DOD-1 operations, only a wide-angle view of the Mission Control Center will be available. Normal NASA Select coverage will resume after the completion of the DOD-1 payload operations. Downlink of video taken outside the orbiter crew cabin is prohibited; downlink of video inside the crew cabin is allowed if specified precautions are taken.

MISSION OBJECTIVES

. Primary objective
  - Department of Defense (DOD) 1 deployment
. Secondary objectives
  - Payload bay
    . Glow Experiment/Cryogenic Heat Pipe Experiment Payload (GCP)
    . Orbital Debris Radar Calibration System (ODERACS)
  - Middeck
    . Hand-held, Earth-oriented, Real-time, Cooperative, User Friendly, Location-targeting, and Environmental System (HERCULES)
    . Space Tissue Loss (STL)
    . Battlefield Laser Acquisition Sensor Test (BLAST)
    . Radiation Monitoring Equipment (RME) III
    . Visual Function Tester (VFT) 2
    . Cosmic Radiation Effects and Activation Monitor (CREAM)
    . Microcapsulation in Space (MIS) 1
    . Cloud Logic To Optimize Use of Defense Systems (CLOUDS) 1A
    . Fluid Acquisition and Resupply Equipment (FARE)
. 13 development test objectives/12 detailed supplementary objectives

FLIGHT ACTIVITIES OVERVIEW

Flight Day 1

Launch
OMS-2
Unstow cabin
DOD-1 deploy (MET 0/06:15)
RCS separation burn
CREAM activation
RME activation
GCP activation

Flight Day 2

GCP operations
HERCULES operations
VFT-2 operations
BLAST operations
FARE tests 1 and 2
Orbit adjust burns (OMS-3 and -4)

Flight Day 3

ODERACS deployment
RCS separation burn
GCP/GLO tests (Orbits 31-36)
HERCULES operations
FARE test 3
BLAST operations

Flight Day 4

HERCULES operations
BLAST operations
GCP/GLO tests (Orbits 50-54)
FARE test 4

Flight Day 5

HERCULES operations
BLAST operations
GCP/GLO tests (Orbits 65-70)
FARE tests 5, 6, and 7

Flight Day 6

HERCULES operations
BLAST operations
MIS operations
FARE test 8
GCP/GLO operations (Orbits 85-87)

Flight Day 7

GCP operations
FCS checkout
RCS hot-fire test
Cabin stow

Flight Day 8

Deorbit preparation
Deorbit burn
Landing

Notes:

- STS-53's unique inclination, altitude, and launch time dictate unusual on-orbit lighting. Extended periods of no orbital darkness exist. The occurrence of these extended lighting conditions varies within the mission timeline depending upon the actual lift-off time. The events listed above are for an on-time lift-off on Dec. 2, 1992. For launch later in the launch window, these events may change significantly.

- Each flight day includes a number of scheduled housekeeping activities. These include inertial measurement unit alignment, supply water dumps (as required), waste water dumps (as required), fuel cell purge, Ku-band antenna cable repositioning, and a daily private medical conference.

CREW ASSIGNMENTS

Commander (David [Dave] M. Walker):
Overall mission decisions
Payload--DOD-1, VFT-2

Pilot (Robert [Bob] D. Cabana):
Payload--GCP, MIS-1

Mission Specialist 1 (Guion [Guy] S. Bluford):
Payload--DOD-1, STL-1, CLOUDS-1A
Other--Earth observations

Mission Specialist 2 (James [Jim] S. Voss):
Payload--HERCULES, VFT-2
Medical DSO lead

Mission Specialist 3 (Michael Richard [Rich] U. Clifford):
Payload--FARE, BLAST, ODERACS
Other--Earth observations

DEVELOPMENT TEST OBJECTIVES/DETAILED SUPPLEMENTARY OBJECTIVES

DTOs

. Ascent structural capability evaluation (DTO 301D)
. Ascent compartment venting evaluation (DTO 305D)
. Descent compartment venting evaluation (DTO 306D)
. Entry structural capability evaluation (DTO 307D)
. Vibration and acoustic evaluation (DTO 308D)
. ET TPS performance (DTO 312)
. Orbiter/payload acceleration and acoustics environment data (DTO 319D)
. Edwards lakebed runway bearing strength assessment for orbiter landings (DTO 520)
. Orbiter drag chute system (DTO 521) (nose in the air deployment after initiation of derotation with crosswind <= 5 knots and touchdown near centerline)
. Evaluation of MK I rowing machine (DTO 653)
. PGSC single-event upset monitoring (DTO 656)
. Acoustical noise dosimeter data (DTO 663)
. Crosswind landing performance (DTO 805)

DSOs

. In-flight radiation dose distribution (TEPC only) (DSO 469)
. Intraocular pressure (DSO 472*)
. Retinal photography (DSO 474*)
. Hyperosmotic fluid countermeasure (DSO 479*)
. Orthostatic function during entry, landing, and egress (DSO 603B*)
. Visual-vestibular integration as a function of adaptation (DSO 604*)
. Posture equilibrium control during landing and egress (DSO 605*)
. Effects of space flight on aerobic and anaerobic metabolism at rest and during exercise (DSO 608*)
. The effect of prolonged space flight on head and gaze stability during locomotion (DSO 614*)
. Documentary television (DSO 901)
. Documentary motion picture photography (DSO 902)
. Documentary still photography (DSO 903)

* EDO buildup medical evaluation

STS-53 PRELAUNCH COUNTDOWN

T - (MINUS) HR:MIN:SEC	TERMINAL COUNTDOWN EVENT
06:00:00	Verification of the launch commit criteria is complete at this time. The liquid oxygen and liquid hydrogen systems chill-down commences in order to condition the ground line and valves as well as the external tank (ET) for cryo loading. Orbiter fuel cell power plant activation is performed.
05:50:00	The space shuttle main engine (SSME) liquid hydrogen chill-down sequence is initiated by the launch processing system (LPS). The liquid hydrogen recirculation valves are opened and start the liquid hydrogen recirculation pumps. As part of the chill-down sequence, the liquid hydrogen prevalves are closed and remain closed until T minus 9.5 seconds.
05:30:00	Liquid oxygen chill-down is complete. The liquid oxygen loading begins. The liquid oxygen loading starts with a "slow fill" in order to acclimate the ET. Slow fill continues until the tank is 2-percent full.
05:15:00	The liquid oxygen and liquid hydrogen slow fill is complete and the fast fill begins. The liquid oxygen and liquid hydrogen fast fill will continue until that tank is 98-percent full.
05:00:00	The calibration of the inertial measurement units (IMUs) starts. The three IMUs are used by the orbiter navigation systems to determine the position of the orbiter in flight.
04:30:00	The orbiter fuel cell power plant activation is complete.
04:00:00	The Merritt Island (MILA) antenna, which transmits and receives communications, telemetry and ranging information, alignment verification begins.
03:45:00	The liquid hydrogen fast fill to 98 percent is complete, and a slow topping-off process is begun and stabilized to 100 percent.
03:30:00	The liquid oxygen fast fill is complete to 98 percent.

T - (MINUS) HR:MIN:SEC	TERMINAL COUNTDOWN EVENT
03:20:00	The main propulsion system (MPS) helium tanks begin filling from 2,000 psi to their full pressure of 4,500 psi.
03:15:00	Liquid hydrogen stable replenishment begins and continues until just minutes prior to T minus zero.
03:10:00	Liquid oxygen stable replenishment begins and continues until just minutes prior to T minus zero.
03:00:00	The MILA antenna alignment is completed.
03:00:00	The orbiter closeout crew goes to the launch pad and prepares the orbiter crew compartment for flight crew ingress.
03:00:00 Holding	Begin 2-hour planned hold. An inspection team examines the ET for ice or frost formation on the launch pad during this hold.
03:00:00 Counting	Two-hour planned hold ends.
02:55:00	Flight crew departs Operations and Checkout (O&C) Building for launch pad.
02:25:00	Flight crew orbiter and seat ingress occurs.
02:10:00	Post ingress software reconfiguration occurs.
02:00:00	Checking of the launch commit criteria starts at this time.
02:00:00	The ground launch sequencer (GLS) software is initialized.
01:50:00	The solid rocket boosters' (SRBs') hydraulic pumping units' gas generator heaters are turned on and the SRBs' aft skirt gaseous nitrogen purge starts.
01:50:00	The SRB rate gyro assemblies (RGAs) are turned on. The RGAs are used by the orbiter's navigation system to determine rates of motion of the SRBs during first-stage flight.
01:35:00	The orbiter accelerometer assemblies (AAs) are powered up.

T - (MINUS) HR:MIN:SEC	TERMINAL COUNTDOWN EVENT
01:35:00	The orbiter reaction control system (RCS) control drivers are powered up.
01:35:00	The flight crew starts the communications checks.
01:25:00	The SRB RGA torque test begins.
01:20:00	Orbiter side hatch is closed.
01:10:00	Orbiter side hatch seal and cabin leak checks are performed.
01:01:00	IMU preflight align begins. Flight crew functions from this point on will be initiated by a call from the orbiter test conductor (OTC) to proceed. The flight crew will report back to the OTC after completion.
01:00:00	The orbiter RGAs and AAs are tested.
00:50:00	The flight crew starts the orbiter hydraulic auxiliary power units' (APUs') water boilers preactivation.
00:45:00	Cabin vent redundancy check is performed.
00:45:00	The GLS mainline activation is performed.
00:40:00	The eastern test range (ETR) shuttle range safety system (SRSS) terminal count closed-loop test is accomplished.
00:40:00	Cabin leak check is completed.
00:32:00	The backup flight control system (BFS) computer is configured.
00:30:00	The gaseous nitrogen system for the orbital maneuvering system (OMS) engines is pressurized for launch. Crew compartment vent valves are opened.
00:26:00	The ground pyro initiator controllers (PICs) are powered up. They are used to fire the SRB hold-down posts, liquid oxygen and liquid hydrogen tail service mast (TSM), and ET vent arm system pyros at lift-off and the SSME hydrogen gas burn system prior to SSME ignition.
00:25:00	Simultaneous air-to-ground voice communications are checked. Weather aircraft are launched.

T - (MINUS) HR:MIN:SEC	TERMINAL COUNTDOWN EVENT
00:22:00	The primary avionics software system (PASS) is transferred to the BFS computer in order for both systems to have the same data. In case of a PASS computer system failure, the BFS computer will take over control of the shuttle vehicle during flight.
00:21:00	The crew compartment cabin vent valves are closed.
00:20:00	A 10-minute planned hold starts.
Hold 10 Minutes	All computer programs in the firing room are verified to ensure that the proper programs are available for the final countdown. The test team is briefed on the recycle options in case of an unplanned hold.
	The landing convoy status is again verified and the landing sites are verified ready for launch.
	The IMU preflight alignment is verified complete.
	Preparations are made to transition the orbiter onboard computers to Major Mode (MM)-101 upon coming out of the hold. This configures the computer memory to a terminal countdown configuration.
00:20:00	The 10-minute hold ends.
Counting	Transition to MM-101. The PASS onboard computers are dumped and compared to verify the proper onboard computer configuration for launch.
00:19:00	The flight crew configures the backup computer to MM-101 and the test team verifies the BFS computer is tracking the PASS computer systems. The flight crew members configure their instruments for launch.
00:18:00	The Mission Control Center-Houston (MCC-H) now loads the onboard computers with the proper guidance parameters based on the prestated lift-off time.
00:16:00	The MPS helium system is reconfigured by the flight crew for launch.
00:15:00	The OMS/RCS crossfeed valves are configured for launch.
	All test support team members verify they are "go for launch."

T - (MINUS) HR:MIN:SEC	TERMINAL COUNTDOWN EVENT
00:12:00	Emergency aircraft and personnel are verified on station.
00:10:00	All orbiter aerosurfaces and actuators are verified to be in the proper configuration for hydraulic pressure application. The NASA test director gets a "go for launch" verification from the launch team.
00:09:00	A planned 10-minute hold starts.
Hold 10 Minutes	NASA and contractor project managers will be formally polled by the deputy director of NASA, Space Shuttle Operations, on the Space Shuttle Program Office communications loop during the T minus 9-minute hold. A positive "go for launch" statement will be required from each NASA and contractor project element prior to resuming the launch countdown. The loop will be recorded and maintained in the launch decision records.
	All test support team members verify that they are "go for launch."
	Final GLS configuration is complete.
00:09:00 Counting	The GLS auto sequence starts and the terminal countdown begins.
	From this point, the GLSs in the integration and backup consoles are the primary control until T-0 in conjunction with the onboard orbiter PASS redundant-set computers.
00:09:00	Operations recorders are on. MCC-H, Johnson Space Center, sends a command to turn these recorders on. They record shuttle system performance during ascent and are dumped to the ground once orbit is achieved.
00:08:00	Payload and stored prelaunch commands proceed.
00:07:30	The orbiter access arm (OAA) connecting the access tower and the orbiter side hatch is retracted. If an emergency arises requiring flight crew activation, the arm can be extended either manually or by GLS computer control in approximately 30 seconds or less.
00:06:00	APU prestart occurs.

T - (MINUS) HR:MIN:SEC	TERMINAL COUNTDOWN EVENT
00:05:00	Orbiter APUs start. The orbiter APUs provide pressure to the three orbiter hydraulic systems. These systems are used to move the SSME engine nozzles and aerosurfaces.
00:05:00	ET/SRB range safety system (RSS) is armed. At this point, the firing circuit for SRB ignition and destruct devices is mechanically enabled by a motor-driven switch called a safe and arm device (S&A).
00:04:30	As a preparation for engine start, the SSME main fuel valve heaters are turned off.
00:04:00	The final helium purge sequence, purge sequence 4, on the SSMEs is started in preparation for engine start.
00:03:55	At this point, all of the elevons, body flap, speed brake, and rudder are moved through a preprogrammed pattern. This is to ensure that they will be ready for use in flight.
00:03:30	Transfer to internal power is done. Up to this point, power to the space vehicle has been shared between ground power supplies and the onboard fuel cells. The ground power is disconnected and the vehicle goes on internal power at this time. It will remain on internal power through the rest of the mission.
00:03:25	The SSMEs' nozzles are moved (gimbaled) through a preprogrammed pattern to ensure that they will be ready for ascent flight control. At completion of the gimbal profile, the SSMEs' nozzles are in the start position.
00:02:55	ET liquid oxygen prepressurization is started. At this point, the liquid oxygen tank vent valve is closed and the ET liquid oxygen tank is pressurized to its flight pressure of 21 psi.
00:02:50	The gaseous oxygen arm is retracted. The cap that fits over the ET nose cone to prevent ice buildup on the oxygen vents is raised off the nose cone and retracted.
00:02:35	Up until this time, the fuel cell oxygen and hydrogen supplies have been adding to the onboard tanks so that a full load at lift-off is assured. This filling operation is terminated at this time.

T - (MINUS) HR:MIN:SEC	TERMINAL COUNTDOWN EVENT
00:02:30	The caution/warning memory is cleared.
00:01:57	Since the ET liquid hydrogen tank was filled, some of the liquid hydrogen has turned into gas. In order to keep pressure in the ET liquid hydrogen tank low, this gas was vented off and piped out to a flare stack and burned. In order to maintain flight level, liquid hydrogen was continuously added to the tank to replace the vented hydrogen. This operation terminates, the liquid hydrogen tank vent valve is closed, and the tank is brought up to a flight pressure of 44 psia at this time.
00:01:15	The sound suppression system will dump water onto the mobile launcher platform (MLP) at ignition in order to dampen vibration and noise in the space shuttle. The firing system for this dump, the sound suppression water power bus, is armed at this time.
00:01:00	The SRB joint heaters are deactivated.
00:00:55	The SRB MDM critical commands are verified.
00:00:47	The liquid oxygen and liquid hydrogen outboard fill and drain valves are closed.
00:00:40	The external tank bipod heaters are turned off.
00:00:38	The onboard computers position the orbiter vent doors to allow payload bay venting upon lift-off and ascent in the payload bay at SSME ignition.
	The SRB forward MDM is locked out.
00:00:37	The gaseous oxygen ET arm retract is confirmed.
00:00:31	The GLS sends "go for redundant set launch sequence start." At this point, the four PASS computers take over main control of the terminal count. Only one further command is needed from the ground, "go for main engine start," at approximately T minus 9.7 seconds. The GLS in the integration console in the launch control center still continues to monitor several hundred launch commit criteria and can issue a cutoff if a discrepancy is observed. The GLS also sequences ground equipment and sends selected vehicle commands in the last 31 seconds.

T - (MINUS) HR:MIN:SEC	TERMINAL COUNTDOWN EVENT
00:00:28	Two hydraulic power units in each SRB are started by the GLS. These provide hydraulic power for SRB nozzle gimbaling for ascent first-stage flight control.
	The orbiter vent door sequence starts.
00:00:21	The SRB gimbal profile is complete. As soon as SRB hydraulic power is applied, the SRB engine nozzles are commanded through a preprogrammed pattern to assure that they will be ready for ascent flight control during first stage.
00:00:21	The liquid hydrogen high-point bleed valve is closed.
	The SRB gimbal test begins.
00:00:18	The onboard computers arm the explosive devices, the pyrotechnic initiator controllers, that will separate the T-0 umbilicals, the SRB hold-down posts, and SRB ignition, which is the final electrical connection between the ground and the shuttle vehicle.
00:00:16	The sound suppression system water is activated.
00:00:15	If the SRB pyro initiator controller (PIC) voltage in the redundant-set launch sequencer (RSLS) is not within limits in 3 seconds, SSME start commands are not issued and the onboard computers proceed to a countdown hold.
00:00:13	The aft SRB MDM units are locked out. This is to protect against electrical interference during flight. The electronic lock requires an unlock command before it will accept any other command.
	SRB SRSS inhibits are removed. The SRB destruct system is now live.
00:00:12	The MPS helium fill is terminated. The MPS helium system flows to the pneumatic control system at each SSME inlet to control various essential functions.
00:00:10	LPS issues a "go" for SSME start. This is the last required ground command. The ground computers inform the orbiter onboard computers that they have a "go" for SSME start. The GLS retains hold capability until just prior to SRB ignition.

T - (MINUS) HR:MIN:SEC	TERMINAL COUNTDOWN EVENT
00:00:09.7	Liquid hydrogen recirculation pumps are turned off. The recirculation pumps provide for flow of fuel through the SSMEs during the terminal count. These are supplied by ground power and are powered in preparation for SSME start.
00:00:09.7	In preparation for SSME ignition, flares are ignited under the SSMEs. This burns away any free gaseous hydrogen that may have collected under the SSMEs during prestart operations. The orbiter goes on internal cooling at this time; the ground coolant units remain powered on until lift-off as a contingency for an aborted launch. The orbiter will redistribute heat within the orbiter until approximately 125 seconds after lift-off, when the orbiter flash evaporators will be turned on.
00:00:09.5	The SSME engine chill-down sequence is complete and the onboard computers command the three MPS liquid hydrogen prevalves to open. (The MPSs three liquid oxygen prevalves were opened during ET tank loading to permit engine chill-down.) These valves allow liquid hydrogen and oxygen flow to the SSME turbopumps.
00:00:09.5	Command decoders are powered off. The command decoders are units that allow ground control of some onboard components. These units are not needed during flight.
00:00:06.6	The main fuel and oxidizer valves in each engine are commanded open by the onboard computers, permitting fuel and oxidizer flow into each SSME for SSME start. All three SSMEs are started at 120-millisecond intervals (SSME 3, 2, then 1) and throttle up to 100-percent thrust levels in 3 seconds under control of the SSME controller on each SSME.
00:00:04.6	All three SSMEs are verified to be at 100-percent thrust and the SSMEs are gimbaled to the lift-off position. If one or more of the three SSMEs does not reach 100-percent thrust at this time, all SSMEs are shut down, the SRBs are not ignited, and an RSLS pad abort occurs. The GLS RSLS will perform shuttle and ground systems safing. Vehicle bending loads caused by SSME thrust buildup are allowed to initialize before SRB ignition. The vehicle moves towards ET including ET approximately 25.5 inches.

T - (MINUS) HR:MIN:SEC	TERMINAL COUNTDOWN EVENT
00:00:00	The two SRBs are ignited under command of the four onboard PASS computers, the four hold-down explosive bolts on each SRB are initiated (each bolt is 28 inches long and 3.5 inches in diameter), and the two T-0 umbilicals on each side of the spacecraft are retracted. The onboard timers are started and the ground launch sequence is terminated. All three SSMEs are at 104-percent thrust. Boost guidance in attitude hold.
00:00	Lift-off.

STS-53 MISSION HIGHLIGHTS TIMELINE

Editor's Note: This timeline lists selected highlights only. For full detail, please refer to the NASA Mission Operations Directorate STS-53 Flight Plan, Ascent Checklist, Post Insertion Checklist, Deorbit Prep Checklist, Entry Checklist, and Special Deploy Checklist.

STS-53's unique inclination, altitude, and launch time dictate unusual on-orbit lighting. Extended periods of no orbital darkness exist. The occurrence of these extended lighting conditions varies within the mission timeline depending upon the actual lift-off time. The times listed below are for an on-time lift-off on Dec. 2, 1992. For launch later in the launch window, these events may change significantly. The DOD-1 deploy and SEP-1 burn times are also subject to change for any subsequent launch date change.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
DAY ZERO	
0/00:00:07	Tower is cleared (SRBs above lightning-rod tower).
0/00:00:10	180-degree positive roll maneuver (right-clockwise) is started. Pitch profile is heads down, wings level.
0/00:00:19	Roll maneuver ends.
0/00:00:28	All three SSMEs throttle down from 100 to 67 percent for maximum aerodynamic load (max q).
0/00:00:53	Max q occurs.
0/00:01:01	All three SSMEs throttle to 104 percent.
0/00:02:04	SRBs separate.
	When chamber pressure (Pc) of the SRBs is less than 50 psi, automatic separation occurs with manual flight crew backup switch to the automatic function (does not bypass automatic circuitry). SRBs descend to approximately 15,400 feet, when the nose cap is jettisoned and drogue chute is deployed for initial deceleration.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
	At approximately 6,600 feet, drogue chute is released and three main parachutes on each SRB provide final deceleration prior to splashdown in Atlantic Ocean, where the SRBs are recovered for reuse on another mission. Flight control system switches from SRB to orbiter RGAs.
0/00:04:05	Negative return. The vehicle is no longer capable of return-to-launch site abort at Kennedy Space Center runway.
0/00:07:02	Single engine press to main engine cutoff (MECO).
0/00:08:26	All three SSMEs throttle down to 67 percent for MECO.
0/00:08:34	MECO occurs at approximate velocity 25,885 feet per second, 11 by 198 nautical miles (13 by 228 statute miles).
0/00:08:54	ET separation is automatic with flight crew manual backup switch to the automatic function (does not bypass automatic circuitry).
	The orbiter forward and aft RCSs, which provide attitude hold and negative Z translation of 11 fps to the orbiter for ET separation, are first used.
	Orbiter/ET liquid oxygen/liquid hydrogen umbilicals are retracted.
	Negative Z translation is complete.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
	In conjunction with this thrusting period, approximately 1,700 pounds of liquid hydrogen and 3,700 pounds of liquid oxygen are trapped in the MPS ducts and SSMEs, which results in an approximate 7-inch center-of-gravity shift in the orbiter. The trapped propellants would sporadically vent in orbit, affecting guidance and creating contaminants for the payloads. During entry, liquid hydrogen could combine with atmospheric oxygen to form a potentially explosive mixture. As a result, the liquid oxygen is dumped out through the SSME combustion chamber nozzles, and the liquid hydrogen is dumped out through the right-hand T-minus-zero umbilical overboard fill and drain valves.
	MPS dump terminates.
	APUs shut down.
	MPS vacuum inerting occurs.
	--Remaining residual propellants are vented to space vacuum, inerting the MPS.
	--Orbiter/ET umbilical doors close (one door for liquid hydrogen and one door for liquid oxygen) at bottom of aft fuselage, sealing the aft fuselage for entry heat loads.
	--MPS vacuum inerting terminates.
0/00:37	OMS-2 thrusting maneuver is performed, approximately 3 minutes, 22 seconds in duration, at 336 fps, 200 by 201 nautical miles.
0/00:51	Commander closes all current breakers, panel L4.
0/00:53	Mission specialist (MS) seat egress.
0/00:54	Commander and pilot configure GPCs for OPS-2.
0/00:57	MS configures preliminary middeck.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
0/00:59	MS configures aft flight station.
0/01:02	MS unstows, sets up, and activates PGSC.
0/01:06	Pilot activates payload bus (panel R1).
0/01:08	Commander and pilot don and configure communications.
0/01:12	Pilot maneuvers vehicle to payload bay door opening attitude, biased negative Z local vertical, positive Y velocity vector attitude.
0/01:17	Commander activates radiators.
0/01:19	If go for payload bay door operations, MS configures for payload bay door operations.
0/01:27	Orbit 2 begins.
0/01:28	MS opens payload bay doors.
0/01:30	Commander loads payload data interleaver decommutator format.
0/01:30	MS performs standard switch panel/display check (DOD-1).
0/01:33	Commander switches star tracker power 2 (panel 06) to ON.
0/01:36	Mission Control Center (MCC), Houston (H), informs crew to "go for orbit operations."
0/01:37	Commander and pilot seat egress.
0/01:38	Commander and pilot clothing configuration.
0/01:39	MS/PS clothing configuration.
0/01:40	MS performs DOD-1 activation.
0/01:50	Pilot initiates fuel cell auto purge.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
0/01:51	MS activates teleprinter (if flown).
0/01:53	Commander begins post-payload bay door operations and radiator configuration.
0/01:55	MS/PS remove and stow seats.
0/01:55	DOD-1 radio frequency check.
0/01:56	Commander starts ST self-test and opens door.
0/01:57	MS configures middeck.
0/01:59	Pilot closes main B supply water dump isolation circuit breaker, panel ML86B, opens supply water dump isolation valve, panel R12L.
0/02:01	Pilot activates auxiliary power unit steam vent heater, panel R2, boiler controller/heater, 3 to A, power, 3 to ON.
0/02:05	MS performs MPM rollout.
0/02:10	Commander configures vernier controls.
0/02:12	Commander, pilot configure controls for on-orbit.
0/02:15	MS continues DOD-1 activation.
0/02:24	MS enables hydraulic thermal conditioning.
0/02:26	MS resets caution/warning (C/W).
0/02:28	Pilot plots fuel cell performance.
0/02:58	Orbit 3 begins.
0/03:05	DOD-1 radio frequency check.
0/03:15	STL activation.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
0/03:35	Ku-band antenna deployment.
0/04:32	Orbit 4 begins.
0/04:40	DOD-1 radio frequency check.
0/05:40	Maneuver orbiter to DOD-1 deploy attitude
0/05:55	P/TV02 activation.
0/06:04	Orbit 5 begins.
0/06:15	DOD-1 deployment.
0/06:35	SEP-1 DOD-1 RCS separation burn.
0/07:00	CREAM activation (Station 1--airlock).
0/07:05	DSO 474--retinal photography.
0/07:10	GCP activation.
0/07:15	RME-III activation/checkout.
0/07:20	HERCULES unstow.
0/07:20	DSO 469--radiation dose distribution.
0/07:35	Orbit 6 begins.
0/07:40	Ku-band antenna deployment.
0/07:45	DSO 472--intraocular pressure.
0/07:45	DTO 656--PGSC single-event upset monitoring.
0/07:50	Ku-band antenna activation.
0/08:00	Crew begins presleep activities.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
0/09:07	Orbit 7 begins.
0/10:40	Orbit 8 begins.
0/11:00	Crew begins sleep period.
0/12:11	Orbit 9 begins.
0/13:43	Orbit 10 begins.
0/15:16	Orbit 11 begins.
0/16:47	Orbit 12 begins.
0/18:20	Orbit 13 begins.
0/19:00	Crew begins postsleep activities.
0/19:51	Orbit 14 begins.
0/20:35	DTO 656--PGSC single-event upset monitoring.
0/21:23	Orbit 15 begins.
0/22:00	HERCULES attitude processor activation.
0/22:05	HERCULES enter time.
0/22:10	HERCULES electronic still camera activation.
0/22:15	DTO 663--acoustical noise dosimeter.
0/22:30	HERCULES state vector update.
0/22:35	HERCULES inertial measurement unit alignment.
0/22:50	HERCULES operations--Baltra Island, Kingston, NAS Bermuda.
0/22:55	Orbit 16 begins.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
0/23:15	HERCULES operations--Bornholm Island.
0/23:40	BLAST unstow.
0/23:40	DSO 604--visual-vestibular integration.

MET DAY ONE

1/00:20	HERCULES electronic still camera activation.
1/00:25	STL filter check.
1/00:27	Orbit 17 begins.
1/00:30	HERCULES operations--Tampico International.
1/00:30	Exercise.
1/00:40	HERCULES operations--Anticosti Island.
1/00:50	HERCULES operations--Isle of Man, Imroz Adasi.
1/01:00	FARE setup.
1/01:50	BLAST setup.
1/01:58	Orbit 18 begins.
1/02:05	BLAST operations--Ft. Huachuca, Ft. Carson.
1/02:05	HERCULES electronic still camera activation.
1/02:10	HERCULES operations--Shakespeare Island, Mistasin Lake.
1/02:15	Exercise.
1/02:20	BLAST temporary stow.
1/03:32	Orbit 19 begins.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
1/04:00	VFT-2 (commander).
1/04:05	P/TV05 activation.
1/04:05	FARE 1 test.
1/04:30	VFT-2 (MS2).
1/05:00	FARE 2 test.
1/05:03	Orbit 20 begins.
1/05:56	OMS-3 height adjust burn.
1/06:00	Exercise.
1/06:35	Orbit 21 begins.
1/06:43	OMS-4 circularization burn.
1/06:50	Exercise.
1/06:55	DSO 474--retinal photography.
1/07:15	RME detector move to Station 2--middeck wall.
1/07:30	DTO 656--PGSC single-event upset monitoring.
1/07:35	DSO 472--intraocular pressure.
1/07:50	DTO 663--acoustical dosimeter.
1/08:00	Crew begins presleep activities.
1/08:06	Orbit 22 begins.
1/08:45	BLAST overflight--Malabar.
1/09:37	Orbit 23 begins.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
1/10:15	BLAST overflights--White Sands, Lazap.
1/11:00	Crew begins sleep period.
1/11:08	Orbit 24 begins.
1/12:38	Orbit 25 begins.
1/14:10	Orbit 26 begins.
1/15:41	Orbit 27 begins.
1/17:12	Orbit 28 begins.
1/18:43	Orbit 29 begins.
1/19:00	Crew begins postsleep activities.
1/19:30	DTO 656--PGSC single-event upset monitoring.
1/20:13	Orbit 30 begins.
1/21:30	P/TV03 activation.
1/21:45	Orbit 31 begins.
1/21:58	ODERACS deployment.
1/22:03	SEP-2 ODERACS RCS separation maneuver.
1/22:10	DTO 663--acoustical dosimeter.
1/22:55	GCP VRCS observations.
1/23:16	Orbit 32 begins.
1/23:40	RME-III memory module replacement.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
MET DAY TWO	
2/00:00	P/TV05 activation.
2/00:00	FARE test 3.
2/00:25	GCP OG yaw observations.
2/00:47	Orbit 33 begins.
2/01:00	Exercise.
2/01:25	GCP OG PRCS observations.
2/02:00	Exercise.
2/02:18	Orbit 34 begins.
2/02:30	BLAST setup.
2/02:50	GCP AG 90 observation.
2/03:49	Orbit 35 begins.
2/03:50	BLAST operations--AMOS.
2/04:00	BLAST temporary stow.
2/04:00	P/TV04 activation.
2/04:00	VFT-2 (MS2).
2/04:30	VFT-2 (commander).
2/04:55	GCP VRCS observations.
2/05:20	Orbit 36 begins.
2/05:30	Exercise.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
2/06:15	RME-III detector move to station 1--airlock ceiling.
2/06:15	P/TV04 activation.
2/06:25	GCP OG yaw observations.
2/06:45	Exercise.
2/06:51	Orbit 37 begins.
2/08:10	Exercise.
2/08:15	DTO 656--PGSC single-event upset monitoring.
2/08:22	Orbit 38 begins.
2/08:35	DTO 663--acoustical dosimeter.
2/08:40	BLAST setup.
2/08:45	DTO 663--acoustical dosimeter.
2/08:55	BLAST operations--Malabar.
2/09:00	Crew begins presleep activities.
2/09:05	BLAST temporary stow.
2/09:53	Orbit 39 begins.
2/10:30	BLAST overflights--China Lake, Edwards, Ft. Huachuca.
2/11:24	Orbit 40 begins.
2/12:00	Crew begins sleep period.
2/12:55	Orbit 41 begins.
2/14:26	Orbit 42 begins.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
2/15:57	Orbit 43 begins.
2/17:28	Orbit 44 begins.
2/18:58	Orbit 45 begins.
2/20:00	Crew begins postsleep activities.
2/20:30	Orbit 46 begins.
2/21:15	DTO 656--PGSC single-event upset monitoring.
2/22:02	Orbit 47 begins.
2/22:55	P/TV06 activation.
2/23:05	HERCULES HAP activation.
2/23:10	HERCULES ESC activation.
2/23:15	HERCULES HIMU alignment.
2/23:25	HERCULES state vector update.
2/23:30	HERCULES operations--Veracruz International, Keesler Air Force Base, Anticosti Island, Isle of Man.
2/23:33	Orbit 48 begins.
2/23:40	DTO 663--acoustical dosimeter.

MET DAY THREE

3/00:00	DTO 653--MK I rowing machine evaluation.
3/00:30	Exercise.
3/00:30	DTO 653--P/TV.
3/00:55	BLAST setup.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
3/01:00	HERCULES ESC activation.
3/01:04	Orbit 49 begins.
3/01:10	BLAST operations--Ft. Huachuca, White Sands, Ft. Carson and Lazap.
3/01:10	HERCULES operations--Duluth International, Charlton Island.
3/01:20	DTO 653.
3/01:25	HERCULES ESC activation.
3/01:30	BLAST temporary stow.
3/01:30	HERCULES operations--Cap Bon.
3/01:40	DTO 653 P/TV.
3/01:40	Exercise.
3/01:45	HERCULES operations--Zanzibar Island.
3/02:05	HERCULES ESC activation.
3/02:15	HERCULES operations--Tauranga.
3/02:35	Orbit 50 begins.
3/02:55	HERCULES ESC activation.
3/03:05	HERCULES operations--Meddouza.
3/03:15	DTO 663--acoustical dosimeter.
3/03:55	GCP AG 30 observation.
3/04:06	Orbit 51 begins.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
3/05:15	VFT-2 (MS2).
3/05:25	GCP AG 10 observation.
3/05:37	Orbit 52 begins.
3/05:45	VFT-2 (commander).
3/06:00	FARE test 4.
3/06:15	RME-III detector move to station 2--middeck wall.
3/06:15	P/TV05 activation.
3/06:30	RME-III memory module replacement.
3/06:45	GCP PRCS burn observations.
3/07:08	Orbit 53 begins.
3/07:25	GCP PRCS observations.
3/08:00	Exercise.
3/08:15	GCP PRCS observations.
3/08:39	Orbit 54 begins.
3/08:50	BLAST setup.
3/09:05	BLAST operations--Ft. Carson, White Sands, Lazap.
3/09:30	DTO 663--acoustical dosimeter.
3/09:35	DTO 656--PGSC single-event upset monitoring.
3/09:40	BLAST temporary stow.
3/09:50	GCP water dump.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
3/10:00	Crew begins presleep activities.
3/10:10	Orbit 55 begins.
3/11:41	Orbit 56 begins.
3/13:00	Crew begins sleep period.
3/13:12	Orbit 57 begins.
3/14:43	Orbit 58 begins.
3/16:14	Orbit 59 begins.
3/17:45	Orbit 60 begins.
3/19:16	Orbit 61 begins.
3/20:47	Orbit 62 begins.
3/21:00	Crew begins postsleep activities.
3/21:40	DTO 656--PGSC single-event upset monitoring.
3/22:18	Orbit 63 begins.
3/22:30	BLAST overflight--Malabar.
3/23:20	HERCULES ESC activation.
3/23:25	HERCULES HAP activation.
3/23:30	HERCULES HIMU alignment.
3/23:40	HERCULES state vector update.
3/23:40	BLAST setup.
3/23:49	Orbit 64 begins.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
3/23:55	BLAST operations--Ft. Leonard Wood.

MET DAY FOUR

4/00:00	BLAST operations--Ft. Leonard Wood.
4/00:00	DTO 663--acoustical dosimeter.
4/00:00	HERCULES operations--Cape Hurd, Goose Apt, Isle of Wight.
4/00:10	BLAST temporary stow.
4/00:15	DTO 663--acoustical dosimeter.
4/00:25	HERCULES operations--Djibouti.
4/00:30	Exercise.
4/01:10	BLAST setup.
4/01:20	Orbit 65 begins.
4/01:20	HERCULES ESC activation.
4/01:25	BLAST operations--Edwards, China Lake.
4/01:30	HERCULES operations--Winnipeg International, Mistasin Lake.
4/01:45	BLAST temporary stow.
4/02:25	GCP VRCS observations.
4/02:51	Orbit 66 begins.
4/03:00	FARE test 5.
4/03:00	P/TV05 activation.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
4/03:35	GCP OG PRCS observations.
4/04:00	VFT-2 (MS2).
4/04:15	Exercise.
4/04:23	Orbit 67 begins.
4/04:30	VFT-2 (commander).
4/05:15	GCP OG observation.
4/05:53	Orbit 68 begins.
4/06:00	CREAM deactivation.
4/06:15	P/TV08 activation.
4/06:30	Crew press conference.
4/06:45	GCP OG observation.
4/07:15	FARE test 6.
4/07:15	P/TV05 activation.
4/07:25	Orbit 69 begins.
4/07:30	Free drift.
4/08:15	FARE test 7.
4/08:30	GCP VRCS observations.
4/08:50	P/TV05 activation.
4/08:55	Orbit 70 begins.
4/09:05	Free drift.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
4/10:05	GCP water dump.
4/10:10	DTO 663--acoustical dosimeter.
4/10:25	DTO 656--PGSC single-event upset monitoring.
4/10:27	Orbit 71 begins.
4/10:30	Crew begins presleep activities.
4/11:57	Orbit 72 begins.
4/12:15	GCP FCP observation.
4/12:35	BLAST overflight--AMOS.
4/13:29	Orbit 73 begins.
4/13:30	Crew begins sleep period.
4/14:59	Orbit 74 begins.
4/16:31	Orbit 75 begins.
4/18:02	Orbit 76 begins.
4/19:33	Orbit 77 begins.
4/21:05	Orbit 78 begins.
4/21:30	Crew begins postsleep activities.
4/22:10	DTO 656--PGSC single-event upset monitoring.
4/22:35	Orbit 79 begins.
4/22:45	BLAST overflight--Malabar.
4/23:30	BLAST setup.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
4/23:35	HERCULES HAP activation.
4/23:40	HERCULES ESC activation.
4/23:50	HERCULES HIMU alignment.

MET DAY FIVE

5/00:00	HERCULES state vector update.
5/00:06	Orbit 80 begins.
5/00:10	BLAST operations--Ft. Huachuca, White Sands, Ft. Carson, Lazap.
5/00:15	HERCULES operations--Keeweenaw Pt.
5/00:30	HERCULES operations--Isola Asinala.
5/00:30	BLAST temporary stow.
5/00:45	DTO 663--acoustical noise dosimeter.
5/00:50	RME-III memory module replacement.
5/01:05	Dumpline purge.
5/01:05	HERCULES ESC activation.
5/01:15	HERCULES operations--Banks Peninsula.
5/01:35	HERCULES ESC activation.
5/01:37	Orbit 81 begins.
5/01:45	Exercise.
5/01:45	HERCULES operations--Reindeer Island, Mistasin Lake.
5/02:05	HERCULES operations--Maputo.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
5/02:10	VFT-2 (commander).
5/02:15	HERCULES ESC activation.
5/02:20	HERCULES operations--Mohammedia.
5/02:40	VFT-2 (MS2).
5/02:55	BLAST setup.
5/03:08	Orbit 82 begins.
5/03:10	BLAST operations--AMOS.
5/03:20	BLAST temporary stow.
5/03:35	Exercise.
5/03:45	HERCULES deactivation.
5/03:55	HERCULES stow.
5/04:15	DSO 604--visual vestibular integration.
5/04:20	GCP GLO test.
5/04:39	Orbit 83 begins.
5/05:00	Maneuver and initiate gravity gradient.
5/05:15	MIS-1 activation.
5/05:20	Free drift.
5/06:10	Orbit 84 begins.
5/06:25	BLAST setup.
5/06:40	BLAST operations--Malabar.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
5/06:45	P/TV05 activation.
5/06:45	FARE test 8.
5/07:00	Free drift.
5/07:00	DSO 474--retinal photography.
5/07:40	DSO 472--intraocular pressure.
5/07:40	GCP FCP observation.
5/07:41	Orbit 85 begins.
5/07:50	FARE stow.
5/08:20	BLAST overflight--Ft. Carson.
5/08:30	BLAST stow.
5/08:55	GCP FES observation.
5/09:12	Orbit 86 begins.
5/09:50	MIS-1 deactivation.
5/10:15	DTO 656--PGSC single-event upset monitoring.
5/10:25	GCP water dump.
5/10:30	Crew begins presleep activities.
5/10:35	DTO 663--acoustical dosimeter.
5/10:43	Orbit 87 begins.
5/12:14	Orbit 88 begins.
5/13:30	Crew begins sleep period.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
5/13:45	Orbit 89 begins.
5/15:16	Orbit 90 begins.
5/16:47	Orbit 91 begins.
5/18:18	Orbit 92 begins.
5/19:50	Orbit 93 begins.
5/21:21	Orbit 94 begins.
5/21:30	Crew begins postsleep activities.
5/22:52	Orbit 95 begins.
5/23:00	GCP GLO tests (Orbits 95-101).

MET DAY SIX

Note: MET day six is an extension day added to the mission following release of the Final NASA MOD Flight Plan. The extension day was added to provide additional time for GCP operations. The full activities schedule for this day was not available at press time.

6/00:23	Orbit 96 begins.
6/01:00	DTO 663--acoustical dosimeter.
6/01:15	DTO 656--PGSC single-event upset monitoring.
6/01:25	CREAM deactivation.
6/01:45	DSO 469--radiation dose distribution.
6/01:54	Orbit 97 begins.
6/03:20	FCS checkout.
6/03:25	Orbit 98 begins.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
6/04:40	RCS hot fire test.
6/04:56	Orbit 99 begins.
6/06:27	Orbit 100 begins.
6/07:30	Cabin stow.
6/07:58	Orbit 101 begins.
6/09:29	Orbit 102 begins.
6/10:30	Crew begins presleep activities.
6/11:00	Orbit 103 begins.
6/11:20	Ku-band antenna stow.
6/12:00	Maneuver and initiate PTCs.
6/12:31	Orbit 104 begins.
6/13:30	Crew begins sleep period.
6/14:02	Orbit 105 begins.
6/15:33	Orbit 106 begins.
6/17:04	Orbit 107 begins.
6/18:35	Orbit 108 begins.
6/20:06	Orbit 109 begins.
6/21:30	Crew begins postsleep activities.
6/21:37	Orbit 110 begins.
6/23:08	Orbit 111 begins.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
6/23:35	Terminate PTCs.

MET DAY SEVEN

7/00:30	GCP deactivation.
7/00:39	Orbit 112 begins.
7/00:52	Begin deorbit preparation.
7/00:52	CRT timer setup.
7/00:57	Commander initiates coldsoak.
7/01:06	Stow radiators, if required.
7/01:24	Commander configures DPS for deorbit preparation.
7/01:27	Mission Control Center updates IMU star pad, if required.
7/01:36	MS configures for payload bay door closure.
7/01:47	MCC-H gives "go/no-go" command for payload bay door closure.
7/01:57	Maneuver vehicle to IMU alignment attitude.
7/02:10	Orbit 113 begins.
7/02:12	IMU alignment/payload bay door operations.
7/02:30	Entry DSO preparation (DSO 603--entry preparation).
7/02:35	MCC gives the crew the go for OPS 3.
7/02:42	Pilot starts repressurization of SSME systems.
7/02:46	Commander and pilot perform DPS entry configuration.
7/02:55	MS deactivates ST and closes ST doors.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
7/02:57	All crew members verify entry payload switch list.
7/03:12	All crew members perform entry review.
7/03:14	Crew begins fluid loading, 32 fluid ounces of water with salt over next 1.5 hours (2 salt tablets per 8 ounces).
7/03:27	Commander and pilot configure clothing.
7/03:35	STL entry preparation.
7/03:41	Orbit 114 begins.
7/03:42	MS/PS configure clothing.
7/03:53	Commander and pilot seat ingress.
7/03:55	Commander and pilot set up heads-up display (HUD).
7/03:57	Commander and pilot adjust seat, exercise brake pedals.
7/04:05	Final entry deorbit update/uplink.
7/04:11	OMS thrust vector control gimbal check is performed.
7/04:12	APU prestart.
7/04:27	Close vent doors.
7/04:31	MCC-H gives "go" for deorbit burn period.
7/04:37	Maneuver vehicle to deorbit burn attitude.
7/04:40	MS/PS ingress seats.
7/04:47	First APU is activated.
7/04:52	Deorbit burn.
7/04:53	DOD-1 ASE heater deactivation.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
7/04:57	Initiate post-deorbit burn period attitude.
7/05:01	Terminate post-deorbit burn attitude.
7/05:09	Dump forward RCS, if required.
7/05:12	Orbit 115 begins.
7/05:17	Activate remaining APUs.
7/05:23	Entry interface, 400,000 feet altitude.
7/05:27	Automatically deactivate RCS roll thrusters.
7/05:34	Automatically deactivate RCS pitch thrusters.
7/05:35	Initiate first roll reversal.
7/05:41	Initiate second roll reversal.
7/05:43	TACAN acquisition.
7/05:45	Initiate air data system (ADS) probe deploy.
7/05:46	Initiate third roll reversal.
7/05:47	Begin entry/terminal area energy management (TAEM).
7/05:47	Initiate payload bay venting.
7/05:49	Automatically deactivate RCS yaw thrusters.
7/05:53	Begin TAEM/approach/landing (A/L) interface.
7/05:53	Initiate landing gear deployment.
7/05:54	Vehicle has weight on main landing gear.
7/05:54	Vehicle has weight on nose landing gear.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
7/05:54	Initiate main landing gear braking.
7/05:55	Wheel stop.

GLOSSARY

A/G	air-to-ground
AG	airglow
AA	accelerometer assembly
ACS	active cooling system
ADS	air data system
AFB	Air Force base
AIS	Arizona Imaging Spectrograph (GCP)
A/L	approach and landing
AMOS	Air Force Maui Optical Site
AOS	acquisition of signal
APC	autonomous payload controller
APCS	autonomous payload control system
APU	auxiliary power unit
ASE	airborne support equipment
BLAST	Battlefield Laser Acquisition Sensor Test
BFS	backup flight control system
CCD	charge-coupled device
CDMS	command and data management subsystem
CLOUDS-1A	Cloud Logic To Optimize Use of Defense Systems 1A
COAS	crewman optical alignment sight
CREAM	Cosmic Radiation Effects and Activation Monitor
CRT	cathode ray tube
CRYHOP	Cryogenic Heat Pipe Experiment (GCP)
C/W	caution/warning
DACA	data acquisition and control assembly
DAP	digital autopilot
DMSP	Defense Meteorological Satellite Program
DOD	Department of Defense
DOD-1	Department of Defense 1 payload
DPS	data processing system
DSO	detailed supplementary objective
DTO	development test objective
EAFB	Edwards Air Force Base
ECLSS	environmental control and life support system
EDO	extended duration orbiter
EDOMP	extended duration orbiter medical project

PCMMU	pulse code modulation master unit
PCS	pressure control system
PDU	playback/downlink unit
PGSC	payload and general support computer
PI	payload interrogator
PIC	pyro initiator controller
POCC	Payload Operations Control Center
PRCS	primary reaction control system
PRD	payload retention device
PRLA	payload retention latch assembly
PRSD	power reactant storage and distribution
PS	payload specialist
PTI	preprogrammed test input
P/TV	photo/TV
RAAN	right ascension of the ascending node
RCRS	regenerable carbon dioxide removal system
RCS	reaction control system
RF	radio frequency
RGA	rate gyro assembly
RME-III	Radiation Monitoring Equipment III
RMS	remote manipulator system
ROEU	remotely operated electrical umbilical
RPM	revolutions per minute
RSLS	redundant-set launch sequencer
RSS	range safety system
RTLS	return to launch site
S&A	safe and arm
SA	solar array
SAF	Secretary of the Air Force
SAMS	space acceleration measurement system
SEA	system electronics assembly (BLAST)
SHF	superhigh frequency
SM	statute miles
SOHA	system optical head assembly (BLAST)
SRB	solid rocket booster
SRM	solid rocket motor
SRSS	shuttle range safety system
SSME	space shuttle main engine
SSP	standard switch panel
SSPP	Shuttle Small Payload Project
SSPP	solar/stellar pointing platform
ST	star tracker

STA	structural test article
STL	Space Tissue Loss
STS	Space Transportation System
SURS	standard umbilical retraction/retention system
TAEM	terminal area energy management
TAGS	text and graphics system
TAL	transatlantic landing
TDRS	tracking and data relay satellite
TDRSS	tracking and data relay satellite system
TFL	telemetry format load
TI	thermal phase initiation
TIG	time of ignition
TPS	thermal protection system
TSM	tail service mast
TT&C	telemetry, tracking, and communications
TV	television
TVC	thrust vector control
UHF	ultrahigh frequency
VFT-2	Visual Function Tester 2
VIU/C	orbiter CCTV video interface unit (BLAST)
VRCS	vernier reaction control system
VTR	videotape recorder
WCS	waste collection system
WRAIR	Walter Reed Army Institute of Research