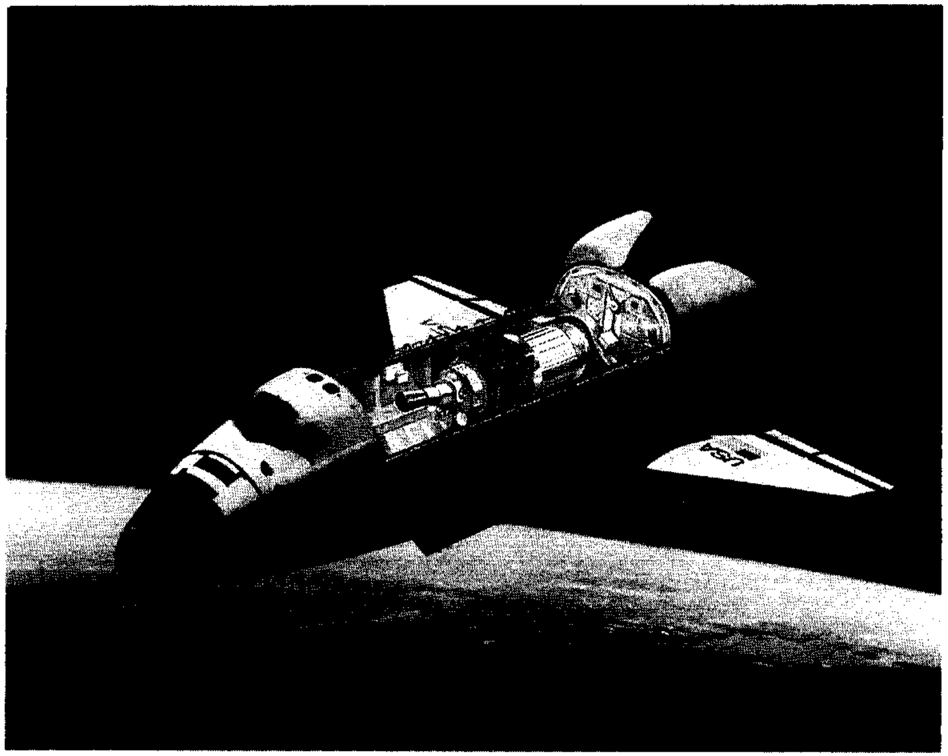

STS-44

PRESS INFORMATION

November 1991

Rockwell International
Space Systems Division

Office of Media Relations

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CONTENTS

MISSION OVERVIEW

This is the 10th flight of Atlantis and the 44th for the space shuttle.

The flight crew for the STS-44 mission is commander Frederick (Fred) D. Gregory; pilot Terence (Tom) T. Henricks; mission specialists F. Story Musgrave, Mario Runco, Jr., and James (Jim) S. Voss; and payload specialist Thomas (Tom) J. Hennen.

STS-44 is the eighth dedicated Department of Defense shuttle mission and the second such mission to be unclassified. STS-44's primary mission objective is to successfully deploy the Defense Support Program satellite with its inertial upper stage. Secondary objectives include using the orbiter Atlantis to conduct several DOD experiments and to perform medical evaluations in support of future extended-duration orbiter missions. Secondary mission objectives will be accomplished during flight days 2 through 10.

The DSP is a survivable and reliable satellite-borne system that detects and reports on real-time missile launches, space launches and nuclear detonations using infrared detectors to sense heat from missile plumes against the Earth background. The DSP will be launched into low Earth orbit, where the IUS, a two-stage solid rocket propellant booster with redundant avionics systems, will propel the spacecraft to a geosynchronous orbit. Upon separation from the IUS, the DSP satellite will initiate various on-board programs that will allow the spacecraft to complete its primary mission.

The nominal planned deployment opportunity for DSP release from Atlantis's payload bay is on Orbit 5 at 0/06:19 mission elapsed time. A backup opportunity exists on flight day 2 on Orbit 16. DSP is sponsored by the U.S. Air Force Systems Command's Space Systems Division, Los Angeles Air Force Base, Calif.

Nine secondary objectives will be flown on STS-44: Interim Operational Contamination Monitor, Terra Scout, Military Man in Space (M88-1), Shuttle Activation Monitor, Cosmic Radiation Effects and Activation Monitor, Radiation Monitoring Equipment III, Air Force Maui Optical Site Calibration Test, Visual Function Tester 1 and Ultraviolet Plume Instrument. In addition, nine of the 14 detailed supplementary objectives are part of NASA's continuing effort to prepare for planned extended-duration orbiter missions by collecting data to develop in-flight activities and medical protocols to help astronauts readjust to a 1-g environment after a space flight.

The IOCM measures molecular and particulate contamination in the orbiter payload bay during all mission phases and uses a variety of optional sensor modules that allow it to be tailored for each shuttle mission. The primary objectives of IOCM are as follows: (1) characterize by direct measurement the deposition of molecular and particular contamination during any phase of flight, prelaunch through ferry flight; (2) measure the optical property changes of thermal control surfaces, the flux of the ambient atomic oxygen environment, incident solar flux and the absolute ambient pressure in the payload bay; and (3) provide a structure and sample holders for exposing passive material samples to the space environment. The IOCM is a totally automated system, with powered components that are activated by sound or by barometric switches at selected altitudes. IOCM modules are mounted to the payload bay and may include: an interface tape recorder; the Jet Propulsion Laboratory contamination monitor, which serves as the IOCM's primary electronic support unit; the sensor module; the material sample array; and an ascent particle monitor. IOCM requires no command and control support. The only crew involvement is photo documentation that the coupon doors have closed. IOCM is sponsored by DOD's Air Force Space Test Program.

Terra Scout is an Earth observation system to be used by a specially trained payload specialist (Tom Hennen) to detect and characterize specific objects at predefined targets on the Earth using spaceborne Earth observation tools. The quality of the spacebound payload specialist observations will be compared to an Earthbound observer examining the same targets using conventional techniques. Hennen will use Spaceborne Direct-View Optical System (SpaDVOS) hardware. The payload occupies two and a half middeck lockers. Terra Scout is sponsored by the U.S. Army Intelligence Center.

Military Man in Space (M88-1) will use special optics and communication equipment to evaluate the capability of man in space to enhance air, naval, and ground force operations. M88-1 consists of three experiments: Maritime Observation Experiments in Space, Battlefield Surveillance From Space (Battleview) and Night Mist. MOSES is designed to establish direct and indirect communication between the orbiter and selected sites or naval units, conduct maritime observations and observe ocean phenomena related to ship detection. Battleview will also establish communication between the orbiter and a ground site, but the observations will be of ground site operations, such as armored mechanical formations, military ground sites and flying aircraft. Night Mist will test the use of an encrypted UHF communication system to link astronaut observers with target personnel on Earth. M88-1 is sponsored by the Air Force Special Command, the Chief of Naval Operations and the U.S. Army Intelligence Center.

The SAM experiment is designed to measure specific types of radioactivity produced in spacecraft and sensor materials when they are exposed to the space environment to determine their effect on the sensitivity of gamma ray detectors used in space. On this flight, SAM detectors will be moved to several locations throughout the orbiter middeck to map time-dependent variations in the radiation background as they change with location, type of detector material and amount of shielding. SAM occupies two middeck lockers. It is sponsored by the Strategic Defense Initiative Organization.

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 five passive foil detector packages. CREAM is sponsored by the Department of Defense.

The RME-III payload in Atlantis's middeck measures ionizing radiation exposure in the orbiter crew compartment during sequential time intervals. The unit contains a liquid crystal display for real-time data display and a keyboard for controlling its functions. It occupies half of a middeck locker. RME-III is sponsored by the Department of Defense in cooperation with NASA.

The primary objective of AMOS is to use the orbiter during cooperative overflights of the AMOS electrical-optical facility in Maui, Hawaii, to obtain imagery and/or signature data to support the calibration of the AMOS ground-based sensors and to observe orbiter plume phenomenology under a variety of orbiter attitude and lighting conditions. No unique on-board hardware is associated with the AMOS test; crew and orbiter participation may be required to establish the controlled conditions for the Maui cooperative overflight. AMOS is sponsored by the U.S. Air Force Space Systems Division.

VFT-1 is a handheld, battery-powered testing device the crew will look into to measure changes in a number of vision parameters affected by microgravity. The experiment is stowed in one middeck locker.

UVPI is an instrument located on the SDIO's Low-Power Atmospheric Compensation Experiment satellite in orbit at an inclination of 43 degrees and an altitude of approximately 273 nautical miles at the time of STS-44's scheduled launch on November 19. The primary objectives of the UVPI activity are to use the orbiter during cooperative encounters with the LACE satellite to obtain imagery and/or signature data to calibrate the UVPI sensors and to observe orbiter events. UVPI is manifested as a payload of opportunity. A UVPI test will be scheduled late in the flight if a conjunction opportunity meets crew scheduling constraints and if propellant margins permit it.

Nine development test objectives and 14 detailed supplementary objectives are scheduled to be flown on STS-44.

STS-44 Mission Insignia

MISSION STATISTICS

Vehicle: Atlantis (OV-104), 10th flight

Launch Date/Time:

11/19/91 6:51 p.m., EST
5:51 p.m., CST
3:51 p.m., PST

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

Launch Window: 2 hours, 30 minutes

Launch Clearance Window for 11/19/91: 6:51 p.m. EST to 9:29 p.m. EST

Mission Duration: 9 days, 19 hours, 36 minutes

Landing: Nominal end of mission on Orbit 155

11/29/91 2:27 p.m., EST
1:27 p.m., CST
11:27 a.m., PST

Runway: Nominal end-of-mission landing on runway 15, KSC, Fla. Weather alternates are Edwards Air Force Base, Calif., and Northrup Strip, White Sands, New Mexico.

Transatlantic Abort Landing: Banjul, Senegal; alternates are Moron, Spain, and Ben Guerir, Morocco

Return to Launch Site: KSC

Abort-Once-Around: EAFB; alternates are KSC and NOR

Inclination: 28.45 degrees (due east)

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 2 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: 195-nautical-mile (225-statute-mile) circular orbit

Space Shuttle Main Engine Thrust Level During Ascent: 104 percent

Space Shuttle Main Engine Locations:

No. 1 position: Engine 2015
No. 2 position: Engine 2030
No. 3 position: Engine 2029

Total Lift-off Weight: Approximately 4,526,272 pounds

Orbiter Weight, Including Cargo, at Lift-off: Approximately 259,629 pounds

Payload Weight Up: Approximately 44,628 pounds

Payload Weight Down: Approximately 7,010 pounds

Orbiter Weight at Landing: Approximately 193,825 pounds

Payloads—Payload Bay (* denotes primary payload): Defense Support Program satellite/inertial upper stage;* Interim Operational Contamination Monitor

Payloads—Middeck: Terra Scout, Military Man in Space, Shuttle Activation Monitor, Cosmic Radiation Effects and Activation Monitor, Radiation Monitoring Equipment III, Air Force Maui Optical Site Calibration Test, Ultraviolet Plume Instrument, Visual Function Tester 1

Flight Crew Members:

- **Commander:** Frederick (Fred) D. Gregory, third space shuttle flight
- **Pilot:** Terence (Tom) T. Henricks, first space shuttle flight
- **Mission Specialist 1:** James (Jim) S. Voss, first space shuttle flight
- **Mission Specialist 2:** F. Story Musgrave, fourth space shuttle flight
- **Mission Specialist 3:** Mario Runco, Jr., first space shuttle flight
- **Payload Specialist 1:** Thomas (Tom) J. Hennen, first space shuttle flight

Ascent Seating:

- Flight deck, front left seat, commander Frederick (Fred) D. Gregory
- Flight deck, front right seat, pilot Terence (Tom) T. Henricks
- Flight deck, aft center seat, mission specialist F. Story Musgrave
- Flight deck, aft right seat, mission specialist James (Jim) S. Voss
- Middeck, mission specialist Mario Runco, Jr.
- Middeck, payload specialist Thomas (Tom) J. Hennen

Entry Seating:

- Flight deck, front left seat, commander Frederick (Fred) D. Gregory
- Flight deck, front right seat, pilot Terence (Tom) T. Henricks
- Flight deck, aft center seat, mission specialist F. Story Musgrave
- Flight deck, aft right seat, mission specialist Mario Runco, Jr.
- Middeck, payload specialist Thomas (Tom) J. Hennen
- Middeck, mission specialist James (Jim) S. Voss

Extravehicular Activity Crew Members, If Required:

- Extravehicular astronaut 1 is Mario Runco, Jr.; EV-2 is James (Jim) S. Voss
- Intravehicular Astronaut: Terence (Tom) T. Henricks

STS-44 Flight Directors:

- Ascent/Entry: Ron Dittemore
- Orbit 1 Team: Phil Engelauf
- Orbit 2 Team (lead): Milt Heflin
- Planning Team: Chuck Shaw

Entry: Automatic mode until subsonic, then control-stick steering

Notes:

- Approximately one dozen modifications or enhancements have been made to Atlantis. These modifications enhance the performance and efficiency of the orbiter's complex systems. For instance, this flight will be the first test of an improved inertial measurement unit called HAINS (high accuracy inertial navigation system). The new unit features improved performance and accuracy and was installed in the No. 3 position. The orbiter's three redundant IMUs are part of the guidance and navigation system. Eventually all IMUs in the shuttle fleet will be replaced with the HAINS model as part of the fleet's continuous improvement program.
- The remote manipulator system is not installed in Atlantis's payload bay for this mission. The galley is installed in Atlantis's middeck.

MISSION OBJECTIVES

- Primary Payload
  - Deployment of Defense Support Program satellite/inertial upper stage
- Secondary Payloads
  - Payload Bay
    - Interim Operational Contamination Monitor
  - Middeck
    - Terra Scout
    - Military Man in Space
    - Shuttle Activation Monitor
    - Cosmic Radiation Effects and Activation Monitor
    - Radiation Monitoring Equipment III
    - Air Force Maui Optical Site Calibration Test
    - Ultraviolet Plume Instrument
    - Visual Function Tester 1
- Development Test Objectives/Detailed Supplementary Objectives

FLIGHT ACTIVITIES OVERVIEW

Flight Day 1

Launch
OMS-2 burn
DSP/IUS deploy
FRCS-1 burn
OMS-3 separation burn
SRM ignition (node 6A)
RME-III activation (Station 1)
AMOS RCS test
VFT-1
Group B powerdown

Flight Day 2

LBNP setup (DSO 478)
LBNP ramp (MS3)
Terra Scout observations
LBNP ramp (MS1)
ARCS-1 burn
VFT-1
SAM/CREAM/RME setup (NaI Station 1)
FRCS-2 burn

Flight Day 3

Terra Scout observations
M88-1 CCD camera, radio setup
LBNP ramp (MS2)
MOSES observations
LBNP ramp (pilot)
Terra Scout observations
SAM/CREAM/RME operations (NaI Station 2)
VFT-1
Educational Earth observation photography
AMOS RCS test

Flight Day 4

VFT-1
Terra Scout observations
MOSES observations
Battleview observations
SAM/CREAM/RME operations (BGO Station 1)
AMOS FES test

Flight Day 5

Educational Earth observation photography
Terra Scout observations
LBNP ramp (MS3)
Battleview observations
LBNP ramp (MS1)
SAM/CREAM/RME operations (BGO Station 2)
VFT-1
AMOS nose track test

Flight Day 6

MOSES observations
LBNP ramp (MS2)
Terra Scout observations
Battleview observations
LBNP ramp (pilot)
Crew press conference
SAM/CREAM/RME operations (BGO Station 3)
VFT-1

Flight Day 7

SAM/CREAM/RME operations (BGO Station 4)
Terra Scout observations
LBNP soak (MS1)
MOSES observations
Battleview observations
VFT-1

Flight Day 8

MOSES observations
SAM/CREAM/RME operations (NaI Station 1)
LBNP soak (MS3)
Terra Scout observations
Battleview observations
LBNP ramp (MS1)
VFT-1

Flight Day 9

SAM operations (Station 1); CREAM/RME operations (Station 2)
Battleview observations
LBNP ramp (MS2 and MS3)
Terra Scout observations
LBNP ramp (MS1)
LBNP ramp (pilot)
MOSES observations
Educational Earth observation photography

Flight Day 10

SAM/CREAM deactivation, stow
RCS hot fire
FCS checkout
MOSES observations
Terra Scout observations
Battleview observations
LBNP ramp (MS3)
VFT-1
M88-1 stow
Terra Scout stow
LBNP stow
Cabin stow
Group B powerup

Flight Day 11

DSO entry preparation
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.

- Due to power requirements and the length of the mission, an equipment powerdown (referred to as a Group B powerdown), is executed on flight day 1 to conserve cryogenics for a full mission duration plus two extension days (if required). Powerdown activities include powering off three of Atlantis's four CRTs, placing three of Atlantis's five general-purpose computers on standby, placing one of Atlantis's three inertial measurement units on standby, and powering off three of Atlantis's eight flight-critical multiplexers (two forward, one aft).

- An approved exemption authorizes MS2 (F. Story Musgrave) not to be scheduled for exercise. He will be a control subject for DSO 608: Effects of Space Flight on Aerobic and Anaerobic Metabolism at Rest and During Exercise.
- An approved exemption authorizes a total sleep shift of 6 hours earlier during this 10-day mission, with the last sleep period shortened to 6.5 hours in order to maximize the probability of a lighted KSC landing.

STS-44 CREW ASSIGNMENTS

Commander (Frederick [Fred] D. Gregory):

Overall mission decisions
Orbiter—DPS, MPS,* OMS/RCS,* APU/hydraulics,* EPS,* ECLSS, communications/instrumentation,* flight rules
Payload—Terra Scout,* AMOS
DTOs/DSOs—DTOs 517 and 649; DSOs 478, 605 and 608

Pilot (Terence [Tom] T. Henricks):

Orbiter—DPS,* MPS, OMS/RCS, APU/hydraulics, EPS, ECLSS,* communications/instrumentation,* payload bay door/radiator, SPOC, FDF
Payload—DSP,* VFT-1,* RME-III, SAM, CREAM, Terra Scout,* M88-1,* AMOS*
DTOs/DSOs—DSOs 603, 608, 611 and 614
Other—intravehicular astronaut, Earth observations

Mission Specialist 1 (James [Jim] S. Voss):

Orbiter—IFM
Payload—DSP, M88-1*
DTOs/DSOs—DSOs 463, 478,* 603, 608 and 613
Other—extravehicular astronaut 2

Mission Specialist 2 (F. Story Musgrave):

Orbiter—DPS,* MPS,* OMS/RCS,* APU/hydraulics,* EPS,* ECLSS,* communications/instrumentation, photo equipment, medical, HP
Payload—DSP*
DTOs/DSOs—DSOs 316, 472, 478, 603, 613, 901, 902 and 903
Other—Earth observations

Mission Specialist 3 (Mario Runco, Jr.):

Orbiter—Crew equipment, TV equipment
Payload—DSP,* M88-1
DTOs/DSOs—DSOs 463, 472,* 478* and 608
Other—extravehicular astronaut 1, Earth observations

Payload Specialist 1 (Thomas [Tom] J. Hennen):

Orbiter—Crew equipment*
Payload—VFT-1, Terra Scout
DTOs/DSOs—DSOs 604, 605 and 614

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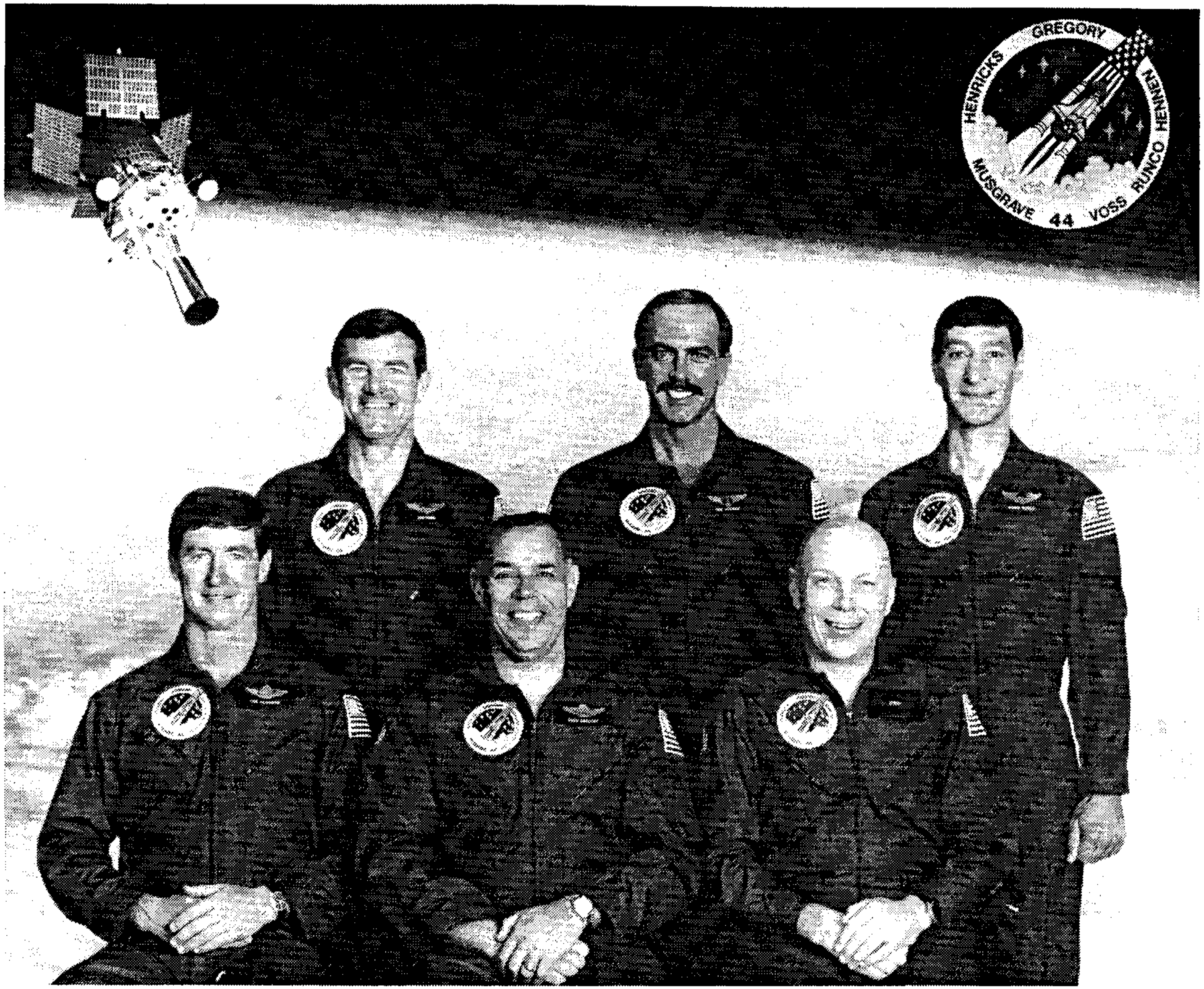
*Backup responsibility



STS-44 Crew (front, left to right), pilot Terence T. Henricks, commander Frederick D. Gregory and mission specialist F. Story Musgrave. Rear, from left, mission specialist James S. Voss, payload specialist Thomas J. Hennen and mission specialist Mario Runco, Jr.

DEVELOPMENT TEST OBJECTIVES/DETAILED SUPPLEMENTARY OBJECTIVES

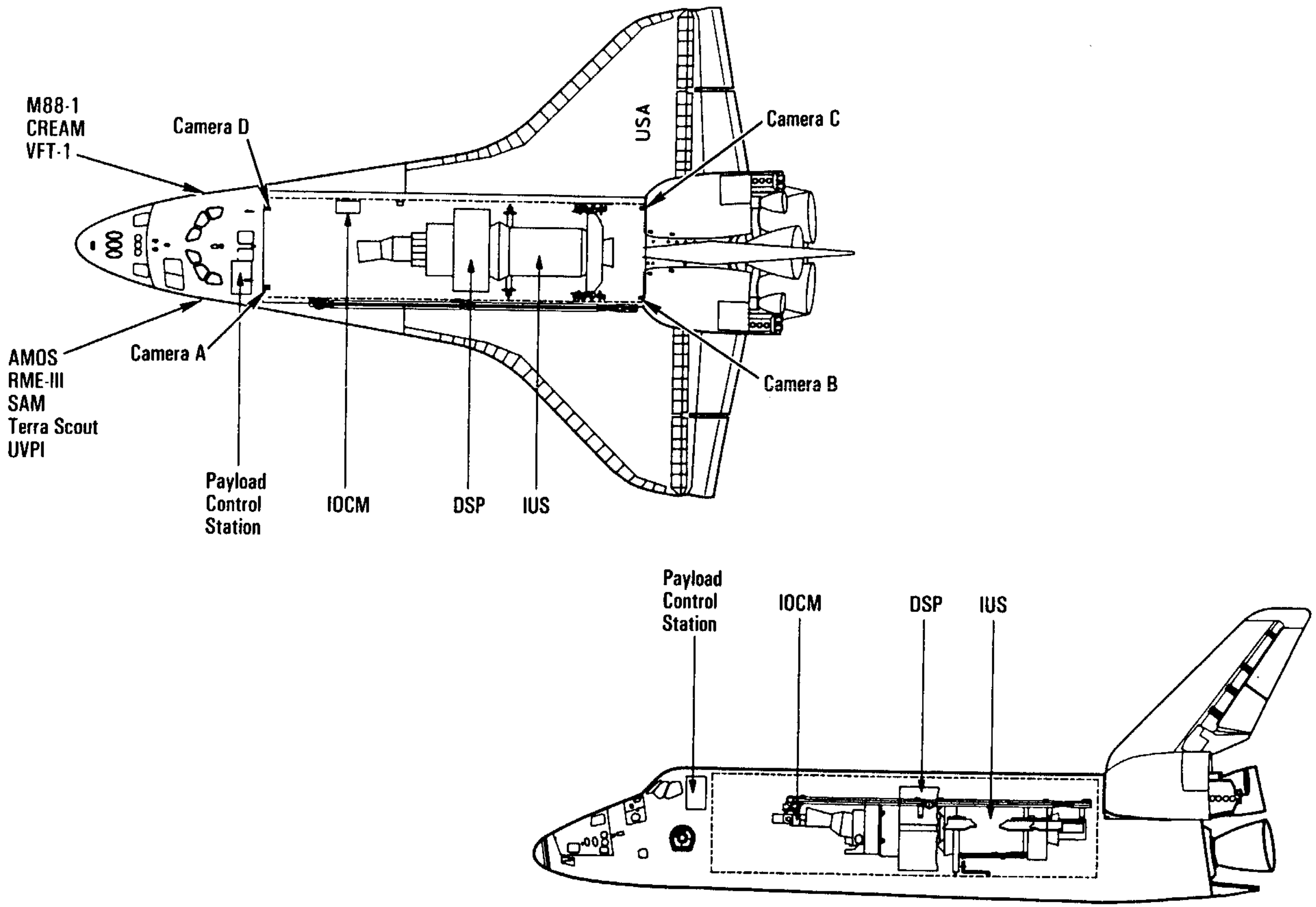
DTOs

- Entry aerodynamic control surfaces test (DTO 242)
- Ascent structural capability evaluation (DTO 301D)
- Entry structural capability (DTO 307D)
- ET TPS performance—method 2 (DTO 312)
- Edwards lakebed runway bearing strength and rolling friction assessment for orbiter landings (if Edwards landing) (DTO 520)
- Combustion products analyzer (DTO 645)
- Shuttle extended-duration orbiter (EDO) rehydratable food package evaluation (DTO 649)
- Star line maneuver validation (DTO 797)
- Crosswind landing performance (DTO 805)

DSOs

- Bioreactor/flow and particle trajectory in microgravity (DSO 316)
- In-flight holter monitoring (DSO 463)
- Intraocular pressure (DSO 472)
- In-flight lower body negative pressure (DSO 478)
- Orthostatic function during entry, landing and egress (DSO 603)
- Visual vestibular integration as a function of adaption, OI-1 and 3 (DSO 604)
- Postural equilibrium control during landing/egress (DSO 605)
- Effects of space flight on aerobic and anaerobic metabolism at rest and during exercise (DSO 608)
- Air monitoring instrument evaluation and atmosphere characterization (DSO 611)
- Changes in endocrine regulation of orthostatic tolerance following space flight (DSO 613)
- 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)

PAYLOAD CONFIGURATION



DEFENSE SUPPORT PROGRAM

The Defense Support Program satellite detects and reports real-time missile launches, space launches, and nuclear detonations using infrared detectors to sense heat from missile plumes against the Earth background. The satellites have been a survivable and reliable part of the U.S. NORAD Tactical Warning and Attack Assessment System since 1970.

Over the past 20 years, the DSP system has repeatedly proven its reliability and growth potential. Through five upgrade programs, the specified design life of the DSP satellites has been exceeded by 30 percent. The upgrades have allowed the DSP to provide accurate, reliable data in the face of changing requirements, such as greater numbers of targets, smaller targets and advanced countermeasures, with no interruption in service. Planned evolutionary growth has improved the satellite's capability, survivability and life expectancy without a major redesign.

The original DSP satellite weighed 2,100 pounds and required 400 watts of power. It contained 2,000 detectors and had a design life of 3 years. After the satellite was upgraded in the 1970s to meet new mission requirements, it weighed 3,960 pounds, required 680 watts of power and had 6,000 detectors. It also had a new design life goal of 5 years. Today's DSP satellite weighs 5,200 pounds and requires 1,250 watts of power.

The satellite's highly reliable sensor has provided uninterrupted service well past the sensor's design lifetime. Recent technological improvements in sensor design include above-the-horizon capability for full hemispheric coverage and improved resolution. Increased on-board signal-processing capability improves clutter rejection, enhancing the satellite's reliability and survivability.

The DSP/IUS cargo element comprises the DSP satellite, a DSP satellite-to-IUS mounting adapter, a DOD two-stage solid motor inertial upper stage, associated airborne support equipment and advanced RADEC I sensor covers.

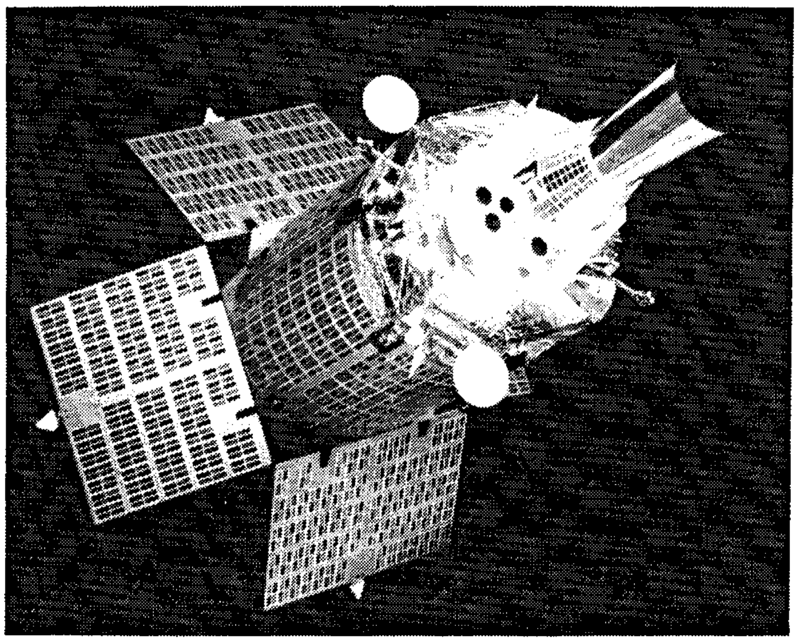
The DSP satellite, mated to the IUS, will be carried into low Earth orbit in the payload bay of the space shuttle Atlantis. On orbit the DSP and IUS will be deployed from the payload bay, and the IUS will propel the spacecraft to a geosynchronous orbit 22,300 miles above the Earth.

After reaching its predefined orbit and separating from the IUS, the DSP satellite will initiate on-board programs that will allow it to complete its primary mission. The satellite is spun about its Earth-pointing axis to provide a scanning motion for the infrared sensor. Earth sensors and a reaction wheel introduce an equal and opposite momentum to reduce the satellite's spin momentum to zero, allowing the satellite to maintain its position. Hydrazine thrusters control the satellite's attitude.

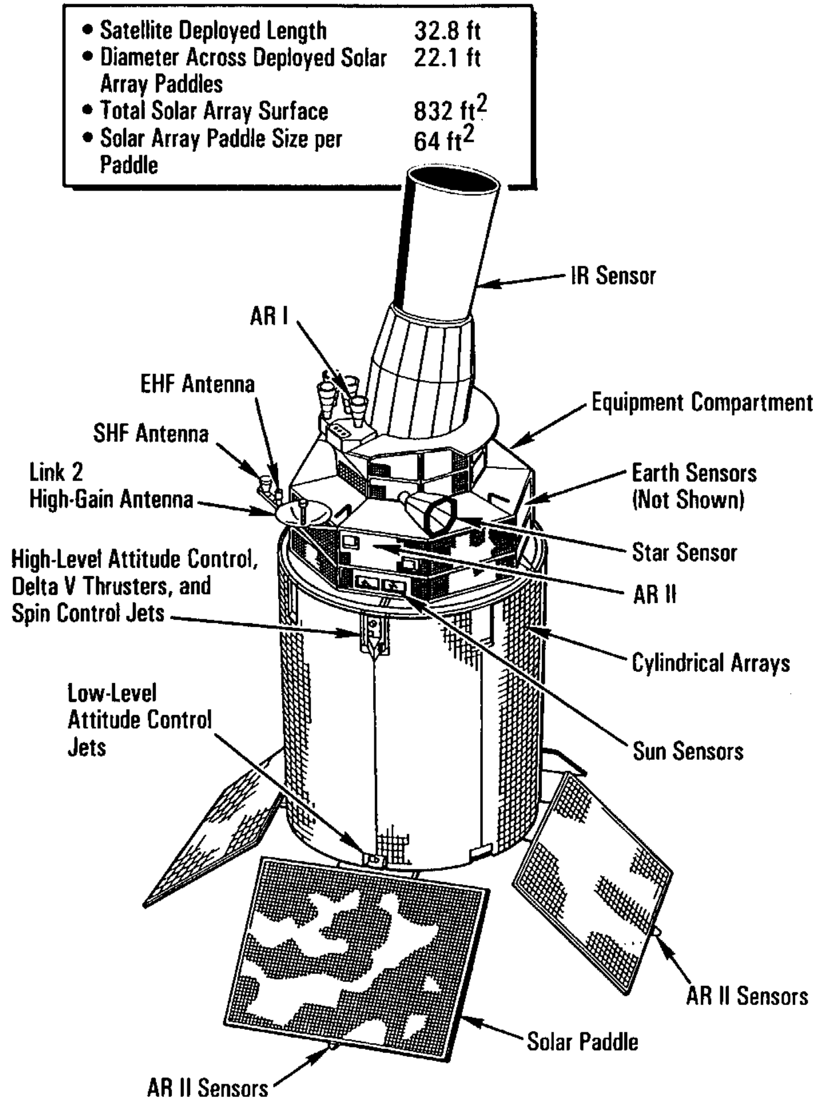
The DSP satellite is approximately 33 feet long and 14 feet in diameter. It consists of an IR sensor and spacecraft. The elements of the sensor are the IR telescope subsystem, star sensor subsystem, status monitor subsystem, signal electronics subsystem, thermal control subsystem and advanced RADEC I sensor covers. The spacecraft consists of structure, communication and command and mission data message, electrical power and distribution, propulsion, attitude control and thermal systems. The satellite's electrical power is provided by solar arrays and storage batteries. Satellite communication is provided by a variety of transmitters, receivers and antennas.

The IR sensor detects, locates and identifies targets that are intense sources of IR radiation. The photoelectric cell array, which is mounted in the IR telescope's centerline to coincide with the image surface of the telescope's optics, scans the Earth's surface as the satellite rotates at six revolutions per minute. When a detector passes across an IR source, it develops an electronic signal. The many signals generated are relayed to processing units, which group the signals and send them to the ground.

A prime requirement of the spacecraft element is to maintain pointing direction accurately for the data-sensing and processing equipment. It also furnishes the on-board functions required to position, control and maintain the satellite in its proper Earth orbit and furnishes, conditions and controls electrical power for the satellite. The spacecraft provides a secure downlink for transmitting mission data, satellite state of health and other information to the ground for processing and a secure uplink for receiving, processing and distributing ground commands for both the spacecraft and sensor.



DSP Satellite



DSP Operational Configuration

TRW builds the DSP satellites in Redondo Beach, Calif., and integrates their sensor payloads under contract to the U.S. Air Force Systems Command's Space Systems Division, Los Angeles Air Force Base, Calif. The sensor payloads are built by Aerojet Electronics Systems Division of Azusa, Calif.

Onizuka Air Force Station, Consolidated Space Test Center, Sunnyvale, Calif., serves as the DSP/IUS deploy control center for STS-44.

The following Air Force personnel are key management and operations participants in STS-44.

Key Management Participants

Mission Director

Col. John R. Kidd, Program Director, Defense Support Program

Deputy Mission Director

Col. John E. Armstrong, Program Manager, Space Test and Transportation System Program Office

IUS Program Management

Col. Norman H. Buchanan, Program Director, Upper Stages Program Office

Mission Director Representatives

Col. Edward R. Dietz, Deputy Program Director, Defense Support Program

Maj. Michael W. Booen, Director, Space Systems

Mission Director Support Team

Capt. Linda R. Cole, Mission Manager, SSD/ MJSO

Capt. Gregory D. Moxley, DSP Integration Manager, SSD/MJSO

Capt. Samuel J. Domino, MD Action Officer, JSC/OL-AW

Lt. Anthony F. Papatyi, IUS Integration Manager, SSD/CLUI

Key Operations Participants

Air Force Test Director

Maj. John Traxler, 6555th ASTG

CSTC Flight Directors

Capt. Rick Kellogg, Ascent, CSTC/VOS

Capt. Frank Alexa (Lead), Deploy Phase, CSTC/VOS

Capt. Bill Moriarity, Transfer Orbit, CSTC/VOS

Spacecraft Flight Directors

Capt. Rich Edmonds (Lead), Deploy Phase, SSD/MJSO

Capt. Kathy Hays, Transfer Orbit, SSD/MJSO

Secondary Payload Operations Manager

Capt. Rick L. Shimon, JSC/OL-AW

INERTIAL UPPER STAGE

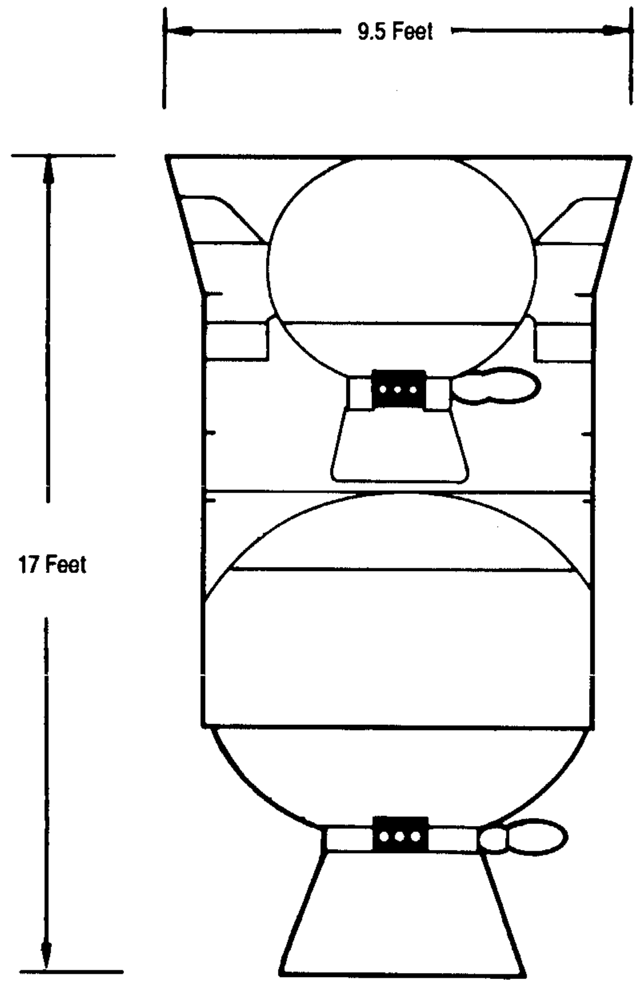
The inertial upper stage is used with the space shuttle to transport the Defense Support Program satellite to geosynchronous orbit, 22,300 statute miles above the Earth. The IUS was also selected by NASA to transport the Tracking and Data Relay satellites to geosynchronous orbit and for the Magellan, Galileo and Ulysses planetary missions.

The IUS was originally designed as a temporary stand-in for a reusable space tug and was called the interim upper stage. Its name was changed to inertial upper stage (signifying the satellite's guidance technique) when it was realized that the IUS would be needed through the mid-1990s.

The IUS was developed and built under contract to the Air Force Systems Command's Space Systems Division. The Space Systems Division is executive agent for all Department of Defense activities pertaining to the space shuttle system and provides the IUS to NASA for space shuttle use. In August 1976, after 2.5 years of competition, Boeing Aerospace Company, Seattle, Wash., was selected to begin preliminary design of the IUS.

The IUS is a two-stage vehicle weighing approximately 32,500 pounds. Each stage is a solid rocket motor. This design was selected over those with liquid-fueled engines because of its relative simplicity, high reliability, low cost and safety.

The IUS is 17 feet long and 9.25 feet in diameter. It consists of an aft skirt, an aft stage SRM with 21,400 pounds of propellant generating 42,000 pounds of thrust, an interstage, a forward stage SRM with 6,000 pounds of propellant generating approximately 18,000 pounds of thrust and using an extendable exit cone, and an equipment support section. The equipment support section contains the avionics that provide guidance, navigation, telemetry, command and data management, reaction control and electrical



Inertial Upper Stage Booster

power. All mission-critical components of the avionics system and thrust vector actuators, reaction control thrusters, motor igniter and pyrotechnic stage separation equipment are redundant to ensure better than 98-percent reliability.

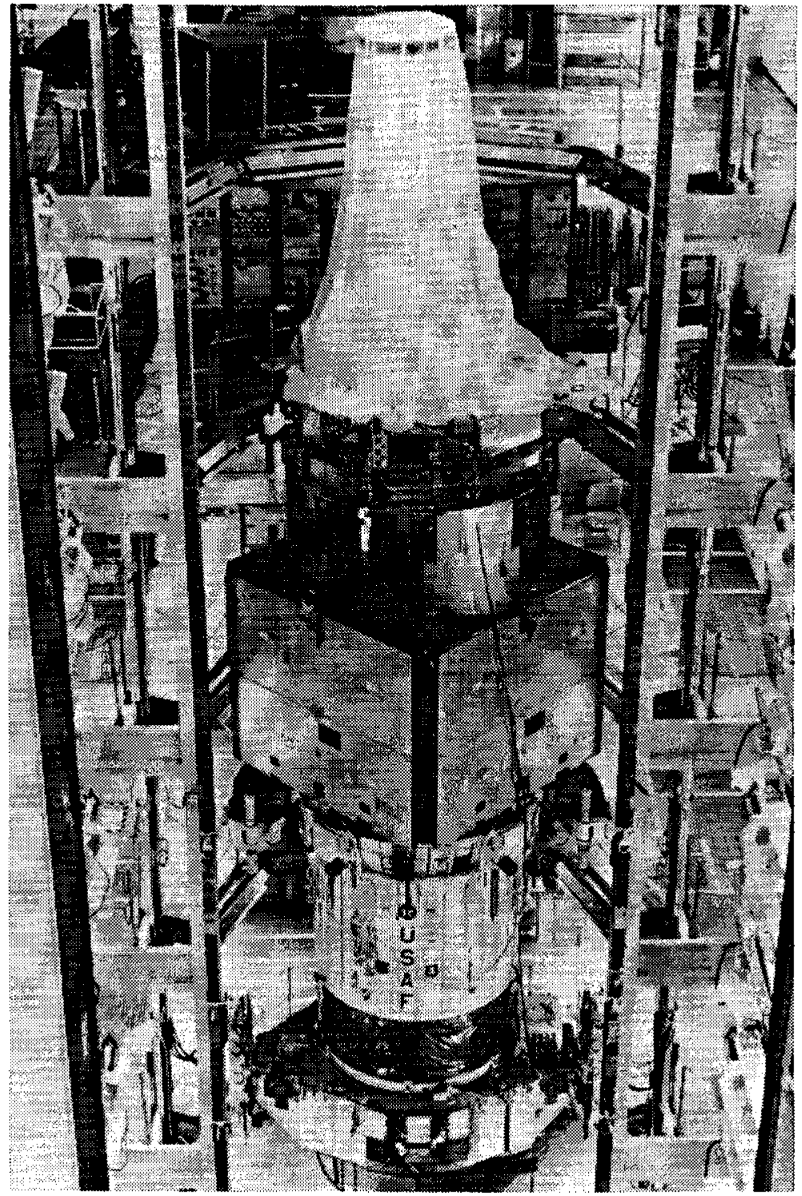
FLIGHT SEQUENCE

After the orbiter's payload bay doors are opened in Earth orbit, the orbiter maintains a preselected attitude to fulfill payload thermal requirements and constraints except during those operations that require special attitudes (e.g., orbital inertial measurement unit alignments, RF communications and deployment operations).

On-orbit predeployment checkout is followed by an IUS command link check and spacecraft RF command check, if required. The state vector is uplinked to the orbiter for trim maneuvers the orbiter performs. The state vector is transferred to the IUS.

The forward airborne support equipment payload retention latch actuator is released, and the aft frame ASE electromechanical tilt actuator tilts the IUS and spacecraft combination to 29 degrees. This extends the spacecraft into space just outside the orbiter payload bay, which allows direct communication with Earth during systems checkout. The orbiter is then maneuvered to the deployment attitude. If a problem develops within the spacecraft or IUS, they can be restowed.

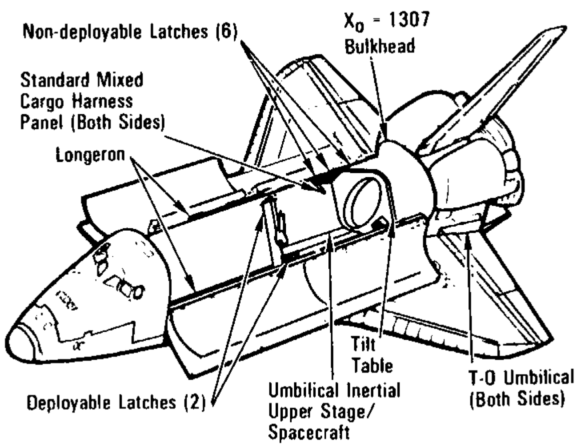
Before deployment, the flight crew switches the spacecraft's electrical power source from orbiter power to IUS internal power. Verification that the spacecraft is on IUS internal power and that all IUS and spacecraft predeployment operations have been successfully completed is ascertained by evaluating data contained in the IUS and spacecraft telemetry. IUS telemetry data are evaluated by the IUS Mission Control Center at Sunnyvale, Calif., and the spacecraft data by the spacecraft control center. Analysis of the telemetry results in a go/no-go decision for IUS and spacecraft deployment from the orbiter.



IUS/DSP With Airborne Support Equipment in Payload Canister Transporter

When the orbiter flight crew is given a go decision, the orbiter flight crew activates the ordnance that separates the IUS and spacecraft's umbilical cables. The flight crew then commands the electromechanical tilt actuator to raise the tilt table to a 58-degree deployment position. The orbiter's reaction control system thrusters are inhibited, and the Super*zip ordnance separation device physically separates the IUS and spacecraft combination from the tilt table. Compressed springs provide the force to jettison the IUS/spacecraft from the orbiter payload bay at approximately 0.4 foot per second. The IUS and spacecraft are deployed in the shadow of the orbiter or in Earth eclipse. The tilt table is lowered to minus 6 degrees after deployment. Approximately 15 minutes after deployment, the orbiter's orbital maneuvering system engines are ignited to separate the orbiter from the IUS and spacecraft.

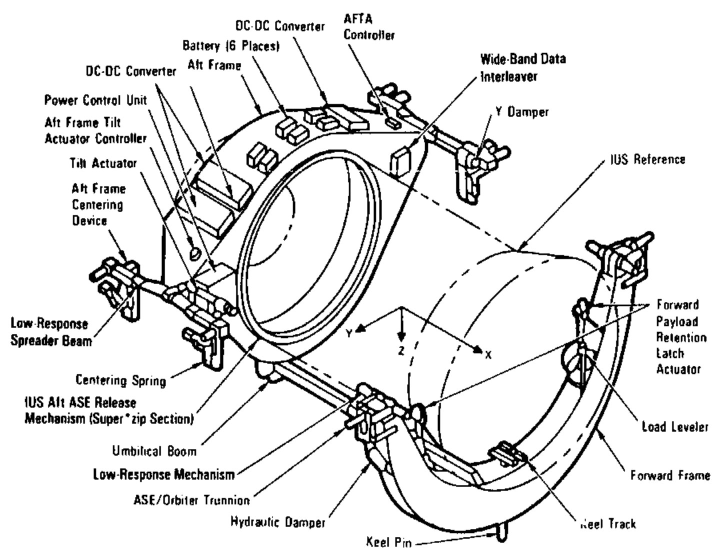
The IUS and spacecraft are now controlled by computers on board the IUS. Approximately 10 minutes after the IUS and spacecraft are ejected from the orbiter, the IUS onboard computers send out discrete signals that are used by the IUS or spacecraft to begin mission sequence events. This signal also enables the reaction control system. All subsequent operations are



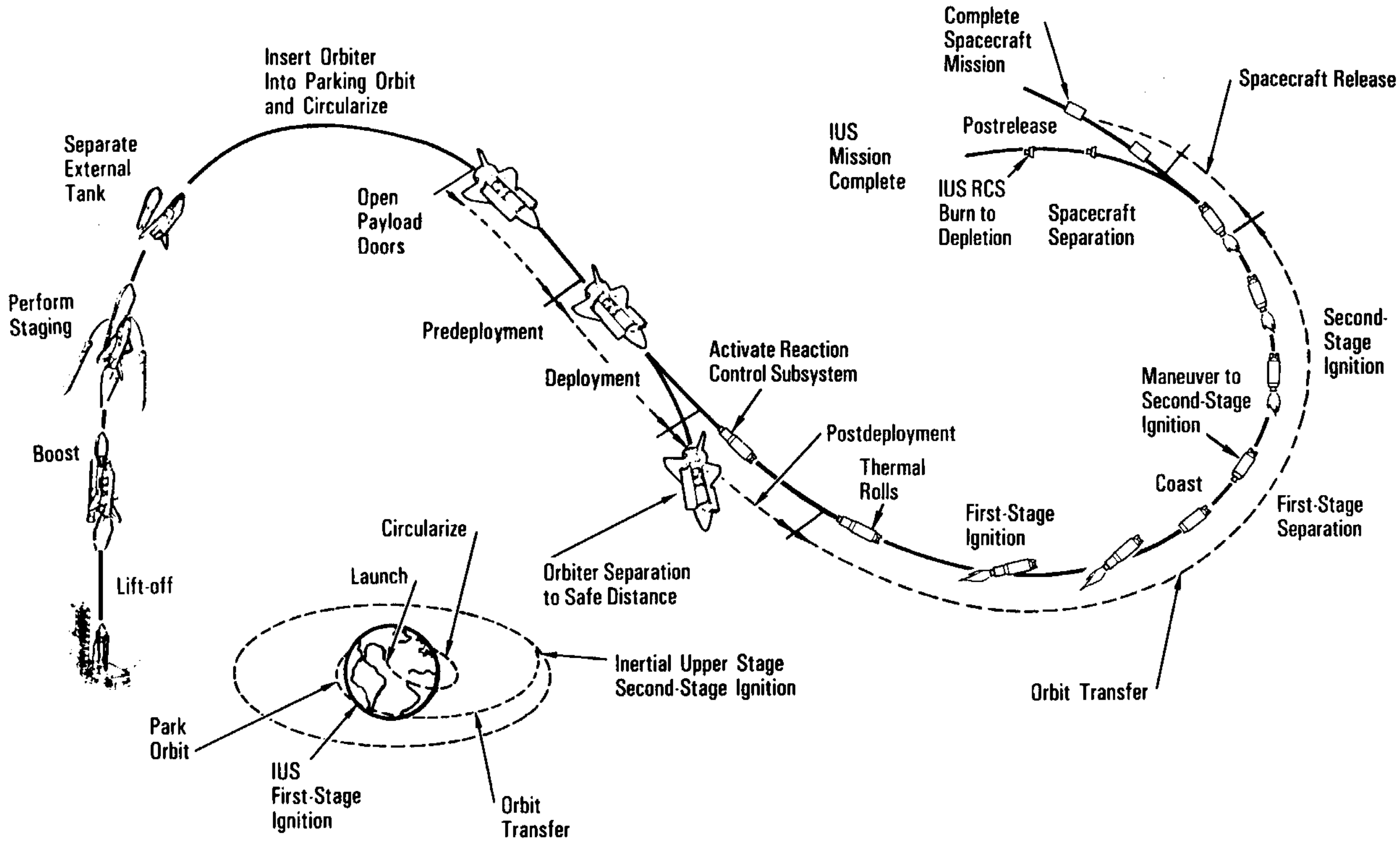
Inertial Upper Stage Airborne Support Equipment

sequenced by the IUS computer from transfer orbit injection through spacecraft separation and IUS deactivation. Following RCS activation, the IUS maneuvers to the required thermal attitude and performs any required spacecraft thermal control maneuver.

Approximately 45 minutes after IUS and spacecraft ejection from the orbiter, the SRM-1 ordnance inhibits are removed. At this time, the bottom of the orbiter is oriented toward the IUS and spacecraft to protect the orbiter windows from the IUS SRM-1 plume. The IUS recomputes the first ignition time and maneuvers necessary to attain the proper attitude for the first thrusting period. When the proper transfer orbit opportunity is reached, the IUS computer sends the signal to ignite the first-stage motor. This is expected approximately 60 minutes after deployment. After firing approximately 146 seconds and before reaching the apogee point of its trajectory, the IUS's first stage expends its fuel. While coasting, the IUS performs any maneuvers needed by the spacecraft for thermal protection or communications. When this is



Inertial Upper Stage Airborne Support Equipment



Sequence of Events For Typical Geosynchronous Mission complete, the IUS first stage and interstage separate from the IUS second stage.

Approximately 6 hours and 20 minutes after deployment, the second-stage motor is ignited and thrusts for about 108 seconds. After the burn is complete, the IUS stabilizes the spacecraft while its solar arrays and two antennas are deployed. The IUS second stage separates and performs a final collision and contamination avoidance maneuver before deactivating.

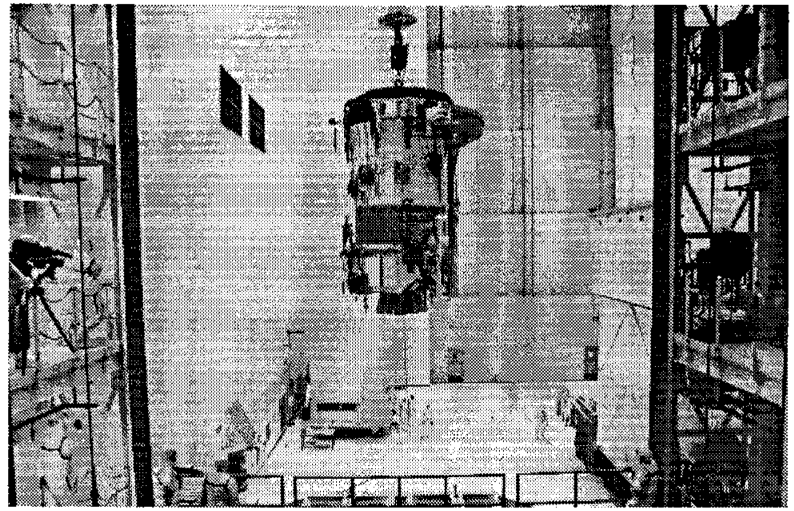
Boeing's propulsion team member, Chemical Systems Division of United Technologies, designed and tests the two solid rocket motors. Supporting Boeing in the avionics area are TRW, Cubic and the Hamilton Standard Division of United Technologies. TRW and Cubic provide IUS telemetry, tracking and command subsystem hardware. Hamilton Standard provides guidance system hardware support. Delco, under subcontract to Hamilton Standard, provides the avionics computer.

In addition to the actual flight vehicles, Boeing is responsible for the development of ground support equipment and software for the checkout and handling of the IUS vehicles from factory to launch pad.

Boeing also integrates the IUS with various satellites and joins the satellite with the IUS, checks out the configuration and supports launch and mission control operations for both the Air Force and NASA. Boeing also develops airborne support equipment to support the IUS in the space shuttle and monitors it while it is in the orbiter payload bay.

The IUS, without the two SRMs, is fabricated and tested at the Boeing Space Center, Kent, Wash. SRMs are shipped directly from Chemical Systems Division in California; to the eastern launch site at Cape Canaveral, Fla. Similarly, the Boeing-manufactured IUS subsystems are shipped from Washington to the eastern launch site. IUS/SRM buildup is done in the Solid Motor Assembly Building and the IUS and spacecraft are mated in the Vertical Processing Facility at the Kennedy Space Center.

The combined IUS and spacecraft payload is installed in the orbiter at the launch pad. Boeing is building 22 IUS vehicles under its contract with the Air Force.



Inertial Upper Stage Booster Testing

AIRBORNE SUPPORT EQUIPMENT

The IUS ASE is the mechanical, avionics and structural equipment located in the orbiter. The ASE supports and provides services to the IUS and the spacecraft in the orbiter payload bay and positions the IUS/spacecraft in an elevated position for final checkout before deployment from the orbiter.

The IUS ASE consists of the structure, aft tilt frame actuator, batteries, electronics and cabling to support the IUS and spacecraft combination. These ASE subsystems enable the deployment of the combined vehicle; provide, distribute, and/or control electrical power to the IUS and spacecraft; and provide communication paths between the IUS, spacecraft and the orbiter.

The ASE incorporates a low-response spreader beam and torsion bar mechanism that reduces spacecraft dynamic loads to less than one-third what they would be without this system. In addition, the forward ASE frame includes a hydraulic load leveler system to provide balanced loading at the forward trunnion fittings.

The ASE data subsystem allows data and commands to be transferred between the IUS and spacecraft and the appropriate aft orbiter interface. Telemetry data include spacecraft data received over dedicated circuits via the IUS and spacecraft telemetry streams. An interleaved stream is provided to the orbiter to transmit to the ground or transfer to ground support equipment.

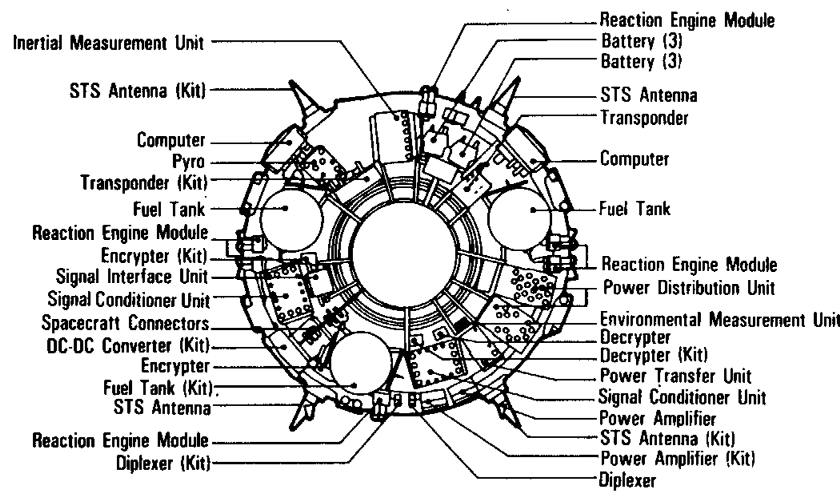
The structural interfaces in the orbiter payload bay consist of six standard non-deployable attach fittings on each longeron that mate with the ASE aft and forward support frame trunnions and two payload retention latch actuators at the forward ASE support frame. The IUS has a self-contained, spring-actuated deployment system that imparts a velocity to the IUS at release from the raised deployment attitude. Ducting from the orbiter purge system interfaces with the IUS at the forward ASE.

IUS STRUCTURE

The IUS structure is capable of transmitting all of the loads generated internally and also those generated by the cantilevered spacecraft during orbiter operations and IUS free flight. In addition, the structure supports all of the equipment and solid rocket motors within the IUS and provides the mechanisms for IUS stage separation. The major structural assemblies of the two-stage IUS are the equipment support section, interstage and aft skirt. The basic structure is aluminum skin-stringer construction with six longerons and ring frames.

EQUIPMENT SUPPORT SECTION

The ESS houses the majority of the IUS avionics and control subsystems. The top of the ESS contains the 10-foot-diameter interface mounting ring and electrical interface connector segment for mating and integrating the spacecraft with the IUS. Thermal isolation is provided by a multilayer insulation blanket across the interface between the IUS and spacecraft. All line replaceable units mounted in the ESS can be removed and replaced via access doors even when the IUS is mated with spacecraft.



Inertial Upper Stage Equipment Support Section

IUS AVIONICS SUBSYSTEM

The avionics subsystem consists of the telemetry, tracking and command; guidance and navigation; data management; thrust vector control; and electrical power subsystems. This includes all of the electronic and electrical hardware used to perform all computations, signal conditioning, data processing and software formatting associated with navigation, guidance, control, data management and redundancy management. The IUS avionics subsystem also provides the communications between the orbiter and ground stations and electrical power distribution.

Data management performs the computation, data processing and signal conditioning associated with guidance, navigation and control; safing and arming and ignition of the IUS two-stage solid rocket motors and electroexplosive devices; command decoding and telemetry formatting; and redundancy management and issues spacecraft discretes. The data management subsystem consists of two computers, two signal conditioner units and a signal interface unit.

Modular general-purpose computers use operational flight software to perform in-flight calculations and to initiate the vehicle thrust and attitude control functions necessary to guide the IUS and spacecraft through a flight path determined on board to a final orbit or planned trajectory. A stored program, including data known as the onboard digital data load, is loaded into the IUS flight computer memory from magnetic tape through the memory load unit during prelaunch operations. Memory capacity is 65,536 (64K) 16-bit words.

The SCU provides the interface for commands and measurements between the IUS avionics computers and the IUS pyrotechnics, power, reaction control system, thrust vector control, TT&C and the spacecraft. The SCU consists of two channels of signal conditioning and distribution for command and measurement functions. The two channels are designated A and B. Channel B is redundant to channel A for each measurement and command function .

The signal interface unit performs buffering, switching, formatting and filtering of TT&C interface signals.

Communications and power control equipment is mounted at the orbiter aft flight deck payload station and operated in flight by the orbiter flight crew mission specialists. Electrical power and signal interfaces to the orbiter are located at the IUS equipment connectors. Cabling to the orbiter equipment is provided by the orbiter. In addition, the IUS provides dedicated hardwires from the spacecraft through the IUS to an orbiter multiplexer/demultiplexer for subsequent display on the orbiter cathode-ray tube of parameters requiring observation and correction by the orbiter flight crew. This capability is provided until IUS ASE umbilical separation.

To support spacecraft checkout or other IUS-initiated functions, the IUS can issue a maximum of eight discretes. These discretes may be initiated either manually by the orbiter flight crew before the IUS is deployed from the orbiter or automatically by the IUS mission-sequencing flight software after deployment. The discrete commands are generated in the IUS computer either as an event-scheduling function (part of normal onboard automatic sequencing) or a command-processing function initiated from an uplink command from the orbiter or Air Force Consolidated Satellite Test Center to alter the onboard event-sequencing function and permit the discrete commands to be issued at any time in the mission.

During the ascent phase of the mission, the spacecraft's telemetry is interleaved with IUS telemetry, and ascent data are provided to ground stations in real time via orbiter downlink. Telemetry transmission on the IUS RF link begins after the IUS and spacecraft are tilted for deployment from the orbiter. Spacecraft data may be transmitted directly to the ground when the spacecraft is in the orbiter payload bay with the payload bay doors open or during IUS and spacecraft free flight.

IUS guidance and navigation consist of strapped-down redundant inertial measurement units. The redundant IMUs consist of five rate-integrating gyros, five accelerometers and associated electronics. The IUS inertial guidance and navigation subsystem provides measurements of angular rates, linear accelerations and other sensor data to data management for appropriate processing by software resident in the computers. The electronics provides conditioned power, digital control; thermal control, synchronization and the necessary computer interfaces for the inertial sensors. The electronics are configured to provide three fully independent channels of data to the computers. Two channels each support two sets of sensors and the third channel supports one set. Data from all five gyro and accelerometer sets are sent simultaneously to both computers.

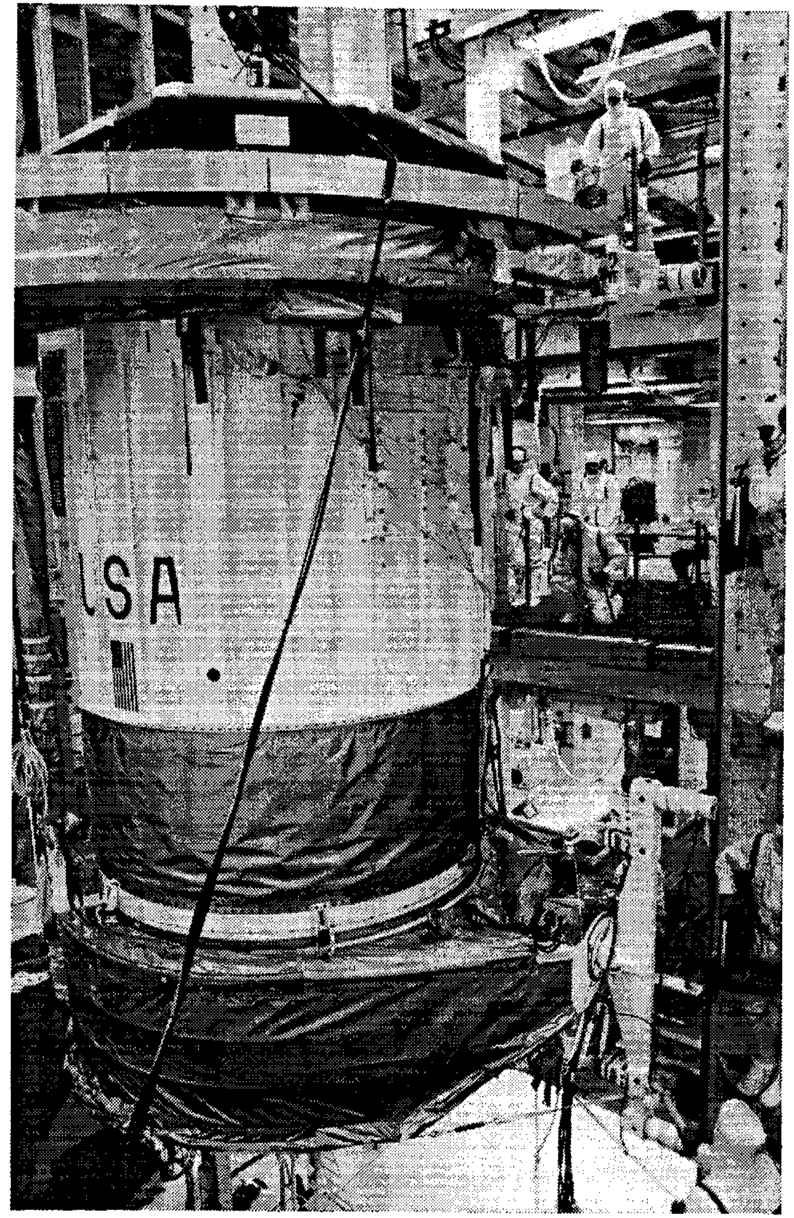
The guidance and navigation subsystem is calibrated and aligned on the launch pad. The navigation function is initialized at lift-off, and data from the redundant IMUs are integrated in the navigation software to determine the current state vector. Before vehicle deployment, an attitude update maneuver may be performed by the orbiter.

If for any reason the computer is powered down before deployment, the navigation function is reinitialized by transferring orbiter position, velocity and attitude data to the IUS vehicle. Attitude updates are then performed as described above.

The IUS vehicle uses an explicit guidance algorithm (gamma guidance) to generate thrust steering commands, SRM ignition time and RCS vernier thrust cutoff time. Before each SRM ignition and each RCS vernier, the vehicle is oriented to a thrust attitude based on nominal performance of the remaining propulsion stages. During the SRM burn, the current state vector determined from the navigation function is compared to the desired state vector, and the commanded attitude is adjusted to compensate for the buildup of position and velocity errors caused by off-nominal SRM performance (thrust, specific impulse).

Vernier thrust compensates for velocity errors resulting from SRM impulse and cutoff time dispersions. Residual position errors from the SRM thrusting and position errors introduced by impulse and cutoff time dispersions are also removed by the RCS.

Attitude control in response to guidance commands is provided by thrust vector control during powered flight and by reaction control thrusters during coast. Measured attitude from the guidance and navigation subsystem is compared with guidance commands to generate error signals. During solid motor thrusting, these error signals drive the motor nozzle actuator electronics in the TVC subsystem. The resulting nozzle deflections produce the desired attitude control torques in pitch and yaw. Roll control is maintained by the RCS roll-axis thrusters. During coast flight, the error signals are processed in the computer to generate RCS thruster commands to maintain vehicle attitude or to maneuver the vehicle. For attitude maneuvers, quarternion rotations are used.



Inertial Upper Stage Booster Testing

TVC provides the interface between IUS guidance and navigation and the SRM gimbaled nozzle to accomplish powered-flight attitude control. Two complete electrically redundant channels minimize single-point failure. The TVC subsystem consists of two controllers, two actuators and four potentiometers for each IUS SRM. Power is supplied through the SCU to the TVC controller that controls the actuators. The controller receives analog pitch and yaw commands that are proportioned to the desired nozzle angle and converts them to pulsewidth-modulated voltages to power the actuator motors. The motor drives a ball screw that extends or retracts the actuator to position the SRM nozzle. Potentiometers provide servoloop closure and position instrumentation. A staging command from the SCU allows switching of the controller outputs from IUS first-stage actuators to the IUS second-stage actuators.

The IUS's electrical power subsystem consists of avionics batteries, IUS power distribution units, a power transfer unit, utility batteries, a pyrotechnic switching unit, an IUS wiring harness and umbilical, and staging connectors. The IUS avionics subsystem distributes electrical power to the IUS and spacecraft interface connector for all mission phases from prelaunch to spacecraft separation. The IUS system distributes orbiter power to the spacecraft during ascent and on-orbit phases. ASE batteries supply power to the spacecraft if orbiter power is interrupted. Dedicated IUS and spacecraft batteries ensure uninterrupted power to the spacecraft after deployment from the orbiter. The IUS will also accomplish an automatic power-down if high-temperature limits are experienced before the orbiter payload bay doors are opened. Dual buses ensure that no single power system failure can disable both A and B channels of avionics. For the IUS two-stage vehicle, four batteries (three avionics and one spacecraft) are carried in the IUS first stage. Five batteries (two avionics, two utility and one spacecraft) supply power to the IUS second stage after staging. The IUS battery complement can be changed to adapt to mission-unique requirements and to provide special spacecraft requirements. Redundant IUS switches transfer the power input among spacecraft, ground support equipment, ASE and IUS battery sources.

Stage 1 to stage 2 IUS separation is accomplished via redundant low-shock ordnance devices that minimize the shock environment on the spacecraft. The IUS provides and distributes ordnance power to the IUS/spacecraft interface for firing spacecraft ordnance devices in two groups of eight initiators: a prime group and a backup group. Four separation switches, or breakwires, provided by the spacecraft are monitored by the IUS telemetry system to verify spacecraft separation.

IUS SOLID ROCKET MOTORS

The two-stage IUS vehicle incorporates a large SRM and a small SRM. These motors employ movable nozzles for thrust vector control. The nozzles are positioned by redundant electromechanical actuators, permitting up to 4 degrees of steering on the large motor and 7 degrees on the small motor. Kevlar filament-wound cases provide high strength at minimum weight. The large motor's 150-second thrusting period is the longest ever developed for space. Variations in user mission requirements are met by tailored propellant off-loading or on-loading. The small motor can be flown either with or without its extendable exit cone, which provides an increase of 14.5 seconds in the delivered specific impulse of the small motor.

IUS REACTION CONTROL SYSTEM

The IUS RCS is a hydrazine monopropellant positive-expulsion system that controls the attitude of the IUS and spacecraft during IUS coast periods, roll during SRM thrustings and delta velocity impulses for accurate orbit injection. Valves and thrusters are redundant, which permits continued operation with a minimum of one failure.

The IUS baseline includes at least one RCS tank with a capacity of 120 pounds of hydrazine. Production options are available to add a second or third tank. IUS-14, the vehicle to be used on STS-44, will carry two tanks, each containing 120 pounds of fuel. To avoid spacecraft contamination, the IUS has no forward-facing thrusters. The system is also used to provide the velocities for spacing between multiple spacecraft deployments and for a collision/contamination avoidance maneuver after spacecraft separation.

The RCS is a sealed system that is serviced before spacecraft mating. Propellant is isolated in the tanks with pyrotechnic squib-operated valves that are not activated until 10 minutes after IUS deployment from the orbiter. The tank and manifold safety factors are such that no safety constraints are imposed on operations in the vicinity of the serviced tanks.

IUS-TO-SPACECRAFT INTERFACES

The spacecraft is attached to the IUS at a maximum of eight attachment points. They provide substantial load-carrying capability while minimizing thermal transfer across the interface.

Power and data transmission to the spacecraft are provided by several IUS interface connectors. Access to these connectors can be provided on the spacecraft side of the interface plane or through the access door on the IUS equipment bay.

The IUS provides a multilayer insulation blanket of aluminumized Kapton with polyester net spacers and an aluminized beta cloth outer layer across the IUS and spacecraft interface. All IUS thermal blankets are vented toward and into the IUS cavity. All gases within the IUS cavity are vented to the orbiter payload bay. There is no gas flow between the spacecraft and the IUS. The thermal blankets are grounded to the IUS structure to prevent electrostatic charge buildup.

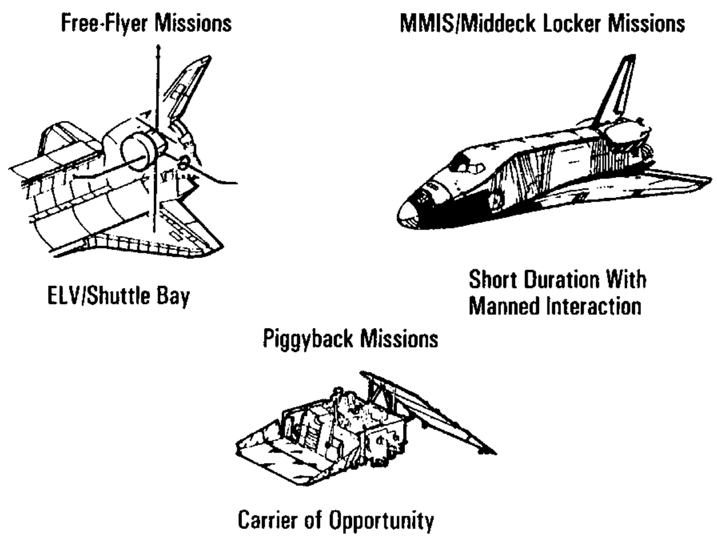
SPACE TEST PROGRAM

The secondary payloads on this mission of the space shuttle are being flown under the auspices of the Space Test Program, a Department of Defense project established in 1965.

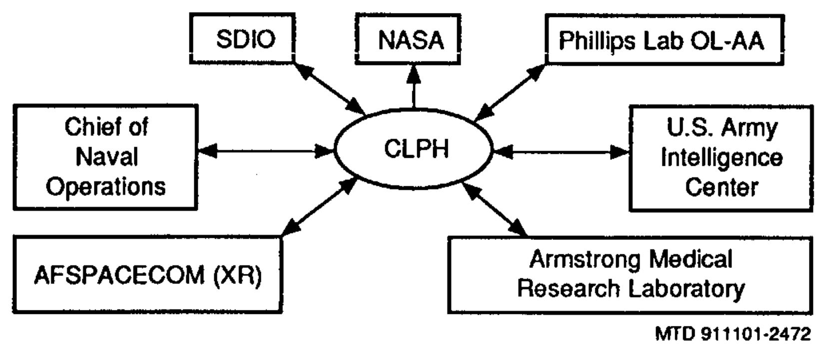
The objectives of the STP are as follows:

- Provide space flight for advanced DOD research and development experiments that are not authorized to fund their own flight
- Plan space flights for payloads on either STP-provided flights or those of NASA or other DOD programs
- Exploit the space shuttle as a manned space laboratory
- Serve as a pathfinder in fully defining man's military role in space

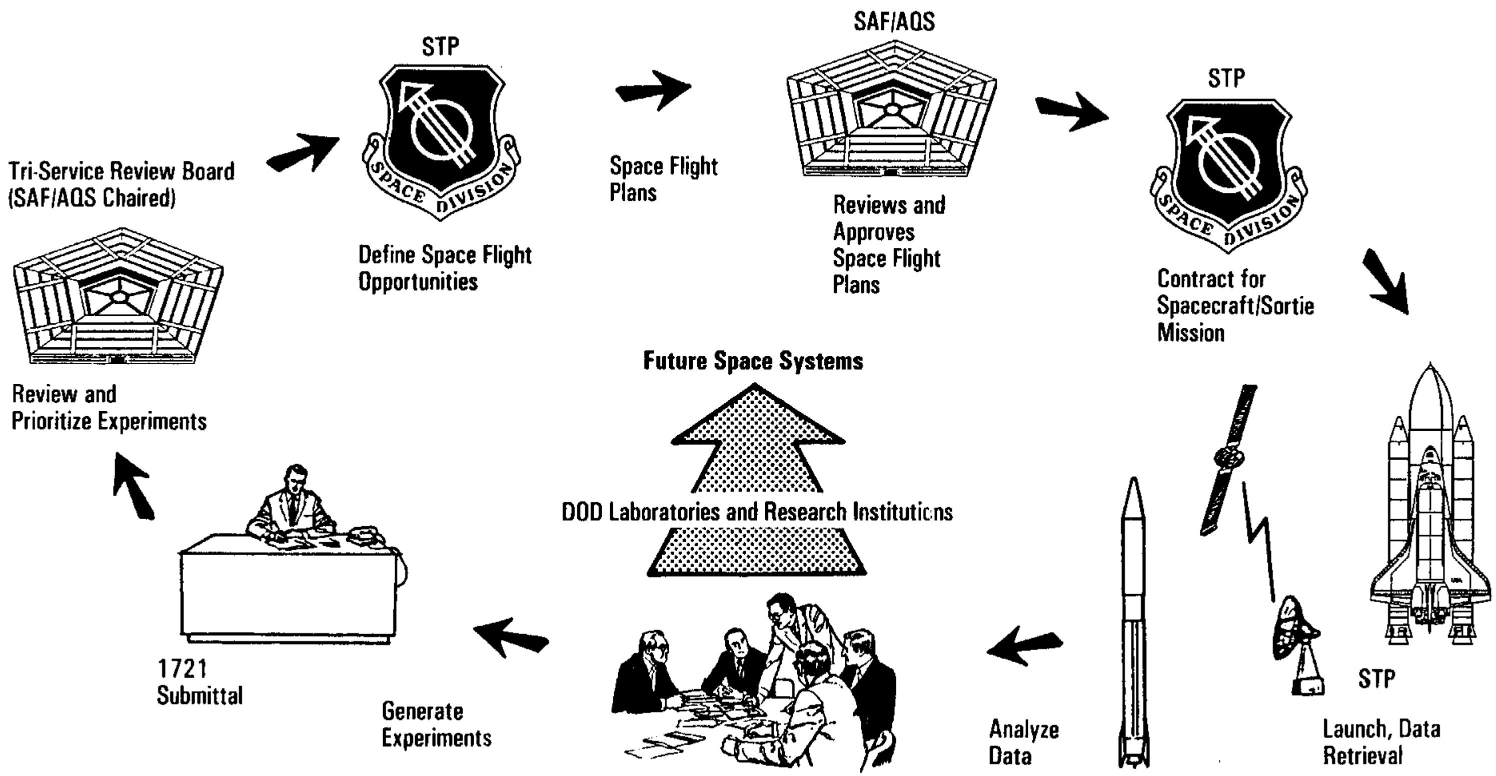
The Air Force, which manages the STP for the DOD, has three primary methods of launching its payloads. Some are free-flying spacecraft that are launched on expendable launch vehicles or the space shuttle. Others, like the eight experiments being flown on this flight, are Military Man in Space or middeck locker experiments conducted by astronauts on board the shuttle. Still others are launched as piggyback missions on other payloads. A total of 201 mission experiments have been successfully conducted by the program, ranging from flight tests of prototype subsystems and systems for operational programs to experiments aimed at further defining the space environment.



STP Modes of Space Flight



STS-44 STP Payload Sponsors



STP Experiment Cycle

INTERIM OPERATIONAL CONTAMINATION MONITOR

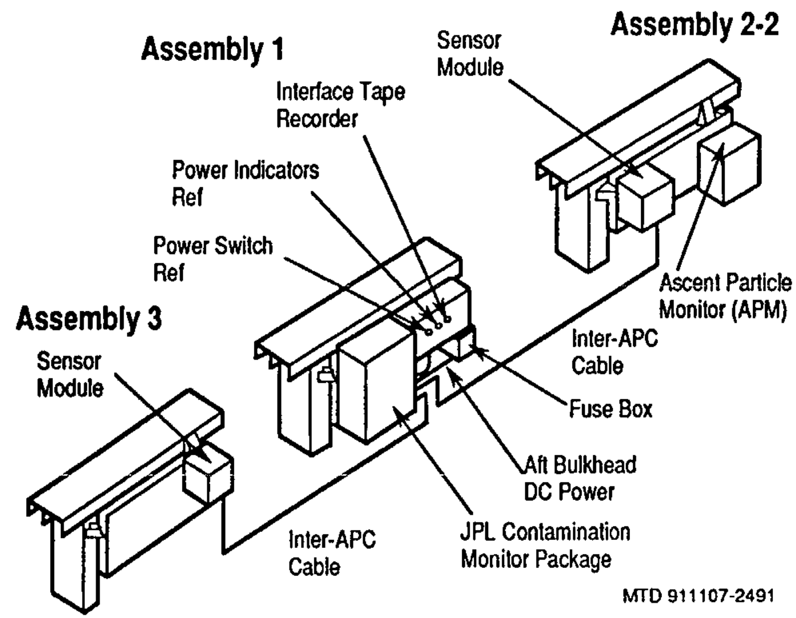
The Interim Operational Contamination Monitor measures contamination in the orbiter's payload bay during all phases of a mission, from immediately before launch through the orbiter's return to the Kennedy Space Center. The IOCM consists of a number of optional sensors and can be tailored for each mission.

The IOCM sensors characterize deposits of molecular and particulate contamination in the payload bay during all phases of flight and measure the optical property changes of thermal control surfaces, the flux of the ambient atomic oxygen environment, the incident solar flux and the absolute ambient pressure in the payload bay. It also serves as a platform for holding samples of passive materials that are exposed to the space environment.

The IOCM is a totally automated system that requires no command and control support. Its powered components are activated by sound immediately before launch or by barometric switches at preselected altitudes. The only crew involvement is photo documentation that coupon doors have closed.

IOCM modules are mounted to the payload bay and include an interface tape recorder, the Jet Propulsion Laboratory contamination monitor that serves as the primary electronic support unit for the IOCM, the sensor module, the material sample array and an ascent particle monitor. The APM measures particle contamination in the payload bay immediately before the launch and during ascent.

The IOCM payload weighs 190 pounds. It is sponsored by the DOD's Air Force Space Test Program.



IOCM Configuration

TERRA SCOUT

Terra Scout is an Earth observation experiment that is part of the Military Man in Space program. The objective of this experiment is to evaluate the ability of a specially trained payload specialist to detect specific objects on the Earth at predefined targets using Earth observation tools and to compare the quality of those observations with observations of the same targets by an Earthbound observer using conventional methods.

The payload specialist who will conduct this experiment, Thomas (Tom) J. Hennen, is an Army imagery analyst who is also experienced in terrain and aerial observation and has some formal training in geology. He will have studied the sites of interest intensively before the flight.

The payload specialist will use the Spaceborne Direct-View Optical System, or SpaDVOS, to observe at least 10, and possibly as many as 30, sites and record his observations. Sites of opportunity may also be identified during the mission. SpaDVOS consists of optics, a gyro stabilizer and binoculars. It is stowed in two and a half middeck lockers.

Once on orbit, Hennen will remove the equipment from its middeck lockers and mount it in the overhead windows on the aft flight deck. Voice downlink of payload data and crew observations is required within 30 minutes of payload operations. His observations will be recorded on a videotape recorder for later playback and analysis. Still photographs will also be taken during the experiment.

Hennen will have a packet containing maps and photographs for each of the sites selected for observation. Weather maps, photos, and other images will be sent to the orbiter via the text and graphics system periodically to help identify sites of opportunity. For some of the sites, large-resolution panels have been laid out in a grid pattern. These grids will facilitate the quantification of the resolution limit from the shuttle cabin.

The visual function tester will be used in conjunction with this experiment to evaluate Hennen's visual acuity. The VFT is a hand-held, battery-powered device that measures eye interaction effects, such as stereopsis and eye dominance, as well as visual acuity.

The Terra Scout experiment is sponsored by the U.S. Army Intelligence Center.

MILITARY MAN IN SPACE

Military Man in Space is a continuing Army, Navy and Air Force program that is designed to assess man's ability to enhance air, naval and ground force operations by making visual observations of fixed or mobile military sites and facilities from space and communicating those observations to forces using special optics and communication equipment. Areas of investigation include dynamic shuttle tasking, near-real-time information relay and quantification of the astronauts' visual resolution limits. Emphasis is on coordinating observations with ongoing DOD exercises to fully assess the military benefits of a spaceborne observer. Three M88-1 experiments will be flown on the STS-44 mission: Maritime Observation Experiments in Space (MOSES), Battlefield Surveillance From Space (Battleview) and Night Mist.

During the MOSES experiment, the crew of Atlantis will observe five to 15 maritime sites, such as ships, ports and ship wakes. Additional targets may be selected during the flight and uplinked to the crew.

Before Atlantis passes over a site, a crew member will establish network communications through the orbiter's communication system with the site for pre- and post-pass briefings. Direct communications with the site will also be established through a portable, secure ultrahigh frequency radio system (transceiver, encrypter, headset, speaker and antenna) that is part of the M88-1 hardware. The crew member will use small-aperture optics with a long focal length to acquire and observe the sites. He will use a charge-coupled device camera with a zoom lens to produce high-resolution digital images that can be stored on a microcassette recorder, manipulated and evaluated on orbit using a high-resolution video monitor. Pertinent findings will then be communicated via the UHF secure radio transceiver to tactical field users seconds after the pass is completed.

If time is available, the crew member will observe and photograph ocean phenomena related to ship detection, such as ship wakes, eddies and disturbances.

The Atlantis crew will make 10 to 20 observations of U.S. armored mechanical formations, military ground sites, and flying aircraft during the Battleview experiment. Additional targets may also be passed to the crew during the flight.

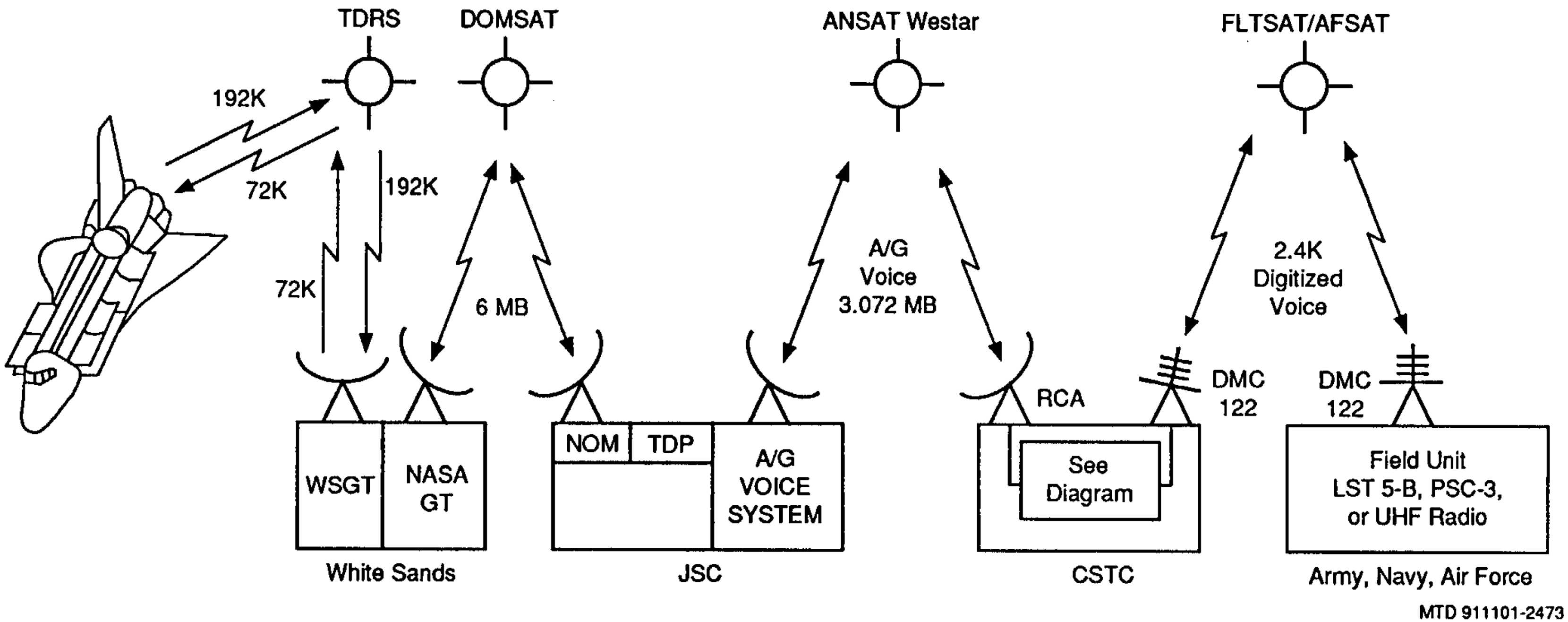
Crew members will establish communications with the ground through the orbiter and UHF systems and will acquire the selected sites and identify site facilities and phenomena, such as armored formations, truck convoys, aircraft operations, dust clouds and smoke. Pertinent data and the location and direction of movement will be reported to the ground site. The observer's comments will also be recorded on the microcassette recorder.

The Night Mist experiment will test the use of an encrypted UHF communication system to link the astronaut observers with personnel on Earth. Hardware includes a microcassette recorder and a UHF transceiver system (radio, encrypter, headset, speaker and antenna).

All observations will be conducted from the orbiter flight deck windows. An Earth-viewing attitude is preferred for the MOSES and Battleview operations, as is landmark tracking. During some observations, the orbiter will be oriented with its payload bay to space to allow the crew to use the orbiter's window antenna for orbiter-to-satellite-to-Earth communications.

The M88-1 program is sponsored by the Air Force Special Command, the Chief of Naval Operations and the U.S. Army Intelligence Center.

Orbiter and Field Are Not in the Line of Sight With Each Other



Network Voice Communications (NVC) Configuration

SHUTTLE ACTIVATION MONITOR

The SAM experiment is designed to measure specific types of radioactivity produced in spacecraft and sensor materials when they are exposed to the space environment to determine their effect on the sensitivity of gamma ray detectors used in space. On this flight, SAM detectors will be moved to several locations throughout the orbiter middeck to map time-dependent variations in the radiation background as they change with location, type of detector material and amount of shielding.

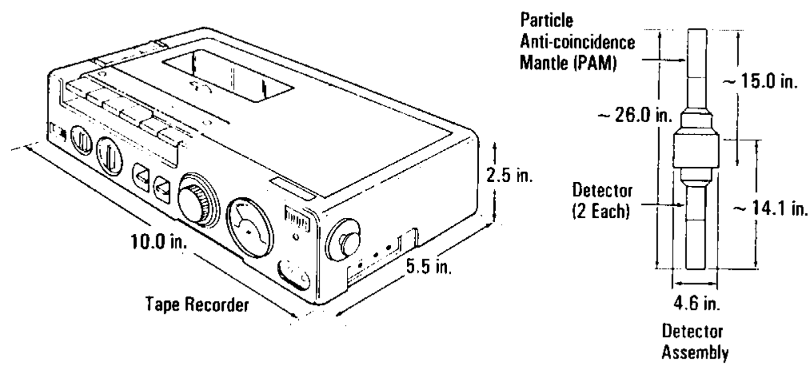
The data obtained in this experiment can be used by instrument designers to improve design decisions, by gamma ray astronomers to understand space-based gamma ray data and by health physicists concerned with long-term radiation exposure of man in space. Two other radiation experiments, CREAM and RME-III, will accompany the SAM detectors, each measuring a different component of the low-Earth-orbit radiation environment.

SAM consists of two separate data collection systems. The passive system requires the crew to install an activation foil packet at four specified stations within the orbiter: areas of maximum shielding (airlock ceiling), areas of minimum shielding (crew sleep station), close to LiOH cannisters and close to water tanks. The active system consists of a tape recorder with cassettes, a multichannel analyzer, a particle anti-coincidence mantle, two gamma ray detector assemblies (sodium iodide and bismuth germinate), photomultiplier tube bases and associated cables. An encapsulated radioisotope source is used for in-flight calibrations. SAM weighs approximately 90 pounds and occupies two shuttle middeck lockers.

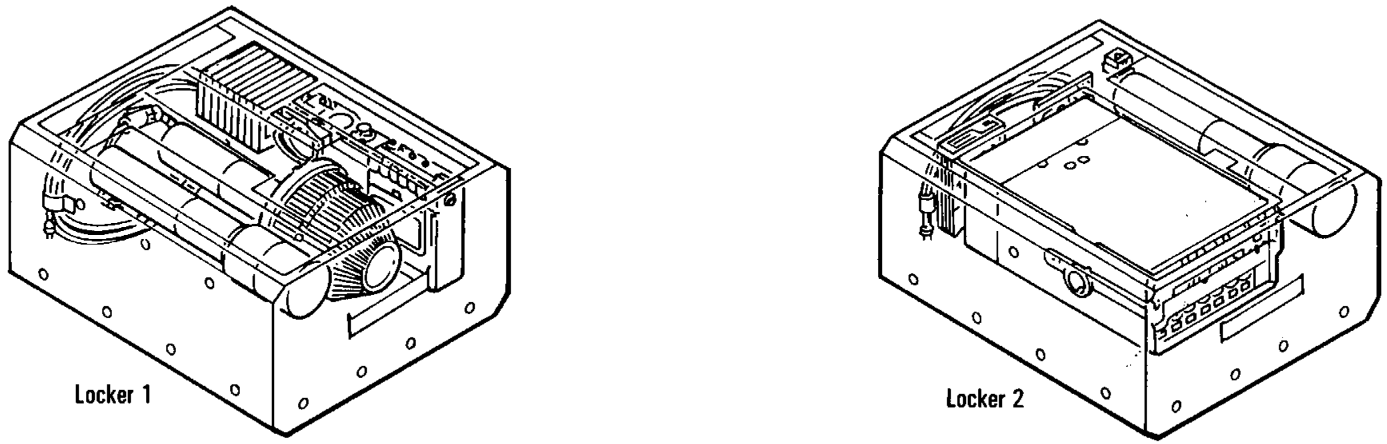
SAM will be operated in the shuttle middeck by pilot Terence (Tom) T. Henricks and mission specialist Mario Runco, Jr. Following orbital insertion, the two will destow and assemble the hardware, start the MCA, calibrate the first detector and place the detector assembly at the first location.

Nominal operations will require approximately 20 minutes per day of crew time and will consist of changing data tapes, changing the sodium iodide and bismuth germinate detectors and repositioning the detector assembly. Each data run lasts approximately 12 hours and requires a specific detector and location. During the final 24 hours of SAM's operation, the PAM will be removed and a composite activation test sample will be installed over the detector. This part of the experiment is designed to evaluate the effectiveness of a graphite epoxy composite material as a shielding device. All hardware will be stowed before deorbit.

SAM is a DOD Space Test Program payload and is sponsored by the Strategic Defense Initiative Organization. It was built by the Space Radiation Effects Group at the Institute for Space Science and Technology in Gainesville, Fla. Dr. Penny Haskins is the principal investigator. Jack McKisson is the program manager. Program support is provided by ISST personnel and a Space Test Program team from the U.S. Air Force, Rockwell International Corporation's Space Systems Division and The Aerospace Corporation.



SAM Configuration



SAM Stowed Configuration

COSMIC RADIATION EFFECTS AND ACTIVATION MONITOR

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 Shuttle Activation Monitor and Radiation Monitoring Equipment experiments in an attempt to correlate the three experiments' data.

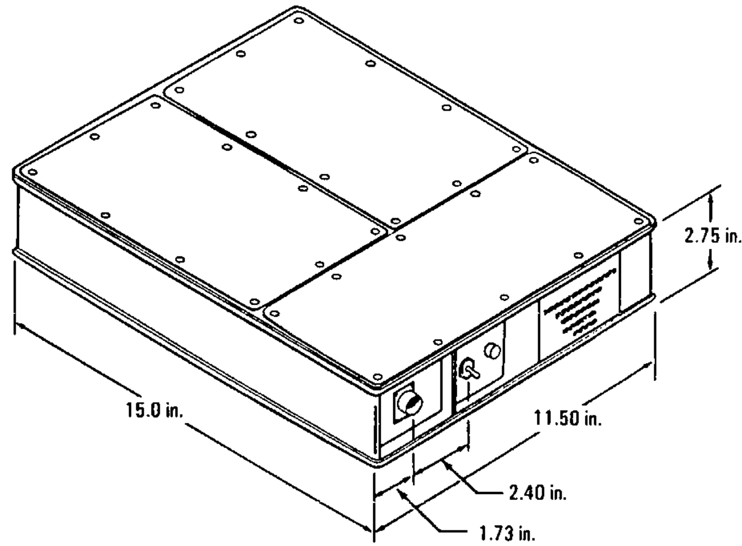
The CREAM payload flight hardware consists of an active cosmic ray monitor, a passive sodium iodide detector and up to five passive foil detector packages. The active monitor will be used to obtain real-time spectral data, and the passive monitors will obtain data integrated over the duration of the 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.

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

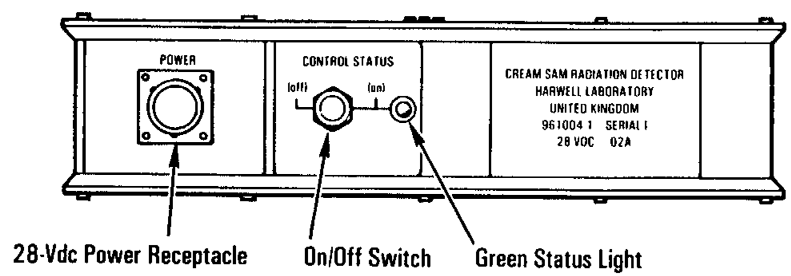
The payload will be unstowed and operated by the crew approximately 2.5 hours after launch. A crew member will be available at regular intervals to monitor the payload/experiment. The crew will be required to document the placement and setup of the payload in each monitoring location with 35mm still photography.

CREAM is sponsored by the Department of Defense.

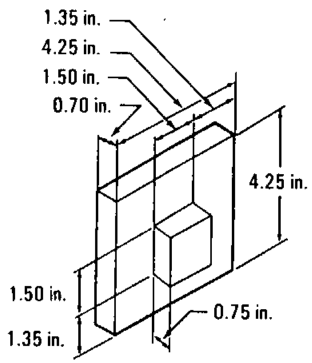


Active Monitor

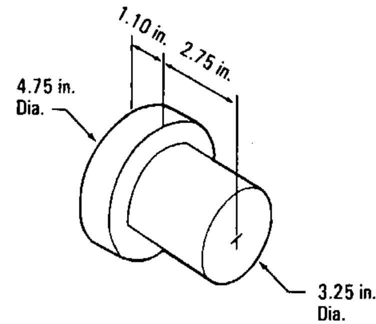
CREAM Payload Configuration



Detail of CREAM Active Monitor Front Panel



Passive Dosimetry Package



Sodium Iodide Crystal Passive Detector

RADIATION MONITORING EQUIPMENT III

Radiation Monitoring Equipment III will measure and record the rate and total dosage of the crew's exposure to ionizing radiation at different locations in Atlantis's crew compartment. RME-III measures gamma ray, electron, neutron and proton radiation and calculates, in real time, exposure in RADS-tissue equivalent.

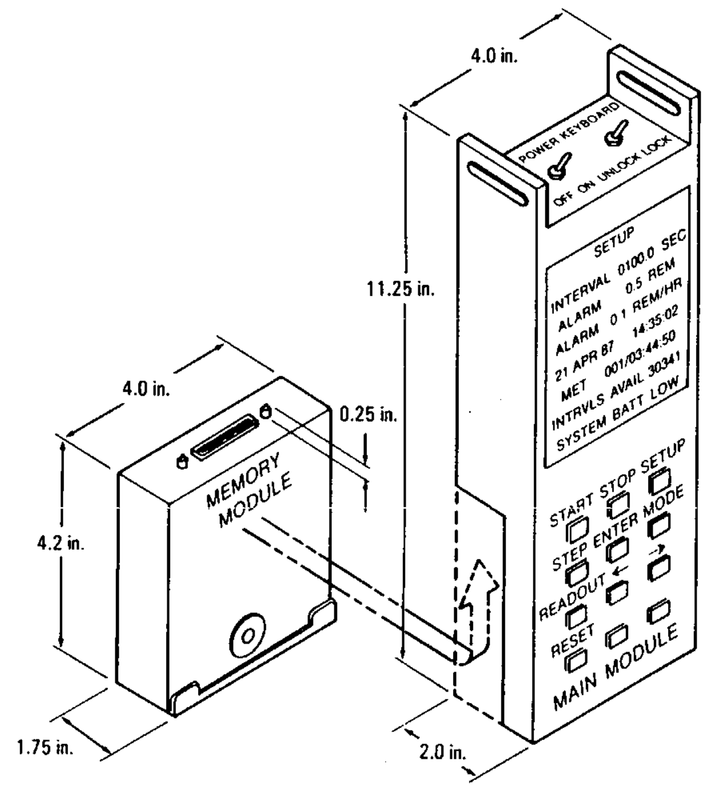
RME-III consists of a hand-held instrument with replaceable memory modules. The equipment contains a liquid crystal display for real-time data presentation and a keyboard for controlling its functions. The self-contained experiment has four zinc-air and five AA batteries in each memory module and four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

RME-III will be stored in a middeck locker during flight except for when it is turned on and when memory modules are being replaced. It will be activated as soon as possible following orbit insertion and will be 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 will be activated and colocated with the SAM and CREAM experiments. The three experiments will be moved to several locations in the shuttle middeck area.

RME-III, which was flown on STS-31, STS-41, STS-37, STS-39 and STS-48, replaces two earlier configurations.

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



RME Configuration

AIR FORCE MAUI OPTICAL SITE CALIBRATION TEST

The AMOS tests allow ground-based electro-optical sensors located on Mt. Haleakala in Maui, Hawaii, to collect imagery and/or signature data of the space shuttle orbiters during cooperative overflights.

This experiment is a continuation of tests made during the STS-29, -30, -34, -32, -31, -41, -35, -37, -43 and -48 missions. The scientific observations of the orbiters during those missions consisted of reaction control system thruster firings and water dumps or activation of payload bay lights. They were used to support the calibration of the AMOS ground-based infrared and optical sensors, using the shuttle as a well-characterized calibration target, and to validate spacecraft contamination models through observations of contamination/exhaust plume phenomenology under a variety of orbiter attitude and lighting conditions.

No unique on-board hardware is associated with the AMOS test. Crew and orbiter participation may be required to establish the controlled conditions for the Maui overflights.

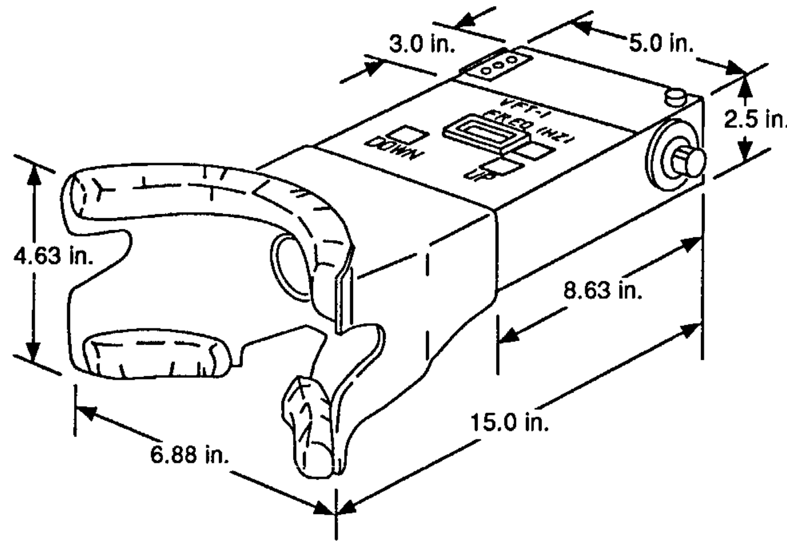
The AMOS facility was developed by the Air Force Systems Command through its Rome Air Development Center at Griffiss Air Force Base, N.Y. It is administered and operated by the AVCO Everett Research Laboratory on Maui. The principal investigators for the AMOS tests on the space shuttle are from AFSC's Air Force Geophysical Laboratory at Hanscom Air Force Base, Mass., and AVCO.

Flight planning and mission support activities for the AMOS test opportunities are performed by a detachment from AFSC's Space Systems Division at the Johnson Space Center in Houston. Flight operations are conducted at the JSC Mission Control Center in coordination with the AMOS facilities in Hawaii.

VISUAL FUNCTION TESTER 1

The Visual Function Tester experiment will measure changes in the vision of an astronaut in microgravity. The VFT is a hand-held, battery-powered device with a binocular eyepiece that uses controlled illumination to present a variety of visual targets for testing primarily visual acuity and eye interaction effects, such as stereopsis and eye dominance. This experiment is being conducted in conjunction with the Military Man in Space activities.

The VFT will be used to measure the visual acuity of payload specialist Thomas (Tom) J. Hennen. He 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 subject's 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.



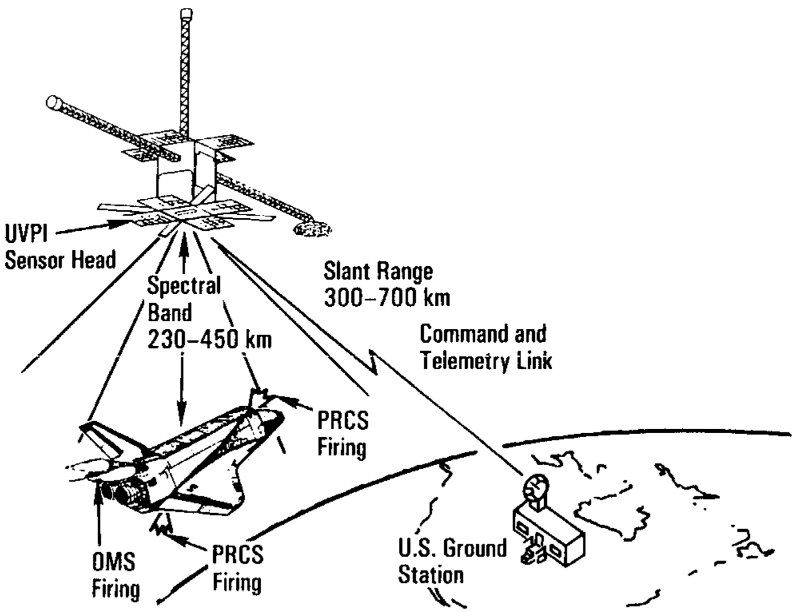
Visual Function Tester Configuration

ULTRAVIOLET PLUME INSTRUMENT

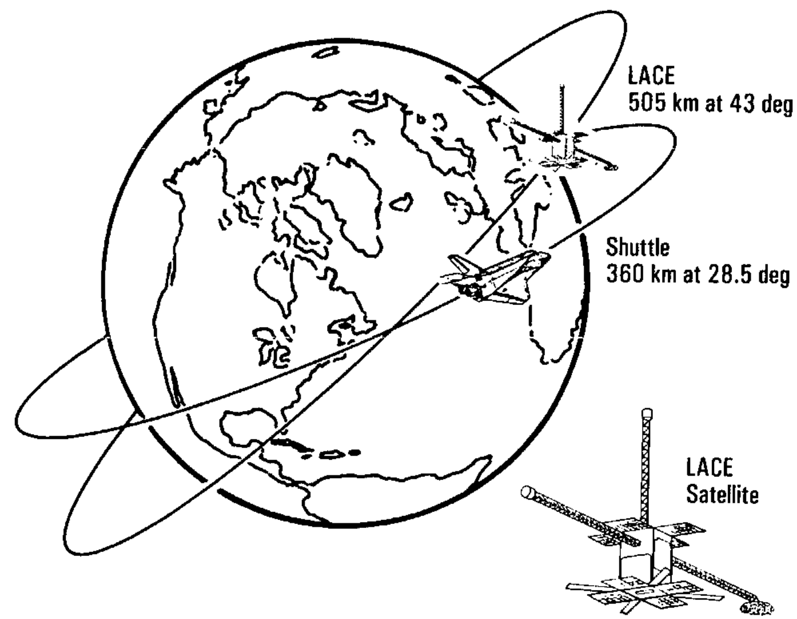
The Ultraviolet Plume Instrument is located on the Low-Power Atmospheric Compensation Experiment satellite, a Strategic Defense Initiative Organization satellite in low Earth orbit at an inclination of 43 degrees and an altitude of approximately 273 nautical miles. The UVPI's sensors will be trained on the orbiter to obtain imagery and/or signature data to calibrate the sensors and to observe orbiter jet firings during cooperative encounters of the orbiter with the LACE satellite.

A UVPI test will be scheduled late in the mission if an orbiter encounter with the satellite fits within the crew's scheduling contraints and the orbiter has enough propellant.

UVPI is sponsored by the Strategic Defense Initiative Organization.



LACE/Shuttle UVPI Encounter



LACE (UVPI)/Shuttle Encounter

ENTRY AERODYNAMIC CONTROL SURFACES TEST (DTO 242). The purpose of this DTO is to perform a series of programmed test input maneuvers and one manual body flap maneuver during the entry and terminal area energy management phases to obtain aerodynamic response data. This data will be used to evaluate the effectiveness of various aerodynamic control surfaces.

ASCENT 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.

ENTRY STRUCTURAL CAPABILITY (DTO 307D). This DTO will collect structure load data for different payload weights and configurations to expand the data base of flight loads during entry.

ET TPS PERFORMANCE (DTO 312). This DTO will photograph the external tank after separation to document overall thermal protection system performance.

EDWARDS LAKEBED RUNWAY BEARING STRENGTH AND ROLLING FRICTION ASSESSMENT FOR ORBITER LANDING (IF EDWARDS 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.

COMBUSTION PRODUCTS ANALYZER (CPA) (DTO 645). This DTO will continue to gather data on the performance of the CPA, which can be used to assist in determining the suitability of cabin air should it become contaminated. The CPA will sample cabin air during the mission to detect the concentration of targeted compounds indicative of a thermodegradation event. This configuration of the instrument tests the calibration, stability and operation of the CPA. Pre- and postflight calibrations (daily baseline readings and collected air samples) will verify the ability of the CPA to remain calibrated during on-orbit operations.

SHUTTLE EXTENDED-DURATION ORBITER (EDO) REHYDRATABLE FOOD PACKAGE EVALUATION (DTO 649). The EDO rehydratable food package was developed to reduce stowage volume, stowage weight and trash volume of the shuttle food system for EDO flights. There are two main objectives of this evaluation: (1) to determine the impact on crew time required for meal preparation using the new package and (2) to obtain astronaut inputs on the performance of the package in the microgravity environment.

STAR LINE MANEUVER (SLM) VALIDATION (DTO 797). The SLM is a technique to align the inertial reference system of a payload directly using the orbiter star trackers with orbiter calibration maneuvers. The procedure is needed to update the inertial alignment of the IMU in the Aeroassist Flight Experiment to provide the required navigation accuracy. The SLM is performed by collecting orbiter star tracker data and payload attitude data at three different orbiter attitudes separated by two maneuvers about near-orthogonal eigen axes. The SLM DTO requirements are satisfied by the design of the DSP/IUS attitude match update sequence.

CROSSWIND LANDING PERFORMANCE (DTO 805). This DTO will continue gathering data for landing with a crosswind.

DETAILED SUPPLEMENTARY OBJECTIVES

Nine of the 14 detailed supplementary objectives to be conducted during STS-44 are part of NASA's continuing effort to collect data to be used in developing in-flight activities and medical protocols to help astronauts' readjust to a 1-g environment after a space flight. These experiments are aimed particularly at answering some of NASA's concerns about the physiological effects of extended space flight on the body and are in preparation for planned extended-duration orbiter missions.

For example, NASA is going to use this flight to try to learn more about bodily fluid shifts. In the microgravity environment of low Earth orbit, fluids in shuttle astronauts' bodies shift upwards. Those fluids shift downwards after the astronauts return to Earth. During this mission, three Atlantis crew members will test a device designed to shift bodily fluids to the lower body before deorbit to enhance the astronauts' performance during reentry and landing (DSO 478). A separate DSO (DSO 472) will study headward fluid shifts in microgravity.

DSO 463 will gather data on the frequency of heart rhythm abnormalities in microgravity, particularly during exercise. Another, DSO 603, will investigate cardiovascular responses during the entry, landing and egress phases of flight.

Other medical experiments to be conducted include the following:

- The body's ability to respond to stressful situations after a flight, such as an emergency exit from the orbiter
- The interaction between vision and balance
- The relationship of the body's neurosensory functions and posture
- The effects of space flight on aerobic and anaerobic metabolism at rest and during exercise
- Cabin air quality for extended-duration flights

The DSOs to be conducted on STS-44 are as follows:

BIOREACTOR/FLOW AND PARTICLE TRAJECTORY IN MICROGRAVITY (DSO 316). Development of a bioreactor system for use in the Space Station Freedom biotechnology facility depends on understanding the fluid dynamics of such a system in microgravity. This equipment test will permit actual microgravity particle trajectories to be compared with calculated trajectories, providing data to improve or modify the current systems. Data obtained from a set of 16 separate experiments will help to fine-tune particle trajectories under varying fluid shear dynamics. Conclusions drawn from these fundamental observations will lead to a better understanding of mass transfer under microgravity conditions. Mass transfer is important for the exchange of nutrients for metabolic waste products during cellular growth and differentiation—a future goal of the program. It is anticipated that the basic understandings derived from this model will lead to an improvement in the design of cell culture systems for tissue assemblies on shuttle flights and in Space Station Freedom.

IN-FLIGHT HOLTER MONITORING (DSO 463). In-flight electrocardiography will be used to document the presence of irregular heart beats during nominal activity and treadmill exercises to determine if their frequency is due to elevated exertion levels in microgravity or simply a function of the space environment itself.

INTRAOCULAR PRESSURE (DSO 472). This DSO will gather data on headward fluid shifts in zero gravity. Pressure measurements 20 to 25 percent above normal preflight levels were observed in bedrest studies, during zero gravity on the KC-135 aircraft and on the STS 61-A shuttle mission. The deleterious effects of sustained deviations in intraocular pressure are difficult to predict since no statistically valid in-flight data exists. Even though a few days or weeks of elevated intraocular pressure would be harmless, months or years of sustained pressures, due to microgravity, could cause ocular disturbances. Significant baseline data is needed to define normal intraocular pressure ranges in microgravity and to determine the magnitude of pressure rises to be expected in crew members. A tono pen is used to measure the IOP of the crew members.

IN-FLIGHT LOWER BODY NEGATIVE PRESSURE (DSO 478). Fluid loading through ingesting salt tablets and water in association with lower body negative pressure treatment will protect tolerance to orthostasis (simulated in flight by LBNP). The objective of this study is to evaluate the effectiveness of fluid loading during LBNP in improving tolerance of an LBNP stress protocol.

ORTHOSTATIC FUNCTION DURING ENTRY, LANDING AND EGRESS (DSO 603). The purpose of this DSO is to document the orthostatic function of crew members during the actual stresses of entry, landing egress from the seat and from the cabin as mission duration increases. This data will be used to determine whether precautions and countermeasures are needed to protect crew members during 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 preparations. The crew member wears the equipment and records verbal comments through entry.

VISUAL VESTIBULAR INTEGRATION AS A FUNCTION OF ADAPTATION, OI-1 AND 3 (DSO 604). The objective of this DSO is to gather data on the interaction between visual and balance systems that work together to maintain balance after a flight. The DSO will investigate visual vestibular and perceptual adaptive responses as a function of longer missions and determine the impact of entry, landing and egress procedures on performance. DSO procedures OI-1 and 3 will be performed on STS-44. Crew members will report their sensations in OI-1, and sensors will be used for OI-3 to record vestibular-ocular reflex and head movement rates.

POSTURAL EQUILIBRIUM CONTROL DURING LANDING/EGRESS (DSO 605). The purpose of this DSO is to quantify the effects of space flight on the body's neurosensory functions and posture response during return to Earth.

EFFECTS OF SPACE FLIGHT ON AEROBIC AND ANAEROBIC METABOLISM AT REST AND DURING EXERCISE (DSO 608). This DSO will quantify the changes in aerobic and anaerobic metabolism during graded treadmill exercise performed before and after flight and relate those changes to alterations in total body water, dry lean tissue, fat mass and fluid volume intake. The data obtained will be used to develop nutrition, fluid and exercise countermeasures for use on extended missions. On STS-44, the on-orbit exercise will be scheduled for two crew members; a third crew member (control) will not exercise.

AIR MONITORING INSTRUMENT EVALUATION AND ATMOSPHERE CHARACTERIZATION (DSO 611). The purpose of this DSO is to evaluate and verify air monitoring equipment to ensure proper function and operation in flight. Data will be collected on contaminant levels during missions of varying durations to establish baseline levels and to evaluate potential risks to crew health and safety. Only the microbial air sampler configuration will be flown on STS-44.

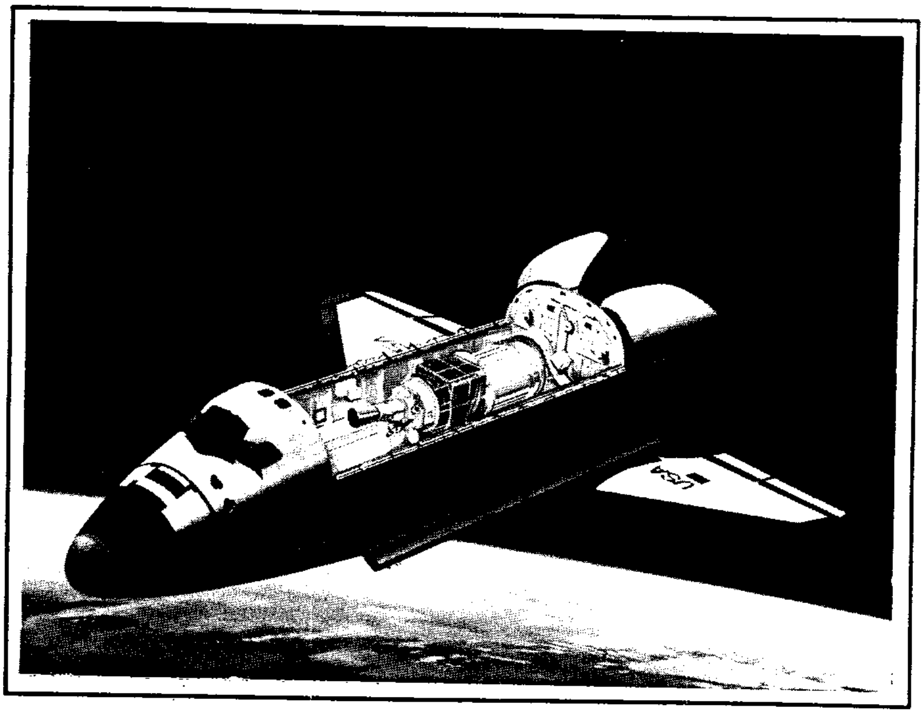
CHANGES IN ENDOCRINE REGULATION OF ORTHOSTATIC TOLERANCE FOLLOWING SPACE FLIGHT (DSO 613). This DSO will characterize the extent and pattern of changes in plasma volume during space flights of up to 16 days. It will also determine whether resting levels of catecholamines are elevated immediately after flight and whether catecholamine release in response to varying degrees of orthostatic and cardiovascular stresses is impaired after space flight. On-orbit activities consist of maintaining a dietary log. This information will be taken from the dietary log kept for DSO 608.

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. During exercise on the treadmill, crew members will read the Landholt Cs chart mounted on the middeck wall.

DOCUMENTARY TELEVISION (DSO 901). This DSO requires live television transmission or VTR dumps of crew activities and spacecraft functions, including payload bay views; DSP predeployment, deployment and separation activities; views of the payload bay attached payloads; in-flight crew press conference; views of middeck payload sessions; 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 objectives. This DSO includes motion picture photography of IUS predeployment and deployment activities, middeck activities and any unscheduled motion picture photography.

DOCUMENTARY STILL PHOTOGRAPHY (DSO 903). This DSO requires still photography of crew activities in the orbiter, spacecraft accommodations and mission-related scenes of general public and historical interest. Still photography in a 70mm format for exterior photographs and 35mm format for interior photographs is required.



STS-44

MISSION STATISTICS

PRELAUNCH COUNTDOWN TIMELINE

MISSION TIMELINE

November 1991

Rockwell International

Space Systems Division

Office of Media Relations

CONTENTS

MISSION OVERVIEW

This is the 10th flight of Atlantis and the 44th for the space shuttle.

The flight crew for the STS-44 mission is commander Frederick (Fred) D. Gregory; pilot Terence (Tom) T. Henricks; mission specialists F. Story Musgrave, Mario Runco, Jr., and James (Jim) S. Voss; and payload specialist Thomas (Tom) J. Hennen.

STS-44 is the eighth dedicated Department of Defense shuttle mission and the second such mission to be unclassified. STS-44's primary mission objective is to successfully deploy the Defense Support Program satellite with its inertial upper stage. Secondary objectives include using the orbiter Atlantis to conduct several DOD experiments and to perform medical evaluations in support of future extended-duration orbiter missions. Secondary mission objectives will be accomplished during flight days 2 through 10.

The DSP is a survivable and reliable satellite-borne system that detects and reports on real-time missile launches, space launches, and nuclear detonations using infrared detectors to sense heat from missile plumes against the Earth background. The DSP will be launched into low Earth orbit, where the IUS, a two-stage solid rocket propellant booster with redundant avionics systems, will propel the spacecraft to a geosynchronous orbit. Upon separation from the IUS, the DSP satellite will initiate various on-board programs that will allow the spacecraft to complete its primary mission.

The nominal planned deployment opportunity for DSP release from Atlantis's payload bay is on Orbit 5 at 0/06:19 mission elapsed time. A backup opportunity exists on flight day 2 on Orbit 16. DSP is sponsored by the U.S. Air Force Systems Command's Space Systems Division, Los Angeles Air Force Base, Calif.

Nine secondary objectives will be flown on STS 44: Interim Operational Contamination Monitor (IOCM), Terra Scout, Military Man in Space (M88-1), Shuttle Activation Monitor, Cosmic Radiation Effects and Activation Monitor, Radiation Monitoring Equipment III, Air Force Maui Optical Site Calibration Test, Visual Function Tester 1, and Ultraviolet Plume Instrument. In addition, nine of the 14 detailed supplementary objectives are part of NASA's continuing effort to prepare for planned extended-duration orbiter missions by collecting data to develop in-flight activities and medical protocols to help astronauts readjust to a 1-g environment after a space flight.

The IOCM measures molecular and particulate contamination in the orbiter payload bay during all mission phases and uses a variety of optional sensor modules that allow it to be tailored for each shuttle mission. The primary objectives of IOCM are as follows: (1) characterize by direct measurement the deposition of molecular and particular contamination during any phase of flight, prelaunch through ferry flight; (2) measure the optical property changes of thermal control surfaces, the flux of the ambient atomic oxygen environment, incident solar flux, and the absolute ambient pressure in the payload bay; and (3) provide a structure and sample holders for exposing passive material samples to the space environment. The IOCM is a totally automated system, with powered components that are activated by sound or by barometric switches at selected altitudes. IOCM modules are mounted to the payload bay and may include an interface tape recorder; the Jet Propulsion Laboratory contamination monitor, which serves as the IOCM's primary electronic support unit; the sensor module; the material sample array; and an ascent particle monitor. IOCM requires no command and control support. The only crew involvement is photo documentation that the coupon doors have closed. IOCM is sponsored by DOD's Air Force Space Test Program.

Terra Scout is an Earth observation system to be used by a specially trained payload specialist (Tom Hennen) to detect and characterize specific objects at predefined targets on the Earth using spaceborne Earth observation tools. The quality of the spacebound payload specialist's observations will be compared to an Earthbound observer examining the same targets using conventional techniques. Hennen will use Spaceborne Direct-View Optical System (SpaDVOS) hardware. The payload occupies two and a half middeck lockers. Terra Scout is sponsored by the U.S. Army Intelligence Center.

Military Man in Space (M88-1) will use special optics and communication equipment to evaluate the capability of man in space to enhance air, naval, and ground force operations. M88-1 consists of three experiments: Maritime Observation Experiments in Space (MOSES), Battlefield Surveillance From Space (Battleview), and Night Mist. MOSES is designed to establish direct and indirect communication between the orbiter and selected sites or naval units, conduct maritime observations, and observe ocean phenomenon related to ship detection. Battleview will also establish communication between the orbiter and a ground site, but the observations will be of ground site operations, such as armored mechanical formations, military ground sites, and flying aircraft. Night Mist will test the use of an encrypted UHF communication system to link astronaut observers with target personnel on Earth. M88-1 is sponsored by the Air Force Special Command, the Chief of Naval Operations, and the U.S. Army Intelligence Center.

The SAM experiment is designed to measure specific types of radioactivity produced in spacecraft and sensor materials when they are exposed to the space environment to determine their effect on the sensitivity of gamma ray detectors used in space. On this flight, SAM detectors will be moved to several locations throughout the orbiter middeck to map time-dependent variations in the radiation background as they change with location, type of detector material, and amount of shielding. SAM occupies two middeck lockers. It is sponsored by the Strategic Defense Initiative Organization.

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 five passive foil detector packages. CREAM is sponsored by the Department of Defense.

The RME-III payload in Atlantis's middeck measures ionizing radiation exposure in the orbiter crew compartment during sequential time intervals. The unit contains a liquid crystal display for real-time data display and a keyboard for controlling its functions. It occupies half of a middeck locker. RME-III is sponsored by the Department of Defense in cooperation with NASA.

The primary objective of AMOS is to use the orbiter during cooperative overflights of the AMOS electrical-optical facility in Maui, Hawaii, to obtain imagery and/or signature data to support the calibration of the AMOS ground-based sensors and to observe orbiter plume phenomenology under a variety of orbiter attitude and lighting conditions. No unique on-board hardware is associated with the AMOS test; crew and orbiter participation may be required to establish the controlled conditions for the Maui cooperative overflight. AMOS is sponsored by the U.S. Air Force Space Systems Division.

VFT-1 is a handheld, battery-powered testing device the crew will look into to measure changes in a number of vision parameters affected by microgravity. The experiment is stowed in a middeck locker.

UVPI is an instrument located on the SDIO's Low-Power Atmospheric Compensation Experiment satellite in orbit at an inclination of 43 degrees and an altitude of approximately 273 nautical miles at the time of STS-44's scheduled launch on November 19, 1991. The primary objectives of the UVPI activity are to use the orbiter during cooperative encounters with the LACE satellite to obtain imagery and/or signature data to calibrate the UVPI sensors and to observe orbiter events. UVPI is manifested as a payload of opportunity. A UVPI test will be scheduled late in the flight if a conjunction opportunity meets crew scheduling constraints and if propellant margins permit it.

Nine development test objectives and 14 detailed supplementary objectives are scheduled to be flown on STS-44.

MISSION STATISTICS

Vehicle: Atlantis (OV-104), 10th flight

Launch Date/Time:

11/19/91 6:51 p.m., EST (night launch)
5:51 p.m., CST
3:51 p.m., PST

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

Launch Window: 2 hours, 30 minutes

Launch Clearance Window for 11/19/91: 6:51 p.m. EST to 9:29 p.m. EST.

Mission Duration: 9 days, 19 hours, 36 minutes

Landing: Nominal end of mission on Orbit 155

11/29/91 2:27 p.m., EST
1:27 p.m., CST
11:27 a.m., PST

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

Transatlantic Abort Landing: Banjul, Senegal; alternates are Moron, Spain; and Ben Guerir, Morocco

Return to Launch Site: KSC

Abort-Once-Around: EAFB; alternates are KSC and NOR

Inclination: 28.45 degrees (due east)

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 2 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: 195-nautical-mile (225-statute-mile) circular orbit

Space Shuttle Main Engine Thrust Level During Ascent: 104 percent

Space Shuttle Main Engine Locations:

No. 1 position: Engine 2015
No. 2 position: Engine 2030
No. 3 position: Engine 2029

Total Lift-off Weight: Approximately 4,526,272 pounds

Orbiter Weight, Including Cargo, at Lift-off: Approximately 259,629 pounds

Payload Weight Up: Approximately 44,628 pounds

Payload Weight Down: Approximately 7,010 pounds

Orbiter Weight at Landing: Approximately 193,825 pounds

Payloads--Payload Bay (* denotes primary payload): Defense Support Program (DSP) satellite/inertial upper stage (IUS)*; Interim Operational Contamination Monitor (IOCM)

Payloads--Middeck: Terra Scout, Military Man in Space (M88-1), Shuttle Activation Monitor (SAM), Cosmic Radiation Effects and Activation Monitor (CREAM), Radiation Monitoring Equipment (RME)-III, Air Force Maui Optical Site (AMOS) Calibration Test, Ultraviolet Plume Instrument (UVPI), Visual Function Tester (VFT)-1.

Flight Crew Members:

Commander: Frederick (Fred) D. Gregory, third space shuttle flight
Pilot: Terence (Tom) T. Henricks, first space shuttle flight
Mission Specialist 1: James (Jim) S. Voss, first space shuttle flight
Mission Specialist 2: F. Story Musgrave, fourth space shuttle flight
Mission Specialist 3: Mario Runco, Jr., first space shuttle flight
Payload Specialist 1: Thomas (Tom) J. Hennen, first space shuttle flight

Ascent Seating:

Flight deck, front left seat, commander Frederick (Fred) D. Gregory
Flight deck, front right seat, pilot Terence (Tom) T. Henricks
Flight deck, aft center seat, mission specialist F. Story Musgrave
Flight deck, aft right seat, mission specialist James (Jim) S. Voss
Middeck, mission specialist Mario Runco, Jr.
Middeck, payload specialist Thomas (Tom) J. Hennen

Entry Seating:

Flight deck, front left seat, commander Frederick (Fred) D. Gregory
Flight deck, front right seat, pilot Terence (Tom) T. Henricks
Flight deck, aft center seat, mission specialist F. Story Musgrave
Flight deck, aft right seat, mission specialist Mario Runco, Jr.
Middeck, mission specialist James (Jim) S. Voss
Middeck, payload specialist Thomas (Tom) J. Hennen

Extravehicular Activity Crew Members, If Required:

Extravehicular (EV) astronaut-1: Mario Runco, Jr.
EV-2: James (Jim) S. Voss

Intravehicular Astronaut: Terence (Tom) T. Henricks

STS-44 Flight Directors:

Ascent/Entry: Ron Dittemore
Orbit 1 Team: Phil Engelauf
Orbit 2 Team (lead): Milt Heflin
Planning Team: Chuck Shaw

Entry: Automatic mode until subsonic, then control-stick steering

Notes:

. Approximately one dozen modifications or enhancements have been made to Atlantis prior to this flight. These modifications enhance the performance and efficiency of the orbiter's complex systems. For instance, this flight will be the first test of an improved inertial measurement unit called HAINS (high accuracy inertial navigation system). The new unit features improved performance and accuracy and was installed in the No. 3 position. The orbiter's three redundant IMUs are part of the guidance and navigation system. Eventually, all IMUs in the shuttle fleet will be replaced with the HAINS model as part of the fleet's continuous improvement program.

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

MISSION OBJECTIVES

. Primary Payload
  - Deployment of Defense Support Program satellite/inertial upper stage
. Secondary Payloads
  - Payload Bay
    . Interim Operational Contamination Monitor
  - Middeck
    . Terra Scout
    . Military Man in Space (M88-1)
    . Shuttle Activation Monitor
    . Cosmic Radiation Effects and Activation Monitor
    . Radiation Monitoring Equipment III
    . Air Force Maui Optical Site Calibration Test
    . Ultraviolet Plume Instrument
    . Visual Function Tester 1
. Development Test Objectives/Detailed Supplementary Objectives

FLIGHT ACTIVITIES OVERVIEW

Flight Day 1

Launch
OMS-2
DSP/IUS deploy
Forward RCS-1 burn
OMS-3 separation burn
SRM ignition (node 6A)
RME-III activation (Station 1)
AMOS RCS test
VFT-1
Group B powerdown

Flight Day 2

LBNP setup (DSO 478)
LBNP ramp (MS3)
Terra Scout observations
LBNP ramp (MS1)
Aft RCS-1 burn
VFT-1
SAM/CREAM/RME setup (NaI Station 1)
Forward RCS-2 burn

Flight Day 3

Terra Scout observations
M88-1 CCD camera, radio setup
LBNP ramp (MS2)
MOSES observations
LBNP ramp (pilot)
Terra Scout observations
SAM/CREAM/RME operations (NaI Station 2)
VFT-1
Educational Earth observations photography
AMOS RCS test

Flight Day 4

VFT-1
Terra Scout observations
MOSES observations
Battleview observations
SAM/CREAM/RME operations (BGO Station 1)
AMOS FES test

Flight Day 5

Educational Earth observations photography
Terra Scout observations
LBNP ramp (MS3)
Battleview observations
LBNP ramp (MS1)
SAM/CREAM/RME operations (BGO Station 2)
VFT-1
AMOS nose track test

Flight Day 6

MOSES observations
LBNP ramp (MS2)
Terra Scout observations
Battleview observations
LBNP ramp (pilot)
Crew press conference
SAM/CREAM/RME operations (BGO Station 3)
VFT-1

Flight Day 7

SAM/CREAM/RME operations (BGO Station 4)
Terra Scout observations
LBNP soak (MS1)
MOSES observations
Battleview observations
VFT-1

Flight Day 8

MOSES observations
SAM/CREAM/RME operations (NaI Station 1)
LBNP soak (MS3)
Terra Scout observations
Battleview observations
LBNP ramp (MS1)
VFT-1

Flight Day 9

SAM operations (Station1); CREAM/RME operations (Station 2)
Battleview observations
LBNP ramp (MS2 and MS3)
Terra Scout observations
LBNP ramp (MS1)
LBNP ramp (pilot)
MOSES observations
Educational Earth observations photography

Flight Day 10

SAM/CREAM deactivation/stow
RCS hot fire
FCS checkout
MOSES observations
Terra Scout observations
Battleview observations
LBNP ramp (MS3)
VFT-1
M88-1 stow
Terra Scout stow
LBNP stow
Cabin stow
Group B powerup

Flight Day 11

DSO entry preparation
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.

- Due to power requirements and the length of the mission, an equipment powerdown (referred to as a Group B powerdown), is executed on flight day 1 to conserve cryogenics for a full mission duration plus two extension days (if required). Powerdown activities include powering off three of Atlantis's four CRT's, placing three of Atlantis's five general-purpose computers on standby, placing one of Atlantis's three inertial measurement units on standby mode, and powering off three of Atlantis's eight flight-critical multiplexers (two forward, one aft).

- An approved exemption authorizes MS2 (F. Story Musgrave) not to be scheduled for exercise. He will be a control subject for DSO 608: Effects of Space Flight on Aerobic and Anaerobic Metabolism at Rest and During Exercise.

- An approved exemption authorizes a total sleep shift of 6 hours earlier during this 10-day mission, with the last sleep period shortened to 6.5 hours in order to maximize the probability of a lighted KSC landing.

STS-44 CREW ASSIGNMENTS

Commander (Frederick [Fred] D. Gregory):

Overall mission decisions

Orbiter---DPS, MPS*, OMS/RCS*, APU/hydraulics*, EPS*, ECLSS, communications/ instrumentation*, flight rules

Payload--Terra Scout, AMOS

DTOs/DSOs--DTOs 517 and 649; DSOs 478, 605, and 608

Pilot (Terence [Tom] T. Henricks):

Orbiter--DPS*, MPS, OMS/RCS, APU/hydraulics, EPS, ECLSS*, communications/ instrumentation*, payload bay door/radiator, SPOC, FDF

Payload--DSP*, VFT-1*, RME-III, SAM, CREAM, Terra Scout*, M88-1*, AMOS*

DTOs/DSOs--DSOs 603, 608, 611, and 614

Other--intravehicular astronaut, Earth observations

Mission Specialist 1 (James [Jim] S. Voss):

Orbiter--IFM

Payload--DSP*, VFT-1*, RME-III, SAM, CREAM, Terra Scout*, M88-1*, AMOS*

DTOs/DSOs--DSOs 463, 478*, 603, 608, and 613

Other--extravehicular astronaut 2

Mission Specialist 2 (F. Story Musgrave):

Orbiter--DPS*, MPS*, OMS/RCS*, APU/hydraulics*, EPS*, ECLSS*, communications/instrumentation, photo equipment, medical, HP

Payload--DSP*

DTOs/DSOs--DSOs 316, 472, 478, 603, 613, 901, 902, d 903

Other--Earth observations

Mission Specialist 3 (Mario Runco, Jr.):

Orbiter--Crew equipment, TV equipment

Payload--DSP*, M88-1

DTOs/DSOs--DSOs 463, 472*, 478*, and 608

Other--extravehicular astronaut 1, Earth observations

Payload Specialist 1 (Thomas [Tom] J. Hennen):

Orbiter--crew equipment*

Payload--VFT-1, Terra Scout

DTOs/DSOs--DSOs 604, 605, and 614

DEVELOPMENT TEST OBJECTIVES/DETAILED SUPPLEMENTARY OBJECTIVES

DTOs

. Entry aerodynamic control surfaces test (DTO 242)
. Ascent structural capability evaluation (DTO 301D)
. Entry structural capability (DTO 307D)
. ET TPS performance--method 2 (DTO 312)
. Edwards lakebed runway bearing strength and rolling friction assessment for orbiter landings (if Edwards landing) (DTO 520)
. Combustion products analyzer (DTO 645)
. Shuttle extended-duration orbiter (EDO) rehydratable food package evaluation (DTO 649)
. Star line maneuver validation (DTO 797)
. Crosswind landing performance (DTO 805)

DSOs

. Bioreactor/flow and particle trajectory in microgravity (DSO 316)
. In-flight holter monitoring (DSO 463)
. Intraocular pressure (DSO 472)
. In-flight lower body negative pressure (DSO 478)
. Orthostatic function during entry, landing, and egress (DSO 603)
. Visual vestibular integration as a function of adaption, OI-1 and -3 (DSO 604)
. Postural equilibrium control during landing/egress (DSO 605)
. Effects of space flight on aerobic and anaerobic metabolism at rest and during exercise (DSO 608)
. Air monitoring instrument evaluation and atmosphere characterization (DSO 611)
. Changes in endocrine regulation of orthostatic tolerance following space flight (DSO 613)
. 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)

STS-44 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-44 MISSION HIGHLIGHTS TIMELINE

Editor's Note: The following timeline lists selected highlights only. For full detail, please refer to the NASA Mission Operations Directorate STS-44 Flight Plan, Ascent Checklist, Post Insertion Checklist, Deorbit Prep Checklist, Entry Checklist, and IUS Deploy Checklist.

Terra Scout, Battleview, and MOSES sites shown are for a November 19, 1991, on-time launch; they are highly dependent on launch date and time.

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 (astronauts), wings level.
0/00:00:19	Roll maneuver ends.
0/00:00:29	All three SSMEs throttle down from 104 to 70 percent for maximum aerodynamic load (max q).
0/00:00:59	All three SSMEs throttle to 104 percent.
0/00:01:03	Max q occurs.
0/00:02:05	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.
0/00:03:59	Negative return. The vehicle is no longer capable of return-to-launch site abort at Kennedy Space Center runway.
0/00:06:54	Single engine press to main engine cutoff (MECO).
0/00:08:23	All three SSMEs throttle down to 67 percent for MECO.
0/00:08:29	MECO occurs at approximate velocity 25,933 feet per second, 35 by 192 nautical miles (40 by 221 statute miles).
0/00:08:48	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.
0/00:41	OMS-2 thrusting maneuver is performed, approximately 3 minutes, 2 seconds in duration, at 284 fps, 196 by 195 nautical miles.
0/00:51	Commander closes all current breakers, panel L4.
0/00:53	Mission specialist (MS)/payload specialist (PS) 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.
0/01:13	Orbit 2 begins.
0/01:17	Commander activates radiators.
0/01:19	If go for payload bay door operations, MS configures for payload bay door operations.
0/01:20	P/TV01--payload bay door opening.
0/01:28	Pilot opens payload bay doors.
0/01:30	Commander loads payload data interleaver decommutator format.
0/01:33	Commander switches star tracker (ST) 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.
0/01:50	Pilot initiates fuel cell auto purge.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
0/01:51	MS activates teleprinter (if flown).
0/01:52	Commander begins post-payload bay door operations and radiator configuration.
0/01:55	MS/PS remove and stow seats.
0/01:56	Commander starts ST self-test and opens door.
0/01:57	MS configures middeck.
0/01:58	Pilot closes main B supply water dump isolation circuit breaker, panel ML86B, opens supply water dump isolation valve, panel R12L.
0/02:00	MS activates and checks out PCP/CIU/SSP.
0/02:01	Pilot activates auxilary power unit steam vent heater, panel R2, boiler controller/heater, 3 to A, power, 3 to ON.
0/02:10	Commander configures for RCS vernier control.
0/02:12	Commander and pilot configure controls for on-orbit operations.
0/02:21	Pilot enables hydraulic thermal conditioning.
0/02:24	MS resets caution/warning (C/W).
0/02:25	MS unstows and installs treadmill.
0/02:26	Pilot switches APU coolant system (panel R2) fuel pump/ valve A to OFF, B to AUTO.
0/02:28	Pilot plots fuel cell performance.
0/02:30	Systems management cockpit initiation occurs.
0/02:30	Unstow cabin.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
0/02:30	P/TV02 activation (DSP predeployment checkout).
0/02:30	Engage actuators (IUS deployment).
0/02:40	IUS predeployment checkout (TDRS West).
0/02:45	Orbit 3 begins.
0/02:50	DSP transmitter on.
0/02:55	IUS direct check.
0/03:00	Aft controller checkout.
0/03:05	IUS PI check.
0/03:10	Cryogenic oxygen tank heater sensor check.
0/03:25	P/TV03 setup.
0/03:35	P/TV03 activation (DSP inspection).
0/03:40	APU steam vent heater deactivation.
0/03:50	Transfer state vector.
0/04:00	AMU/IMU sequence.
0/04:00	P/TV04 setup (DSP deployment).
0/04:05	APU cool off.
0/04:15	Meal.
0/04:17	Orbit 4 begins.
0/04:45	Maneuver vehicle to DSP deployment attitude.
0/05:15	APU heater reconfiguration.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
0/05:20	Flash evaporator system off.
0/05:20	Transfer state vector.
0/05:25	IUS/PI lock.
0/05:30	P/TV04 activation (DSP deployment).
0/05:35	PCRS operations.
0/05:40	Elevate tilt table to 29 degrees (DSP deployment).
0/05:48	Orbit 5 begins.
0/05:50	DSP transfer to internal power.
0/05:50	DSP release umbilicals.
0/05:50	Raise tilt table to 58 degrees (DSP deployment).
0/05:55	DSP deployment countdown.
0/06:19	DSP/IUS deployment.
0/06:22	Separation maneuver.
0/06:25	Lower tilt table to negative 6 degrees.
0/06:34	OMS-3 separation burn.
0/06:35	Maneuver vehicle to IUS viewing attitude.
0/07:03	Maneuver vehicle to window protection attitude.
0/07:05	Closeout.
0/07:20	Orbit 6 begins.
0/07:20	IUS SRM-1 ignition.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
0/07:25	RME-III activation/checkout.
0/07:30	Maneuver vehicle to -ZLV, +XVV attitude.
0/07:30	Load pulse code modulation master unit.
0/07:40	Ku-band antenna deployment.
0/07:50	Ku-band antenna activation.
0/07:53	AMOS RCS burn test.
0/08:00	APU heater reconfiguration.
0/08:00	Crew begins presleep activities.
0/08:10	Flash evaporator system A on.
0/08:15	DSO 472--Intraocular Pressure.
0/08:20	VTR setup.
0/08:30	Priority Group B powerdown.
0/08:35	VTR playback.
0/08:52	Orbit 7 begins.
0/09:15	Maneuver vehicle to IMU alignment attitude.
0/09:30	IMU alignment: ST.
0/09:35	Maneuver vehicle to -ZLV, +YVV attitude.
0/10:00	Private medical conference.
0/10:24	Orbit 8 begins.
0/11:00	Crew begins sleep period.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
0/11:55	Orbit 9 begins.
0/13:27	Orbit 10 begins.
0/15:00	Orbit 11 begins.
0/16:32	Orbit 12 begins.
0/18:04	Orbit 13 begins.
0/19:00	Crew begins postsleep activities.
0/19:36	Orbit 14 begins.
0/21:08	Orbit 15 begins.
0/21:30	Maneuver vehicle to IMU/COAS alignment attitude.
0/21:30	P/TV05 setup (middeck activities).
0/21:45	IMU alignment: ST.
0/21:50	COAS calibration: aft station.
0/21:55	Maneuver vehicle to -ZLV, +XVV attitude.
0/22:00	P/TV05 activation (middeck activities).
0/22:00	LBNP setup (DSO 478--Lower Body Negative Pressure).
0/22:20	VFT-1 operations.
0/22:40	Orbit 16 begins.
0/22:50	Air monitoring instrument evaluation (DSO 611--Microbial Air Sampler).
0/23:05	P/TV06 setup (flight deck activities).
0/23:05	Terra Scout setup.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
0/23:25	Terra Scout activation.
0/23:35	P/TV06 activation (flight deck activities).
0/23:40	Terra Scout systems characterization.
0/23:45	Pilot exercise (DSO 608--Effects of Aerobic and Anaerobic Metabolism).

MET DAY ONE

1/00:12	Orbit 17 begins.
1/00:15	Bioreactor test 1 (DSO 316--Bioreactor Flow and Particle Trajectory in Microgravity).
1/00:30	LBNP preparation (DSO 478--Lower Body Negative Pressure).
1/01:00	LBNP ramp (MS3).
1/01:15	Terra Scout systems characterization (site: Learmouth).
1/01:43	Orbit 18 begins.
1/01:45	LBNP egress.
1/01:50	Terra Scout observation: Ford Island.
1/02:00	Meal.
1/02:00	Terra Scout temporary stow.
1/03:00	Filter cleaning.
1/03:00	Don holter monitor (DSO 463--In-flight Holter Monitoring).
1/03:00	Visual vestibular data (DSO 604--Visual Vestibular Integration OI-3).

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
1/03:16	Orbit 19 begins.
1/03:25	DSO 472--Intraocular Pressure.
1/03:50	Commander exercise (DSO 608).
1/04:47	Orbit 20 begins.
1/04:50	LBNP preparation (DSO 478).
1/05:05	Pre RCS burn configuration.
1/05:20	LBNP ramp (MS1).
1/05:25	Terra Scout setup.
1/05:37	Aft RCS burn.
1/05:45	Maneuver vehicle to -ZLV, +XVV attitude.
1/05:45	Terra Scout activation.
1/06:00	SAM/CREAM setup.
1/06:00	Terra Scout observation: Pretoria City.
1/06:05	LBNP egress.
1/06:10	Terra Scout observation: Diego Garcia.
1/06:20	Orbit 21 begins.
1/06:20	Don holter monitor (DSO 463).
1/06:20	Terra Scout observation: Kampong.
1/06:35	Foil placement (CREAM).
1/06:40	Flash evaporator system off.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
1/06:45	CPA operations (DTO 645--Combustion Products Analyzer).
1/06:45	Visual vestibular data (DSO 604--Visual Vestibular Integration OI-1).
1/07:00	Crew begins presleep activities.
1/07:10	Forward RCS burn.
1/07:15	Maneuver vehicle to -ZLV, +XVV attitude.
1/07:30	Post RCS burn configuration.
1/07:35	Terra Scout observation: Harare.
1/07:40	SAM tape check.
1/07:45	Flash evaporator system A on.
1/07:45	Terra Scout temporary stow.
1/07:52	Orbit 22 begins.
1/08:15	Maneuver vehicle to IMU alignment attitude.
1/08:30	IMU alignment: ST.
1/08:35	Maneuver vehicle to -ZLV, +YVV attitude.
1/08:55	Private medical conference.
1/09:23	Orbit 23 begins.
1/10:00	Crew begins sleep period.
1/10:55	Orbit 24 begins.
1/12:26	Orbit 25 begins.
1/13:58	Orbit 26 begins.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
1/15:30	Orbit 27 begins.
1/17:02	Orbit 28 begins.
1/18:00	Crew begins postsleep activities.
1/18:33	Orbit 29 begins.
1/18:50	Initiate supply water dump.
1/19:45	Terminate supply water dump.
1/20:05	Orbit 30 begins.
1/20:30	Maneuver vehicle to IMU alignment attitude.
1/20:40	Terra Scout setup.
1/20:45	IMU alignment: ST.
1/20:50	Maneuver vehicle to COAS calibration attitude.
1/20:55	COAS calibration: forward station.
1/21:00	Maneuver vehicle to -ZLV, +XVV attitude.
1/21:00	Terra Scout activation.
1/21:10	SAM tape turnover.
1/21:15	Terra Scout observation: Brisbane 2.
1/21:20	PAM power-off.
1/21:36	Orbit 31 begins.
1/21:45	Commander exercise (DSO 608--Effects of Aerobic and Anaerobic Metabolism).
1/21:50	Terra Scout observation: Cape Canaveral.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
1/22:00	Bioreactor test 2 (DSO 316--Bioreactor Flow and Particle Trajectory in Microgravity).
1/22:00	SAM tape check.
1/22:00	Terra Scout temporary stow.
1/22:10	P/TV06 setup (flight deck).
1/22:15	VFT-1 operations.
1/22:40	P/TV06 activation (flight deck).
1/22:45	Maneuver vehicle to -ZLV, +YVV attitude.
1/22:50	PAM power on.
1/22:50	M88-1 CCD camera setup.
1/23:00	LBNP preparation (DSO 478--Lower Body Negative Pressure).
1/23:08	Orbit 32 begins.
1/23:20	M88-1 radio setup.
1/23:30	LBNP ramp (MS2).

MET DAY TWO

2/00:10	M88-1 preparation (network communication).
2/00:15	LBNP egress.
2/00:39	Orbit 33 begins.
2/00:40	MOSES observation: Pearl Harbor.
2/00:45	VTR setup (crew choice).

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
2/00:55	RME-III memory module replacement.
2/01:00	Meal.
2/02:00	Initiate waste water dump.
2/02:05	VTR playback.
2/02:05	LBNP preparation (DSO 478--Lower Body Negative Pressure).
2/02:12	Orbit 34 begins.
2/02:30	LBNP ramp (pilot).
2/03:10	Terminate waste water dump.
2/03:10	Terra Scout setup.
2/03:15	LBNP egress.
2/03:20	Maneuver vehicle to -ZLV, +XVV attitude.
2/03:30	MS3 exercise (DSO 463).
2/03:30	Terra Scout activation.
2/03:43	Orbit 35 begins.
2/03:45	Terra Scout observation: Anderson.
2/04:10	Pilot exercise (DSO 608--Effects of Aerobic and Anaerobic Metabolism).
2/04:30	Doff holter monitor (DSO 463--In-flight Holter Monitoring).
2/04:40	MS1 exercise (DSO 463).
2/04:50	Terra Scout observation: Maputo City.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
2/05:00	CPA operations (DTO 645--Combustion Products Analyzer).
2/05:00	SAM tape removal.
2/05:05	Detector move (Station 2).
2/05:14	Orbit 36 begins.
2/05:15	Terra Scout observations: U.S. Embassy, Manila.
2/05:25	SAM data acquisition.
2/05:30	Doff holter monitor (DSO 463).
2/05:40	Maneuver vehicle to IMU alignment attitude.
2/05:55	IMU alignment: ST.
2/06:00	Maneuver vehicle to -ZLV, +XVV attitude.
2/06:00	Crew begins presleep activities.
2/06:20	SAM tape check.
2/06:30	Terra Scout observation: Bulawayo.
2/06:40	Terra Scout temporary stow.
2/06:46	Orbit 37 begins.
2/07:00	Flash evaporator system off.
2/07:05	Pre RCS burn configuration.
2/07:15	AMOS RCS burn test.
2/07:30	Maneuver vehicle to -ZLV, +YVV attitude.
2/07:45	Post RCS burn configuration.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
2/07:55	Flash evaporator system A on.
2/08:05	Private medical conference.
2/08:17	Orbit 38 begins.
2/09:00	Crew begins sleep period.
2/09:50	Orbit 39 begins.
2/11:21	Orbit 40 begins.
2/12:52	Orbit 41 begins.
2/14:25	Orbit 42 begins.
2/15:55	Orbit 43 begins.
2/17:00	Crew begins postsleep activities.
2/17:27	Orbit 44 begins.
2/18:10	Initiate supply water dump.
2/18:59	Orbit 45 begins.
2/19:05	Terminate supply water dump.
2/19:25	Maneuver vehicle to IMU alignment attitude.
2/19:30	Terra Scout setup.
2/19:40	IMU alignment: ST.
2/19:45	Maneuver vehicle to -ZLV, +XVV attitude.
2/19:50	Terra Scout activation.
2/20:00	SAM tape turnover.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
2/20:05	Terra Scout observation: Brisbane.
2/20:15	Terra Scout temporary stow.
2/20:30	Bioreactor test 3 (DSO 316--Bioreactor Flow and Particle Trajectory in Microgravity).
2/20:30	M88-1 preparation (direct communication).
2/20:31	Orbit 46 begins.
2/20:40	MOSES observation: Yucatan.
2/20:45	SAM tape check.
2/20:55	VFT-1 operations.
2/21:00	MOSES temporary stow.
2/21:25	Terra Scout setup.
2/21:45	Terra Scout activation.
2/22:00	Terra Scout observation: Christmas Island.
2/22:03	Orbit 47 begins.
2/22:10	Commander exercise (DSO 608--Effects of Aerobic and Anaerobic Metabolism).
2/22:10	M88-1 preparation (no communication).
2/22:10	Terra Scout temporary stow.
2/22:20	Battleview observation: Chase Field.
2/22:35	Terra Scout setup.
2/22:55	Terra Scout activation.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
2/23:10	Terra Scout observation: Useless Loop.
2/23:20	Terra Scout temporary stow.
2/23:34	Orbit 48 begins.
2/23:50	Meal.

MET DAY THREE

3/00:50	M88-1 preparation (network/direct communication).
3/01:00	Battleview observation: Darwin Airport.
3/01:05	Battleview observation: Hickam AFB.
3/01:06	Orbit 49 begins.
3/01:30	Battleview temporary stow.
3/01:35	Pilot exercise (DSO 608--Effects of Aerobic and Anaerobic Metabolism).
3/02:20	P/TV05 setup (middeck activities).
3/02:38	Orbit 50 begins.
3/02:50	P/TV05 activation (middeck activities).
3/03:00	SAM tape removal.
3/03:05	Detector move to Station 1.
3/03:25	SAM detector change to BGO.
3/03:55	M88-1 preparation (no communication).
3/04:00	CPA operations (DTO 645--Combustion Products Analyzer).
3/04:05	MOSES observation: Strait of Malacca.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
3/04:09	Orbit 51 begins.
3/04:25	Terra Scout setup.
3/04:30	SAM tape check.
3/04:35	Maneuver vehicle to IMU alignment attitude.
3/04:45	Terra Scout activation.
3/04:50	IMU alignment: ST.
3/04:55	Maneuver vehicle to -ZLV, +XVV attitude.
3/05:00	Crew begins presleep activities.
3/05:20	Terra Scout observation: Gaborone Airfield.
3/05:40	Terra Scout observation: Sattahip.
3/05:41	Orbit 52 begins.
3/05:50	Terra Scout temporary stow.
3/05:50	Flash evaporator system off.
3/06:00	AMOS flash evaporator system supply water dump test.
3/06:30	Maneuver vehicle to -ZLV, +YVV attitude.
3/06:45	Private medical conference.
3/07:13	Orbit 53 begins.
3/08:00	Crew begins sleep period.
3/08:44	Orbit 54 begins.
3/10:16	Orbit 55 begins.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
3/11:47	Orbit 56 begins.
3/13:19	Orbit 57 begins.
3/14:51	Orbit 58 begins.
3/16:00	Crew begins postsleep activities.
3/16:22	Orbit 59 begins.
3/16:45	Initiate supply water dump.
3/17:40	Terminate supply water dump.
3/17:54	Orbit 60 begins.
3/18:25	Maneuver vehicle to IMU alignment attitude.
3/18:25	RME-III memory module replacement.
3/18:40	IMU alignment: ST.
3/18:45	Maneuver vehicle to -ZLV, +XVV attitude.
3/19:00	Humidity separator configuration A.
3/19:00	Cabin temperature control reconfiguration.
3/19:00	Terra Scout setup.
3/19:10	SAM tape turnover.
3/19:20	Reconfigure RCS regulator.
3/19:20	Terra Scout activation.
3/19:25	Bioreactor test 4 (DSO 316--Bioreactor Flow and Particle Trajectory in Microgravity).
3/19:26	Orbit 61 begins.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
3/19:35	Terra Scout observation: Managua 2.
3/19:40	Heater reconfiguration.
3/19:45	Terra Scout temporary stow.
3/19:50	PCS configuration.
3/19:55	ECLSS redundant component checkout.
3/20:00	SAM tape check.
3/20:15	LBNP preparation (DSO 478--Lower Body Negative Pressure).
3/20:35	M88-1 preparation (no communication).
3/20:45	LBNP ramp (MS3).
3/20:45	Battleview observation: Pt. Villa Baurefield.
3/20:57	Orbit 62 begins.
3/21:05	M88-1 preparation (no communication).
3/21:15	Battleview observation: MacDill AFB.
3/21:30	LBNP egress.
3/21:35	Terra Scout setup.
3/21:45	Pilot exercise (DSO 608--Effects of Aerobic and Anaerobic Metabolism).
3/21:55	Terra Scout activation.
3/22:10	Terra Scout observation: Alice Springs 1.
3/22:29	Orbit 63 begins.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
3/22:45	Meal.
3/23:40	Terra Scout observation: Learmouth.

MET DAY FOUR

4/00:01	Orbit 64 begins.
4/00:10	Terra Scout observation: Lualualei.
4/00:20	Terra Scout temporary stow.
4/00:30	Maneuver vehicle to -ZLV, +YVV attitude.
4/00:30	LBNP preparation (DSO 478--Lower Body Negative Pressure).
4/00:30	VFT-1 operations.
4/00:45	Initiate waste water dump.
4/00:45	P/TV05 setup (middeck activities).
4/01:00	LBNP ramp (MS1).
4/01:15	P/TV05 activation (middeck activities).
4/01:33	Orbit 65 begins.
4/01:45	LBNP egress.
4/01:55	Terminate waste water dump.
4/02:00	Commander exercise (DSO 608--Effects of Aerobic and Anaerobic Metabolism).
4/02:15	SAM tape removal.
4/02:20	Detector move to Station 2.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
4/02:40	SAM data acquisition.
4/03:00	Humidity separator configuration B.
4/03:00	M88-1 preparation (no communication).
4/03:05	Orbit 66 begins.
4/03:10	Battleview observation: Saipan Airfield.
4/03:20	CPA operations (DTO 645--Combustion Products Analyzer).
4/03:20	Battleview observation: Midway Naval Air Station.
4/03:30	SAM tape check.
4/03:30	Terra Scout setup.
4/03:35	Maneuver vehicle to IMU alignment attitude.
4/03:50	IMU alignment: ST.
4/03:50	Terra Scout activation.
4/03:55	Maneuver vehicle to -ZLV, +XVV attitude.
4/04:00	Crew begins presleep activities.
4/04:15	Terra Scout observation: Pretoria Sat.
4/04:25	Terra Scout temporary stow.
4/04:30	Flash evaporator system off.
4/04:35	Pre RCS burn configuration.
4/04:36	Orbit 67 begins.
4/05:06	AMOS nose tracking test.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
4/05:15	Maneuver vehicle to -ZLV, +YVV attitude.
4/05:30	Post RCS burn configuration.
4/05:40	Flash evaporator system A on.
4/05:50	Private medical conference.
4/06:08	Orbit 68 begins.
4/07:00	Crew begins sleep period.
4/07:39	Orbit 69 begins.
4/09:10	Orbit 70 begins.
4/10:42	Orbit 71 begins.
4/12:14	Orbit 72 begins.
4/13:46	Orbit 73 begins.
4/15:00	Crew begins postsleep activities.
4/15:18	Orbit 74 begins.
4/15:45	Initiate supply water dump.
4/16:40	Terminate supply water dump.
4/16:48	Orbit 75 begins.
4/17:20	Maneuver vehicle to IMU alignment attitude.
4/17:35	IMU alignment: ST.
4/17:40	Maneuver vehicle to -ZLV, +XVV attitude.
4/18:00	MS1 exercise.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
4/18:00	SAM tape turnover.
4/18:10	M88-1 preparation (network/direct communication).
4/18:20	Bioreactor deactivation/stow.
4/18:20	MOSES observation: Guantanamo Bay.
4/18:21	Orbit 76 begins.
4/18:45	MOSES temporary stow.
4/18:50	LBNP preparation (DSO 478--Lower Body Negative Pressure).
4/18:55	Terra Scout setup.
4/19:15	SAM tape check.
4/19:15	Terra Scout activation.
4/19:20	LBNP ramp (MS2).
4/19:30	Air monitor instrument evaluation (DSO 611--Microbial Air Sampler).
4/19:30	Terra Scout observation: Brisbane.
4/19:40	Terra Scout temporary stow.
4/19:52	Orbit 77 begins.
4/20:00	M88-1 preparation (no communication).
4/20:05	LBNP egress.
4/20:10	Battleview observation: Patrick AFB.
4/20:15	P/TV05 setup (middeck activities).

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
4/20:20	LBNP preparation (DSO 478).
4/20:45	P/TV05 activation (middeck activities).
4/20:50	LBNP ramp (pilot).
4/21:23	Orbit 78 begins.
4/21:30	M88-1 preparation (no communication).
4/21:35	LBNP egress.
4/21:40	Battleview observation: Kingsville Naval Air Station.
4/21:50	Meal.
4/22:40	M88-1 preparation (network/direct communication).
4/22:50	Battleview observation: Hickam AFB.
4/22:55	Orbit 79 begins.
4/23:15	Battleview temporary stow.
4/23:15	Auto maneuver.
4/23:30	Conference audio/TV check.

MET DAY FIVE

5/00:00	Filter cleaning.
5/00:00	VFT-1 operations.
5/00:27	Orbit 80 begins.
5/00:50	Crew press conference.
5/01:15	Maneuver vehicle to -ZLV, +XVV attitude.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
5/01:15	Pilot, commander exercise (DSO 608--Effects of Aerobic and Anaerobic Metabolism).
5/01:55	M88-1 preparation (no communication).
5/01:58	Orbit 81 begins.
5/02:05	Battleview observation: Anderson AFB.
5/02:15	Battleview observation: Midway Naval Air Station.
5/02:25	RME-III memory module replacement.
5/02:25	Terra Scout setup.
5/02:35	SAM tape removal.
5/02:45	Detector move to Station 3.
5/02:45	CPA operations (DTO 645--Combustion Products Analyzer).
5/02:45	Terra Scout activation.
5/03:00	Crew begins presleep activities.
5/03:00	SAM data acquisition.
5/03:05	Terra Scout observation: Maputo Airfield.
5/03:30	Terra Scout observation: Cavite.
5/03:31	Orbit 82 begins.
5/03:40	Terra Scout temporary stow.
5/03:45	SAM tape check.
5/04:05	Maneuver vehicle to IMU alignment attitude.
5/04:20	IMU alignment: ST.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
5/04:25	Maneuver vehicle to -ZLV, +YVV attitude.
5/04:40	Private medical conference.
5/05:03	Orbit 83 begins.
5/06:00	Crew begins sleep period.
5/06:34	Orbit 84 begins.
5/08:06	Orbit 85 begins.
5/09:37	Orbit 86 begins.
5/11:09	Orbit 87 begins.
5/12:40	Orbit 88 begins.
5/14:00	Crew begins postsleep activities.
5/14:12	Orbit 89 begins.
5/14:40	Initiate supply water dump.
5/15:35	Terminate supply water dump.
5/15:44	Orbit 90 begins.
5/16:15	Maneuver vehicle to IMU alignment attitude.
5/16:30	IMU alignment: ST.
5/16:35	Maneuver vehicle to -ZLV, +XVV attitude.
5/16:45	Terra Scout setup.
5/17:00	MS3 exercise.
5/17:00	SAM tape removal.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
5/17:05	Detector move to Station 4.
5/17:05	Terra Scout activation.
5/17:15	Orbit 91 begins.
5/17:20	Terra Scout observation: Santiago.
5/17:25	SAM data acquisition.
5/17:30	Terra Scout temporary stow.
5/17:35	PAM power-off.
5/17:50	LBNP preparation (DSO 478--Lower Body Negative Pressure).
5/18:00	VFT-1 operations.
5/18:20	LBNP soak (MS1).
5/18:35	SAM tape check.
5/18:45	M88-1 preparation (direct communication).
5/18:47	Orbit 92 begins.
5/18:55	MOSES observation: Yucatan.
5/19:00	PAM power on.
5/19:15	MOSES temporary stow.
5/19:25	Terra Scout setup.
5/19:45	Terra Scout activation.
5/20:05	Terra Scout observation: Baurefield.
5/20:15	Terra Scout observation: Christmas Island.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
5/20:18	Orbit 93 begins.
5/20:25	Terra Scout temporary stow.
5/20:30	M88-1 preparation (no communication).
5/20:40	Battleview observation: Cape Canaveral; Terra Scout alternate optics.
5/21:00	Meal.
5/21:50	Orbit 94 begins.
5/22:00	M88-1 preparation (no communication).
5/22:10	Battleview observation: Kelly AFB.
5/22:35	Terra Scout setup.
5/22:55	Terra Scout activation.
5/23:05	LBNP egress.
5/23:10	Terra Scout observation: Darwin.
5/23:20	Terra Scout observation: Kwajalein.
5/23:22	Orbit 95 begins.
5/23:30	Terra Scout observation: Barking Sands.
5/23:40	Terra Scout temporary stow.
5/23:45	Maneuver vehicle to -ZLV, +YVV attitude.

MET DAY SIX

6/00:00	Exercise (commander, pilot, MS1).
6/00:05	P/TV05 setup (middeck activities).

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
6/00:15	Initiate waste water dump.
6/00:20	P/TV05 activation (middeck activities).
6/00:53	Orbit 96 begins.
6/01:25	Terminate waste water dump.
6/01:25	Terra Scout setup.
6/01:35	Maneuver vehicle to -ZLV, +YVV attitude.
6/01:45	Terra Scout activation.
6/01:50	CPA operations (DTO 645--Combustion Products Analyzer).
6/01:55	SAM tape turnover.
6/02:00	Crew begins presleep activities.
6/02:25	Terra Scout observation: Labuan.
6/02:25	Orbit 97 begins.
6/02:35	Terra Scout temporary stow.
6/02:40	Private medical conference.
6/02:45	SAM tape check.
6/03:00	Maneuver vehicle to IMU alignment attitude.
6/03:15	IMU alignment: ST.
6/03:20	Maneuver vehicle to -ZLV, +YVV attitude.
6/03:57	Orbit 98 begins.
6/05:00	Crew begins sleep period.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
6/05:28	Orbit 99 begins.
6/07:00	Orbit 100 begins.
6/08:32	Orbit 101 begins.
6/10:05	Orbit 102 begins.
6/11:35	Orbit 103 begins.
6/13:00	Crew begins postsleep activities.
6/13:07	Orbit 104 begins.
6/13:40	Initiate supply water dump.
6/14:35	Terminate supply water dump.
6/14:38	Orbit 105 begins.
6/15:15	Maneuver vehicle to IMU alignment attitude.
6/15:30	IMU alignment: ST.
6/15:35	Maneuver vehicle to -ZLV, +XVV attitude.
6/16:00	M88-1 preparation (network/direct communication).
6/16:10	Orbit 106 begins.
6/16:10	MOSES observation: Roosevelt Roads.
6/16:30	MOSES temporary stow.
6/16:30	P/TV05 setup (middeck activities).
6/16:30	LBNP preparation (DSO 478--Lower Body Negative Pressure).
6/16:35	SAM tape removal.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
6/16:40	Detector move to Station 1.
6/17:00	P/TV05 activation (middeck activities).
6/17:00	Detector change to NaI.
6/17:00	LBNP soak (MS2).
6/17:15	Terra Scout setup.
6/17:35	Terra Scout activation.
6/17:42	Orbit 107 begins.
6/17:45	SAM tape check.
6/17:50	Terra Scout observation: Managua 1.
6/18:00	Terra Scout temporary stow.
6/18:10	VFT-1 operations.
6/18:45	RME-III memory module replacement.
6/18:50	M88-1 preparation (no communication).
6/19:00	Battleview observation: Pt. Villa Baurefield.
6/19:13	Orbit 108 begins.
6/19:20	M88-1 preparation (no communication).
6/19:30	Battleview observation: Homestead.
6/20:00	Meal.
6/20:45	Orbit 109 begins.
6/20:55	M88-1 preparation (no communication).

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
6/21:05	Battleview observation: Corpus Christi.
6/21:25	Terra Scout setup.
6/21:45	LBNP egress.
6/21:45	Terra Scout activation.
6/22:00	LBNP preparation (DSO 478--Lower Body Negative Pressure).
6/22:00	Terra Scout observation: Tindall.
6/22:10	Terra Scout temporary stow.
6/22:10	M88-1 preparation (network communication).
6/22:17	Orbit 110 begins.
6/22:20	MOSES observation: Pearl Harbor.
6/22:30	LBNP ramp (MS1).
6/22:40	Battleview observation: Laughlin AFB.
6/23:15	LBNP egress.
6/23:30	Exercise (MS3, MS1, pilot, commander).
6/23:30	P/TV06 setup (flight deck crew choice).
6/23:48	Orbit 111 begins.

MET DAY SEVEN

7/01:15	M88-1 preparation (no communication).
7/01:20	Orbit 112 begins.
7/01:25	Battleview observation: Saipan Airfield.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
7/01:30	CPA operations (DTO 645--Combustion Products Analyzer).
7/01:35	Battleview observation: Midway Naval Air Station.
7/01:50	SAM tape turnover.
7/02:00	Crew begins presleep activities.
7/02:35	SAM tape check.
7/02:52	Orbit 113 begins.
7/03:00	Private medical conference.
7/03:30	Maneuver vehicle to IMU alignment attitude.
7/03:45	IMU alignment: ST.
7/03:50	Maneuver vehicle to -ZLV, +YVV attitude.
7/04:23	Orbit 114 begins.
7/05:00	Crew begins sleep period.
7/05:55	Orbit 115 begins.
7/07:27	Orbit 116 begins.
7/08:58	Orbit 117 begins.
7/10:30	Orbit 118 begins.
7/12:02	Orbit 119 begins.
7/13:00	Crew begins postsleep activities.
7/13:34	Orbit 120 begins.
7/14:00	Initiate supply water dump.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
7/14:55	Terminate supply water dump.
7/15:05	Orbit 121 begins.
7/15:30	APU steam vent heater activation.
7/15:45	Maneuver vehicle to IMU alignment attitude.
7/15:55	SAM tape removal.
7/16:00	IMU alignment: ST.
7/16:00	SAM CATS installation.
7/16:05	Maneuver vehicle to -ZLV, +XVV attitude.
7/16:10	LBNP preparation (DSO 478).
7/16:20	M88-1 preparation (network/direct communication).
7/16:30	Battleview observation: Tegucigalpa.
7/16:37	Orbit 122 begins.
7/16:40	LBNP ramp (MS2).
7/16:55	Battleview temporary stow.
7/17:00	P/TV05 setup (middeck activities).
7/17:05	SAM tape check.
7/17:15	Filter cleaning.
7/17:25	P/TV05 activation (middeck activities).
7/17:25	LBNP egress.
7/17:40	LBNP preparation (DSO 478).

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
7/18:09	Orbit 123 begins.
7/18:10	LBNP ramp (MS3).
7/18:15	M88-1 preparation (no communication).
7/18:25	Battleview observation: MacDill AFB.
7/18:55	LBNP egress.
7/19:05	VFT-1 operations.
7/19:10	Exercise (MS3).
7/19:20	Terra Scout setup.
7/19:40	Orbit 124 begins.
7/19:40	Terra Scout activation.
7/19:55	Terra Scout observation: Cape Canaveral.
7/20:10	Meal.
7/21:10	LBNP preparation (DSO 478).
7/21:10	Terra Scout observation: PTA.
7/21:11	Orbit 125 begins.
7/21:20	Terra Scout temporary stow.
7/21:30	M88-1 preparation (no communication).
7/21:40	LBNP ramp (MS1).
7/21:40	Battleview observation: Patrick AFB.
7/22:25	LBNP egress.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
7/22:30	M88-1 preparation (no communication).
7/22:40	LBNP preparation (DSO 478).
7/22:40	Battleview observation: Kwajalein.
7/22:43	Orbit 126 begins.
7/23:10	LBNP ramp (pilot).
7/23:40	Terra Scout setup.
7/23:55	LBNP egress.

MET DAY EIGHT

8/00:00	Exercise (commander, pilot, MS1).
8/00:00	Terra Scout activation.
8/00:10	P/TV06 setup (flight deck activities).
8/00:15	Orbit 127 begins.
8/00:15	Terra Scout observation: Anderson.
8/00:25	Terra Scout temporary stow.
8/00:30	P/TV06 activation (flight deck crew choice).
8/01:00	CPA operations (DTO 645--Combustion Products Analyzer).
8/01:35	M88-1 preparation (no communication).
8/01:45	MOSES observation: Strait of Malacca.
8/01:47	Orbit 128 begins.
8/01:55	SAM tape turnover.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
8/02:00	Private medical conference.
8/02:00	Crew begins presleep activities.
8/02:25	Maneuver vehicle to IMU alignment attitude.
8/02:40	IMU alignment: ST.
8/02:45	Maneuver vehicle to -ZLV, +YVV attitude.
8/02:50	SAM tape check.
8/03:00	Initiate waste water dump.
8/03:00	RME-III memory module replacement.
8/03:18	Orbit 129 begins.
8/04:10	Terminate waste water dump.
8/04:50	Orbit 130 begins.
8/05:00	Crew begins sleep period.
8/06:22	Orbit 131 begins.
8/07:53	Orbit 132 begins.
8/09:25	Orbit 133 begins.
8/10:56	Orbit 134 begins.
8/12:28	Orbit 135 begins.
8/13:00	Crew begins postsleep activities.
8/13:25	Initiate supply water dump.
8/13:59	Orbit 136 begins.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
8/14:20	Terminate supply water dump.
8/14:40	Maneuver vehicle to IMU alignment attitude.
8/14:55	IMU alignment: ST.
8/15:00	Maneuver vehicle to -ZLV, +XVV attitude.
8/15:32	Orbit 137 begins.
8/15:40	APU heater activation.
8/15:55	SAM/CREAM deactivation/stow.
8/16:00	P/TV06 setup (flight deck activities).
8/16:00	DSO 472--Intraocular Pressure.
8/16:15	Pre RCS burn configuration.
8/16:15	Visual vestibular data (DSO 604--Visual Vestibular Integration OI-3).
8/16:20	P/TV06 activation (flight deck activities).
8/16:25	RCS hot fire.
8/16:40	FCS checkout.
8/17:00	M88-1 preparation (direct communication).
8/17:03	Orbit 138 begins.
8/17:10	MOSES observation: Yucatan.
8/17:15	Visual vestibular data (DSO 604--Visual Vestibular Integration OI-1).
8/17:30	MOSES temporary stow.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
8/17:45	Terra Scout setup.
8/18:05	LBNP preparation (DSO 478).
8/18:05	Terra Scout activation.
8/18:10	Post RCS burn configuration.
8/18:20	APU heater reconfiguration.
8/18:20	Terra Scout observation: Baurefield.
8/18:30	Terra Scout observation: Christmas Island.
8/18:35	LBNP ramp (MS2).
8/18:35	Orbit 139 begins.
8/18:40	M88-1 preparation (no communication).
8/18:40	Terra Scout temporary stow.
8/18:50	Battleview observation: Chase Field.
8/18:55	APU Cool A.
8/19:05	VFT-1 operations.
8/19:20	LBNP egress.
8/20:07	Orbit 140 begins.
8/20:15	Commander, pilot exercise (DSO 608--Effects of Aerobic and Anaerobic Metabolism).
8/20:20	M88-1 preparation (no communication).
8/20:30	Battleview observation: Homestead.
8/20:45	M88-1 stow.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
8/20:45	Terra Scout setup.
8/21:05	Terra Scout activation.
8/21:20	Terra Scout observation: Broome.
8/21:30	Terra Scout stow.
8/21:38	Orbit 141 begins.
8/21:45	Meal.
8/22:45	Maneuver vehicle to -ZLV, +YVV attitude.
8/22:45	Air monitor instrument evaluation (DSO 611--Microbial Air Sampler).
8/23:00	Cabin stow.
8/23:00	LBNP stow.
8/23:00	RME-III stow.
8/23:10	Orbit 142 begins.

MET DAY NINE

9/00:41	Orbit 143 begins.
9/01:00	Ku-band antenna stow.
9/01:10	Priority Group B power-up.
9/02:00	Crew begins presleep activities.
9/02:00	CPA operations (DTO 645--Combustion Products Analyzer).
9/02:13	Orbit 144 begins.
9/02:20	Private medical conference.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
9/02:55	Maneuver vehicle to IMU alignment attitude.
9/03:10	IMU alignment: ST.
9/03:15	Maneuver vehicle to -ZLV, +YVV attitude.
9/03:45	Orbit 145 begins.
9/05:00	Crew begins sleep period.
9/05:16	Orbit 146 begins.
9/06:48	Orbit 147 begins.
9/08:20	Orbit 148 begins.
9/09:52	Orbit 149 begins.
9/11:23	Orbit 150 begins.
9/11:30	Crew begins postsleep activities.
9/12:54	Orbit 151 begins.
9/13:30	Maneuver vehicle to IMU alignment attitude.
9/13:45	IMU alignment: ST.
9/13:45	DSO entry preparation (DSOs 463, 603, and 604).
9/13:50	Maneuver vehicle to -XSI attitude.
9/14:26	Orbit 152 begins.
9/14:30	Begin deorbit preparation.
9/14:30	CRT timer setup.
9/14:36	Commander initiates coldsoak.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
9/14:45	Stow radiators, if required.
9/15:03	Commander configures DPS for deorbit preparation.
9/15:06	Mission Control Center updates IMU star pad, if required.
9/15:15	MS configures for payload bay door closure.
9/15:36	Maneuver vehicle to IMU alignment attitude.
9/15:37	MCC-H gives "go/no-go" command for payload bay door closure.
9/15:45	IMU alignment: ST/payload bay door closing operations.
9/15:58	Orbit 153 begins.
9/16:11	Commander and pilot configure dedicated displays for entry.
9/16:14	MCC gives the crew the go for OPS 3.
9/16:17	Maneuver vehicle to deorbit burn attitude.
9/16:21	Pilot starts repressurization of SSME systems.
9/16:26	Commander and pilot perform DPS entry configuration.
9/16:35	MS deactivates ST and closes ST doors.
9/16:37	All crew members verify entry payload switch list.
9/16:52	All crew members perform entry review.
9/16:54	Crew begins fluid loading, 32 fluid ounces of water with salt over next 1.5 hours (2 salt tablets per 8 ounces).
9/17:07	Commander and pilot configure clothing.
9/17:22	MS/PS configure clothing.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
9/17:30	Orbit 154 begins.
9/17:32	Commander and pilot seat ingress.
9/17:34	Commander and pilot set up heads-up display (HUD).
9/17:36	Commander and pilot adjust seat, exercise brake pedals.
9/17:44	Final entry deorbit update/uplink.
9/17:50	OMS thrust vector control gimbal check is performed.
9/17:51	APU prestart.
9/18:06	Close vent doors.
9/18:10	MCC-H gives "go" for deorbit burn period.
9/18:16	Manuever vehicle to deorbit burn attitude.
9/18:17	MS/PS ingress seats.
9/18:25	First APU is activated.
9/18:31	Deorbit burn period, approximately 3 minutes, 3 seconds in duration, at 319 fps, 195 by 195 nm.
9/18:36	Initiate post-deorbit burn period attitude.
9/18:40	Terminate post-deorbit burn attitude.
9/18:48	Dump forward RCS, if required.
9/18:56	Activate remaining APUs.
9/19:02	Orbit 155 begins.
9/19:05	Entry interface, 400,000 feet altitude.
9/19:08	Enter communication blackout.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
9/19:10	Automatically deactivate RCS roll thrusters.
9/19:16	Initiate first roll reversal.
9/19:17	Automatically deactivate RCS pitch thrusters.
9/19:19	Exit communications blackout.
9/19:24	Begin PTI sequence.
9/19:24	Initiate second roll reversal.
9/19:28	Initiate third roll reversal.
9/19:29	Initiate air data system (ADS) probe deploy.
9/19:30	Begin entry/terminal area energy management (TAEM).
9/19:30	Initiate payload bay venting.
9/19:32	Automatically deactivate RCS yaw thrusters.
9/19:32	End PTI sequence.
9/19:35	Begin TAEM/approach/landing (A/L) interface.
9/19:35	Initiate landing gear deployment.
9/19:36	Vehicle has weight on main landing gear.
9/19:36	Vehicle has weight on nose landing gear.
9/19:36	Initiate main landing gear braking.
9/19:37	Wheel stop.

GLOSSARY

A/G	air-to-ground
AA	accelerometer assembly
ACS	active cooling system
ADS	air data system
AFB	Air Force base
A/L	approach and landing
AMOS	Air Force Maui optical site
AMU	attitude match update
APM	ascent particle monitor
APU	auxiliary power unit
ASE	airborne support equipment
BFS	backup flight control system
CATS	composite activation test sample
CCD	charge-coupled device
COAS	crewman optical alignment sight
CPA	combustion products analyzer
CREAM	cosmic radiation effects and activation monitor
CRT	cathode ray tube
C/W	caution/warning
DAP	digital autopilot
DOD	Department of Defense
DPS	data processing system
DSO	detailed supplementary objective
DSP	Defense Support Program
DTO	development test objective
EAFB	Edwards Air Force Base
ECLSS	environmental control and life support system
EDO	extended duration orbiter
EHF	extremely high frequency
ELV	expendable launch vehicle
EMU	extravehicular mobility unit
EOM	end of mission
EPS	electrical power system
ESS	equipment support section
ET	external tank

ETR	Eastern Test Range
EV	extravehicular
EVA	extravehicular activity
FCS	flight control system
FES	flash evaporator system
FDF	flight data file
FPS	feet per second
FRCS	forward reaction control system
FTA	fluid test article
GLS	ground launch sequencer
GN&C	guidance, navigation, and control
GPC	general-purpose computer
GSFC	Goddard Space Flight Center
HAINS	high accuracy inertial navigation system
HRA	helmet retention assembly
HRM	high-rate multiplexer
HUD	heads-up display
IFM	in-flight maintenance
IMU	inertial measurement unit
IOCM	interim operational contamination monitor
IR	infrared
IUS	inertial upper stage
IV	intravehicular
JSC	Johnson Space Center
KSC	Kennedy Space Center
LACE	low-power atmospheric compensation experiment satellite
LBNP	lower-body negative pressure
LCD	liquid crystal display
LES	launch escape system
LPS	launch processing system
LRU	line replaceable unit
M88-1	military man in space
MAS	microbial air sampler
MCC-H	Mission Control Center--Houston
MDM	multiplexer/demultiplexer
MECO	main engine cutoff

MET	mission elapsed time
MILA	Merritt Island
MLP	mobile launcher platform
MM	major mode
MOSES	maritime observation experiments in space
MPS	main propulsion system
MS	mission specialist
MSFC	Marshall Space Flight Center
NMI	nautical miles
NOR	Northrup Strip
O&C	operations and checkout
OAA	orbiter access arm
OMS	orbital maneuvering system
OTC	orbiter test conductor
PAM	particle anticoincidence mantle
PASS	primary avionics software system
PCMMU	pulse code modulation master unit
PCRS	payload cover removal system
PCS	pressure control system
PGSC	payload and general support computer
PI	payload interrogator
PIC	pyro initiator controller
PRLA	payload retention latch assembly
PTI	preprogrammed test input
P/TV	photo/TV
RAAN	right ascension of the ascending node
RCS	reaction control system
RF	radio frequency
RGA	rate gyro assembly
RME	radiation monitoring equipment
RMS	remote manipulator system
ROEU	remotely operated electrical umbilical
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
SAM	shuttle activation monitor

SDIO	Strategic Defense Initiative Organization
SHF	superhigh frequency
SLM	star line maneuver
SM	statute miles
SpaDVOS	spaceborne direct-view optical system
SPOC	shuttle portable on-board computer
SRB	solid rocket booster
SRM	solid rocket motor
SRSS	shuttle range safety system
SSF	Space Station Freedom
SSME	space shuttle main engine
SSP	standard switch panel
SSPP	solar/stellar pointing platform
ST	star tracker
STA	structural test article
STP	Space Test Program
STS	Space Transportation System
SURS	standard umbilical retraction/retention system
TAEM	terminal area energy management
TAGS	text and graphics system
TAL	transatlantic landing
TCD	timing control distributor
TDRS	tracking and data relay satellite
TDRSS	tracking and data relay satellite system
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
USAF	U.S. Air Force
UVPI	ultraviolet plume instrument
VFT	visual function tester
VTR	videotape recorder
WCS	waste collection system

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