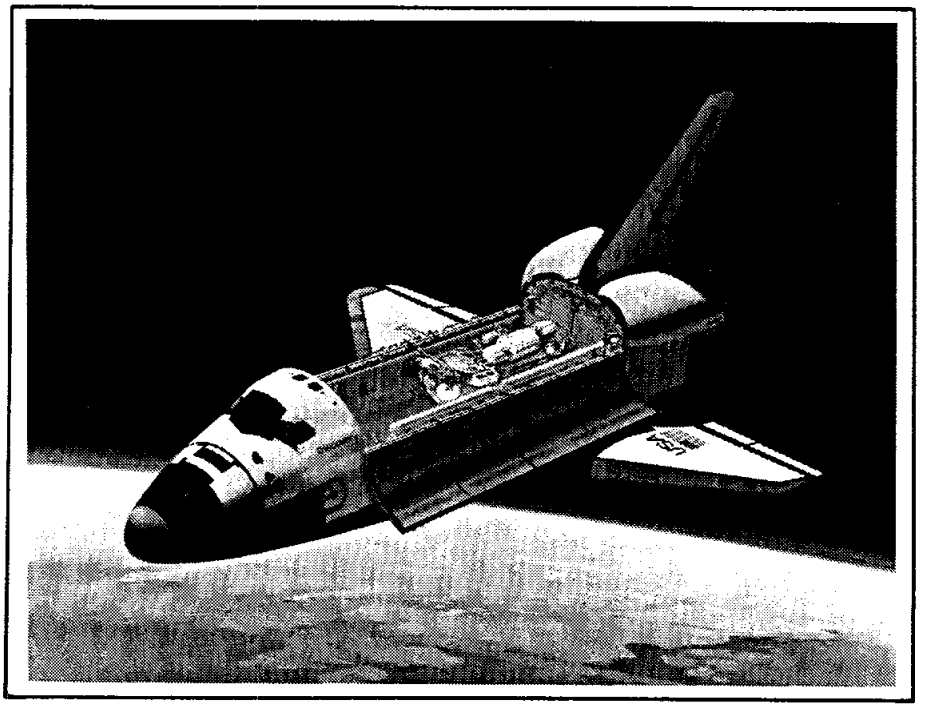

STS-48

MISSION STATISTICS

PRELAUNCH COUNTDOWN TIMELINE

MISSION TIMELINE

September 1991

Rockwell International
Space Systems Division

Office of Media Relations

CONTENTS

MISSION OVERVIEW

This is the 13th flight of Discovery and the 43rd for the space shuttle.

The flight crew for the STS-48 mission consists of commander John O. (J. O.) Creighton; pilot Kenneth (Ken) S. Reightler, Jr.; and mission specialists Charles D. ("Sam") Gemar, James (Jim) F. Buchli, and Mark N. Brown.

STS-48's primary mission objective is to successfully deploy NASA's Upper Atmosphere Research Satellite (UARS), the spearhead element of NASA's Mission to Planet Earth, a long-term, international space research program to study global atmospheric change. UARS will carry out the first simultaneous, systematic, comprehensive study of the physical processes acting within and upon the stratosphere, mesosphere, and lower thermosphere, focusing on the problem of stratospheric ozone depletion linked to human activities. The integrated investigation will provide the comprehensive data base necessary to understand the changes taking place in the upper atmosphere so that scientists and governments around the world can better assess the role of human activities in stratospheric ozone depletion and can develop informed policies in response. UARS will also furnish new insights into upper-atmosphere dynamics and energy balance and lay the foundations for a broader study of upper-atmosphere influence on climate and climatic variations.

UARS consists of the UARS observatory and UARS airborne support equipment (ASE). Nine sensors mounted on the UARS will measure atmospheric composition and temperature, winds, and energy inputs. Another instrument will measure total solar irradiance. Additional correlative data from ten theoretical studies linked to specific sensor objectives will complement the UARS observations to provide a systematic, unified research approach.

The nominal planned deployment opportunity for UARS remote manipulator system (RMS) release from Discovery's payload bay is on Orbit 33 at 02/04:40:00 Mission Elapsed Time (MET). Backup opportunities exist on Orbits 35 and 36. After deployment, Discovery will perform two separation burns to move away from the UARS. UARS will position itself in a 324 nautical mile orbit. The spacecraft's minimum 20-month lifetime allows for two Northern Hemisphere winters and one observation of the formation of an Antarctic ozone hole. UARS is managed by NASA's Goddard Space Flight Center UARS Project Office.

Nine secondary objectives will be flown on STS-48: Physiological and Anatomical Rodent Experiment (PARE)-01, Protein Crystal Growth (PCG)-II-2, Middeck 0-Gravity Dynamics Experiment (MODE)-01, Investigations Into Polymer Membrane Processing (IPMP)-04, Cosmic Radiation Effects and Activation Monitor (CREAM)-02, Radiation Monitoring Equipment (RME)-III-06, Ascent Particle Monitor (APM)-03, Shuttle Activation Monitor (SAM)-03, and the Air Force Maui Optical Site (AMOS) Calibration Test.

The primary objective of PARE-01 is to study muscle atrophy in microgravity. The experiment consists of one animal enclosure module (AEM) and eight rodents, and occupies one middeck locker. PARE is sponsored by the Space Shuttle and Space Station Freedom Payloads Project Office at NASA's Johnson Space Center, Houston, Texas.

PCG II-2 is designed to conduct experiments that will supply information on the scientific methods and commercial potential for growing large, high-quality protein crystals in microgravity. The PCG will be installed and operated in an orbiter middeck locker in a refrigerator/incubator module (R/IM). PCG II-2 is sponsored by the Microgravity Science and Applications Division of NASA's Office of Space Science and Applications, as well as NASA's Office of Commercial Programs.

MODE-01 is designed to study the nonlinear behavior of space structures and contained fluids that are gravity dependent. The experiment occupies three middeck lockers. MODE is funded by the NASA Headquarters Office of Aeronautics and Exploration Technology In-Space Technology Experiments Program (In-Step). NASA's Langley Research Center, Hampton, Va., serves as the program monitor. The MODE experiment was awarded to the Space Engineering Research Center at the Massachusetts Institute of Technology.

The research objective of the IPMP-04 payload is to investigate the formation of polymer membranes in microgravity. The IPMP requires one-half of a middeck locker and approximately 30 minutes of crew time. IPMP is sponsored by the Battelle Advanced Materials Center for the Commercial Development of Space.

CREAM-02 is designed to measure cosmic ray fluxes at various predetermined points in the orbiter middeck. CREAM occupies one-half of a middeck locker and includes five passive packages. CREAM is sponsored by the Department of Defense.

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

The APM-03 is an automatic system mounted in the orbiter payload bay to measure particle detachment, fallout, transportability, and deposition during the immediate prelaunch period and ascent. It will determine the influence of initial cleanliness of the ascent environment. APM is sponsored by the U.S. Air Force (USAF) Space Systems Division.

The objective of SAM-03 is to collect gamma ray data as a function of time and location within the orbiter. The SAM hardware consists of a multichannel analyzer, a tape recorder with cassettes, two detector assemblies, one particle anticoincidence mantle, a composite activation test sample, four activation foil packets, and an encapsulated radioisotope source for in-flight calibrations. SAM occupies two middeck lockers. It is sponsored by the USAF Space Systems Division.

The primary objective of AMOS is to use the orbiter during cooperative overflights of 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. No unique onboard 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 USAF Space Systems Division.

Eight development test objectives and thirteen detailed supplementary objectives are scheduled to be flown on STS-48.

MISSION STATISTICS

Vehicle: Discovery (OV-103), 13th flight

Launch Date/Time:

9/12/91 6:57 p.m., EDT
5:57 p.m., CDT
3:57 p.m., PDT

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

Launch Window: 2 hours, 30 minutes

Launch Window Constraints:

1. Open--UARS right ascension of the ascending node (RAAN) constraint for a backup deploy on Flight Day 4
2. Close--Crew time-on-back constraint or RAAN constraint for primary deploy on Flight Day 3

For the 9/12/91 launch date, the transoceanic abort landing (TAL) aborts and end of mission (EOM) landings are in darkness. The return to launch site (RTLS) abort is in daylight for the first 23 minutes of the launch window. Also, the launch is in daylight for launch slips of up to 34 minutes.

Mission Duration: 5 days, 6 hours, 58 minutes

Landing: Nominal end of mission on Orbit 80

9/18/91 1:55 a.m., EDT
12:55 a.m., CDT
10:55 p.m., PDT (9/17/91)

Runway: Nominal end-of-mission landing on runway 33, KSC, Fla. Weather alternates are Edwards Air Force Base (EAFB), Calif., and Northrup Strip (NOR), White Sands, New Mexico

This will be the first night landing at KSC.

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

Return to Launch Site: KSC

Abort-Once-Around: EAFB

Inclination: 57 degrees

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

The OMS-1 thrusting maneuver after main engine cutoff plus approximately 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: Direct insertion to 292 nautical miles (336 statute miles); on-orbit adjust burns will raise the orbit to an altitude of 305 nautical miles (351 statute miles) circular orbit.

This will be the highest shuttle mission flown to date at an inclination of 57 degrees. The highest overall mission to date was STS-31 at 330 nautical miles.

Space Shuttle Main Engine Thrust Level During Ascent: 104 percent

Total Lift-off Weight: Approximately 4,507,348 pounds

Orbiter Weight, Including Cargo, at Lift-off: Approximately 239,735 pounds

Payload Weight Up: Approximately 17,317 pounds

Payload Weight Down: Approximately 2,898 pounds

Orbiter Weight at Landing: Approximately 192,507 pounds

Payloads--Payload Bay (* denotes primary payload): Upper Atmosphere Research Satellite (UARS)*, Ascent Particle Monitor (APM)-03

Payloads--Middeck: Physiological and Anatomical Rodent Experiment (PARE)-01, Protein Crystal Growth (PCG)-II-2, Middeck 0-Gravity Dynamics Experiment (MODE)-01, Investigations Into Polymer Membrane Processing (IPMP)-04, Cosmic Radiation Effects and Activation Monitor (CREAM)-02, Radiation Monitoring Equipment (RME)-III-06, Shuttle Activation Monitor (SAM)-03, Air Force Maui Optical Site (AMOS) Calibration Test

Flight Crew Members:

Commander: John O. (J. O.) Creighton, third space shuttle flight
Pilot: Kenneth (Ken) S. Reightler, Jr., first space shuttle flight
Mission Specialist 1: Charles D. ("Sam") Gemar, second space shuttle flight
Mission Specialist 2: James (Jim) F. Buchli, fourth space shuttle flight
Mission Specialist 3: Mark N. Brown, second space shuttle flight

Ascent Seating:

Flight deck, front left seat, commander John O. (J. O.) Creighton
Flight deck, front right seat, pilot Kenneth (Ken) S. Reightler, Jr.
Flight deck, aft center seat, mission specialist James (Jim) F. Buchli
Flight deck, aft right seat, mission specialist Charles D. ("Sam") Gemar
Middeck, mission specialist Mark N. Brown

Entry Seating:
Flight deck, aft center seat, mission specialist James (Jim) F. Buchli
Flight deck, aft right seat, mission specialist Mark N. Brown
Middeck, mission specialist Charles D. ("Sam") Gemar

Extravehicular Activity Crew Members, If Required:
Extravehicular (EV) astronaut-1 is James (Jim) F. Buchli; EV-2 is Charles D. ("Sam") Gemar

Intravehicular Astronaut: Kenneth (Ken) S. Reightler, Jr.

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

Notes:

. The remote manipulator system is installed in Discovery's payload bay for this mission. The galley is installed in Discovery's middeck.

MISSION OBJECTIVES

- Primary Payload
  - Deployment of Upper Atmosphere Research Satellite (UARS)
- Secondary Payloads
  - Payload Bay
    - Ascent Particle Monitor (APM)-03
  - Middeck
    - Physiological and Anatomical Rodent Experiment (PARE)-01
    - Protein Crystal Growth (PCG)-II-2
    - Middeck 0-Gravity Dynamics Experiment (MODE)-01
    - Investigations Into Polymer Membrane Processing (IPMP)-04
    - Cosmic Radiation Effects and Activation Monitor (CREAM)-02
    - Radiation Monitoring Equipment (RME)-III-06
    - Shuttle Activation Monitor (SAM)-03
    - Air Force Maui Optical Site (AMOS) Calibration Test
- Development Test Objectives (DTOs)/Detailed Supplementary Objectives (DSOs)

FLIGHT ACTIVITIES OVERVIEW

Flight Day 1

Launch
OMS-2
UARS power-on
RMS checkout
Start UARS in-bay checkout
SAM/CREAM setup
RCS 1
RCS 2
PCG activation

Flight Day 2

Depressurize cabin to 10.2 psi
IPMP
MODE FTA
Extravehicular mobility unit checkout
Electronic still camera downlink
PCG VDA tray

Flight Day 3

RMS power-up
UARS grapple
UARS power transfer
UARS ROEU demate
UARS unberth start
UARS satellite bolt release
Initiate UARS deployment
High gain antenna deployment
High gain antenna tracking
UARS release
Separation 1
Separation 2
Electronic still camera downlink
Repressurize cabin to 14.7 psi

Flight Day 4

MODE operations (FTA and STA)
SAM
Electronic still camera downlink

Flight Day 5

PCG deactivation
SAM stow
MODE STA
Flight control system checkout
RCS hot fire
Electronic still camera downlink
Crew press conference
Cabin stow

Flight Day 6

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.

- An approved exemption authorizes the crew to waive the daily exercise requirement for the entire mission.

STS-48 CREW ASSIGNMENTS

Commander (John O. [J. O.] Creighton):

Overall mission decisions

Payload--IPMP-04, AMOS

DTOs/DSOs--DSOs 469, 479, 602, 613, 614

Pilot (Kenneth [Ken] S. Reightler, Jr.):

Payload--PCG, AMOS, SAM, CREAM

DTOs/DSOs--DSOs 479, 613, 614

Other--intravehicular astronaut

Mission Specialist 1 (Charles D. ["Sam"] Gemar):

Payload--UARS EV2, UARS systems, PARE, SAM, CREAM, PCG

DTOs/DSOs--DTO 648; DSOs 479, 602, 603, 604, 611

Mission Specialist 2 (James [Jim] F. Buchli):

Payload--UARS EV1, MODE, RME, PARE

DTOs/DSOs--DSOs 469, 479, 602, 603, 613

Mission Specialist 3 (Mark N. Brown):

Orbiter--RMS operator for UARS deploy

Payload--MODE, RME

DTOs/DSOs--DTO 648; DSOs 479, 603, 608, 611, 613

DEVELOPMENT TEST OBJECTIVES/DETAILED SUPPLEMENTARY OBJECTIVES

DTOs

- FRCS flight test--12-second pulse (DTO 249)
- Ascent structural capability evaluation (DTO 301D)
- Ascent compartment venting evaluation (DTO 305D)
- Descent compartment venting evaluation (DTO 306D)
- Vibration and acoustic evaluation (DTO 308D)
- ET TPS performance--method 2 (DTO 312)
- Electronic still photography (DTO 648)
- PGSC single-event upset monitoring (DTO 656)

DSOs

- Effects of radiation on photographic film (DSO 318)
- In-flight radiation dose distribution, Configuration 2 (DSO 469)
- Hyperosmotic fluid countermeasure (DSO 479)
- Heart rate and blood pressure variability during space flight (DSO 602)
- Orthostatic function during entry, landing, and egress (DSO 603)
- Visual vestibular integration as a function of adaption, OI-1 (DSO 604)
- Effects of spaceflight 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 or orthostatic tolerance (DSO 613)
- Head and gaze stability during locomotion (DSO 614)
- Documentary television (DSO 901)
- Documentary motion picture photography (DSO 902)
- Documentary still photography (DSO 903)

STS-48 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.
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.

T - (MINUS) HR:MIN:SEC	TERMINAL COUNTDOWN EVENT
03:10:00	Liquid oxygen stable replenishment begins and continues until just minutes prior to T-0.
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.
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.

T - (MINUS) HR:MIN:SEC	TERMINAL COUNTDOWN EVENT
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.
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.

T - (MINUS) HR:MIN:SEC	TERMINAL COUNTDOWN EVENT
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."
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 Hold 10 Minutes	A planned 10-minute hold starts.
	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.

T - (MINUS) HR:MIN:SEC	TERMINAL COUNTDOWN EVENT
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.
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.

T - (MINUS) HR:MIN:SEC	TERMINAL COUNTDOWN EVENT
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.
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.
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.

T - (MINUS) HR:MIN:SEC	TERMINAL COUNTDOWN EVENT
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.
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-48 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-48 Flight Plan, Ascent Checklist, Post Insertion Checklist, Deorbit Prep Checklist, Entry Checklist, and RMA Deploy Checklist.

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.
0/00:00:28	All three SSMEs throttle down from 104 to 67 percent for maximum aerodynamic load (max q).
0/00:00:59	All three SSMEs throttle to 104 percent.
0/00:01:05	Max q occurs.
0/00:02:04	SRBs separate.
	When chamber pressure (Pc) of the SRBs is less than 50 psi, automatic separation occurs with manual flight crew backup switch to the automatic function (does not bypass automatic circuitry). SRBs descend to approximately 15,400 feet, when the nose cap is jettisoned and drogue chute is deployed for initial deceleration. At approximately 6,600 feet, drogue chute is released and three main parachutes on each SRB provide final deceleration prior to splashdown in Atlantic Ocean, where the SRBs are recovered for reuse on another mission. Flight control system switches from SRB to orbiter RGAs.
0/00:04:10	Negative return. The vehicle is no longer capable of return-to-launch site abort at Kennedy Space Center runway.
0/00:05:27	Single engine press to main engine cutoff (MECO).

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
0/00:07:29	All three SSMEs throttle down from 104 percent--vehicle acceleration capability no greater than 3g's.
0/00:08:30	All three SSMEs throttle down to 67 percent for MECO.
0/00:08:35	MECO occurs at approximate velocity 26,005 feet per second, 35 by 288 nautical miles (40 by 332 statute miles).
0/00:08:53	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.
	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.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
	--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.
0/00:44	OMS-2 thrusting maneuver is performed, approximately 4 minutes, 26 seconds in duration, at 450 fps, 292 by 293 nautical miles.
0/00:51	Commander closes all current breakers, panel L4.
0/00:53	Mission specialist (MS) seat egress.
0/00:54	Commander and pilot configure GPCs for OPS-2.
0/00:57	MS configures preliminary middeck.
0/00:59	MS configures aft flight station.
0/01:02	MS unstows, sets up, and activates PGSC.
0/01:06	Pilot activates payload bus (panel R1).
0/01:08	Commander and pilot don and configure communications.
0/01:12	Pilot maneuvers vehicle to payload bay door opening attitude, biased negative Z local vertical, positive Y velocity vector attitude.
0/01:17	Commander activates radiators.
0/01:19	MS performs SSP configuration check.
0/01:19	If go for payload bay door operations, MS configures for payload bay door operations.
0/01:28	Pilot opens payload bay doors.
0/01:30	Orbit 2 begins.
0/01:30	Commander loads payload data interleaver decommutator format.
0/01:33	Commander switches star tracker (ST) power 2 (panel O6) to ON.
0/01:36	Mission Control Center (MCC), Houston (H), informs crew to "go for orbit operations."

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
0/01:37	Commander and pilot seat egress.
0/01:38	Commander and pilot clothing configuration.
0/01:39	MS clothing configuration.
0/01:50	Pilot initiates fuel cell auto purge.
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 removes and stows 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.
0/02:01	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.
0/02:15	MS performs UARS ROEU mate check.
0/02:18	MS performs SSP check.
0/02:19	MS performs on-orbit initialization.
0/02:20	MS powers up UASE.
0/02:21	Pilot enables hydraulic thermal conditioning.
0/02:22	MS resets caution/warning (C/W).
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	UASE checkout.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
0/02:35	Systems management cockpit initiation occurs.
0/02:40	UARS power-on.
0/02:45	Configure UARS communications.
0/02:55	Unstow cabin.
0/02:55	Aft controller checkout.
0/03:06	Orbit 3 begins.
0/03:07	APU steam vent heater deactivation.
0/03:10	Ku-band antenna deployment.
0/03:10	UARS thermal control activation.
0/03:10	UARS keep alive power off.
0/03:12	Ku-band antenna activation.
0/03:25	UARS subsystems configuration.
0/03:30	RMS powerup.
0/03:30	Maneuver vehicle to IMU alignment attitude.
0/03:35	SAM activation.
0/03:40	PI check.
0/03:45	Begin UARS in-bay checkout.
0/03:45	IMU alignment: ST.
0/03:45	RMS checkout.
0/03:50	Maneuver vehicle to -ZLV, -XVV attitude.
0/04:10	UARS monitor display check.
0/04:15	DSO 469--Radiation dose distribution activation.
0/04:15	Cryogenic oxygen tank heater sensor check.
0/04:25	APU cool off.
0/04:35	P/TV04 setup (middeck).

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
0/04:42	Orbit 4 begins.
0/04:45	UARS payload survey.
0/04:47	RME III activation/checkout.
0/05:00	Meal.
0/05:00	RMS powerdown.
0/06:00	P/TV04 activation (middeck).
0/06:00	APU heater reconfiguration.
0/06:00	DSO 611--Air monitoring instrument evaluation and atmosphere characterization.
0/06:02	SAM setup: station 1-NaI.
0/06:02	CREAM activation.
0/06:17	Orbit 5 begins.
0/06:40	CREAM foil placement.
0/06:50	DTO 648 setup--Electronic still camera.
0/07:00	PARE observations.
0/07:10	P/TV07 setup (PCG).
0/07:15	SAM tape check.
0/07:20	PAM off.
0/07:37	PCG activation.
0/07:40	DSO 602 don--Blood Pressure Variability.
0/07:53	Orbit 6 begins.
0/07:55	APU heater reconfiguration.
0/08:00	Maneuver vehicle to IMU alignment attitude.
0/08:00	Crew begins presleep activities.
0/08:05	Private medical conference.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
0/08:15	IMU alignment: ST.
0/08:18	Maneuver vehicle to COAS attitude.
0/08:30	COAS calibration: forward station.
0/08:35	Maneuver vehicle to -ZLV, +YVV attitude.
0/08:53	Initiate supply water dump.
0/08:54	SAM PAM power on.
0/09:15	Initiate UARS prewarm.
0/09:28	Orbit 7 begins.
0/09:50	Terminate supply water dump.
0/10:00	Maneuver vehicle to -ZLV, -XVV attitude.
0/11:00	Crew begins sleep period.
0/11:04	Orbit 8 begins.
0/12:40	Orbit 9 begins.
0/14:16	Orbit 10 begins.
0/15:52	Orbit 11 begins.
0/17:27	Orbit 12 begins.
0/19:00	Crew begins postsleep activities.
0/19:04	Orbit 13 begins.
0/19:35	Maneuver vehicle to -ZLV, +YVV attitude.
0/19:52	Initiate supply water dump.
0/20:40	Orbit 14 begins.
0/20:50	Terminate supply water dump.
0/21:00	EVA aspirin protocol.
0/21:00	Maneuver vehicle to IMU/COAS alignment attitude.
0/21:05	SAM tape turnover.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
0/21:17	IMU alignment: ST.
0/21:20	COAS calibration--aft station.
0/21:25	Maneuver vehicle to -ZLV, -XVV attitude.
0/22:00	EVA crew initiates helmet retention assembly (HRA) prebreathe.
0/22:16	Orbit 15 begins.
0/22:30	SAM tape check.
0/22:50	Crew begins preparation for 10.2 psi cabin depressurization.
0/23:03	10.2 psi cabin depressurization.
0/23:35	10.2 psi cabin configuration.
0/23:35	EVA crew terminates HRA prebreathe.
0/23:45	-X RCS burn.
0/23:52	Orbit 16 begins.
0/23:55	DSO 604--Visual vestibular integration OI-1.
MET DAY ONE	
1/00:10	RCS-1 (forward) thrusting maneuver is performed, at 23.5 fps, 292 by 305 nautical miles.
1/00:15	P/TV06 setup (MODE).
1/00:15	MODE FTA setup.
1/00:30	+X RCS burn.
1/00:58	RCS-2 (aft) thrusting maneuver is performed, at 22.4 fps, 305 by 306 nautical miles.
1/01:00	Maneuver vehicle to -ZLV, -XVV attitude.
1/01:00	MODE FTA operations (flat bottom, oil).
1/01:27	Orbit 17 begins.
1/02:35	Filter cleaning.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
1/02:40	MODE FTA stow.
1/02:45	P/TV04 setup (middeck).
1/03:04	Orbit 18 begins.
1/03:15	Meal.
1/04:15	P/TV04 activities (middeck).
1/04:15	IPMP operations.
1/04:39	Orbit 19 begins.
1/05:00	EVA equipment preparation.
1/05:30	EVA extravehicular mobility unit checkout (two EMUs).
1/06:16	Orbit 20 begins.
1/07:00	DTO 648--Electronic still camera.
1/07:00	P/TV04 setup (middeck).
1/07:30	P/TV04 activation (middeck).
1/07:40	PARE observations.
1/07:45	PCG cleaning/temperature check.
1/07:50	DSO 602 doff--Blood pressure variability.
1/07:51	Orbit 21 begins.
1/08:10	RME III memory module replacement.
1/08:20	Maneuver vehicle to -ZLV, +YVV attitude.
1/08:30	SAM tape removal.
1/08:38	Initiate supply water dump.
1/08:40	SAM detector move (station 2-NaI).
1/09:00	Crew begins presleep activities.
1/09:10	Private medical conference.
1/09:27	Orbit 22 begins.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
1/09:35	Terminate supply water dump.
1/09:45	Maneuver vehicle to IMU alignment attitude.
1/09:45	SAM tape check.
1/09:45	10.2 psi cabin pressure maintenance.
1/10:00	IMU alignment: ST.
1/10:05	Maneuver vehicle to COAS calibration attitude.
1/10:15	COAS calibration, forward station.
1/10:20	Maneuver vehicle to -ZLV, -XVV attitude.
1/11:04	Orbit 23 begins.
1/12:00	Crew begins sleep period.
1/12:39	Orbit 24 begins.
1/14:15	Orbit 25 begins.
1/15:52	Orbit 26 begins.
1/17:27	Orbit 27 begins.
1/19:03	Orbit 28 begins.
1/20:00	Crew begins postsleep activities.
1/20:38	Orbit 29 begins.
1/21:00	Maneuver vehicle to IMU alignment attitude.
1/21:15	RMS heater activation.
1/21:18	IMU alignment: ST.
1/21:20	Maneuver vehicle to -ZLV, +YVV attitude.
1/21:37	Initiate supply water dump.
1/21:48	Reconfigure RCS regulator.
1/21:50	Check humidity separation for water accumulation, then reconfigure humidity separation B to OFF, and A to ON.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
1/22:00	Private medical conference.
1/22:05	EPS heater configuration.
1/22:15	Orbit 30 begins.
1/22:15	RMS powerup.
1/22:15	10.2 psi maintenance.
1/22:25	UARS preparation.
1/22:33	EVA preparation.
1/22:35	Terminate supply water dump.
1/22:48	Maneuver vehicle to deploy attitude, -ZLV, -XVV.
1/23:00	Flash evaporator controller off.
1/23:00	P/TVO2 setup (UARS).
1/23:18	UARS grapple.
1/23:25	PI lock.
1/23:30	P/TVO2 activation (UARS).
1/23:40	UARS configuration.
1/23:51	Orbit 31 begins.
MET DAY TWO	
2/00:04	UARS power transfer.
2/00:12	UARS ROEU demate.
2/00:15	UARS unberth.
2/00:20	PRLA release.
2/00:55	Maneuver vehicle to UARS deploy attitude, -ZLV, -XVV.
2/01:14	UARS solar array (SA) release.
2/01:20	Initiate deploy (UARS SA).
2/01:27	Orbit 32 begins.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
2/01:45	Maneuver vehicle to UARS deploy attitude, -ZLV, -XVV.
2/01:50	Initiate rotation (UARS SA).
2/01:58	UARS high gain antenna unlatch movement tests 1 & 2.
2/02:05	UARS high gain antenna deployment.
2/02:30	Meal.
2/02:55	UARS high gain antenna unlatch movement tests 3 & 4.
2/02:55	UARS high gain antenna ACS initiation.
2/03:03	Orbit 33 begins.
2/03:25	UARS high gain antenna track.
2/03:38	UARS release configuration.
2/04:38	Orbit 34 begins.
2/04:40	UARS release.
2/04:40	Separation 1 burn (RCS-3) at 2 fps, 306 by 308 nautical miles.
2/04:58	Separation 2 burn (RCS-4), at 5.5 fps, 303 by 306 nautical miles.
2/05:00	Maneuver vehicle to PI attitude.
2/05:55	Post EVA.
2/06:05	PCG cleaning/temperature check.
2/06:15	Orbit 35 begins.
2/06:18	PARE observations.
2/06:25	Post-EVA cabin repressurization to 14.7 psi.
2/06:38	RMS powerdown.
2/06:45	VTR setup.
2/06:48	Maneuver vehicle to TDRS attitude.
2/06:50	RMS closeout.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
2/07:00	VTR playback.
2/07:15	PCS configuration.
2/07:20	ECLSS checkout.
2/07:30	Cabin temperature control reconfiguration.
2/07:33	Topping flash evaporator system startup.
2/07:40	Load PCMMU.
2/07:50	Orbit 36 begins.
2/07:50	DTO 648--Electronic still camera.
2/08:00	Post EVA entry preparation.
2/08:10	DSO 611--Air monitoring instrument evaluation and atmosphere characterization.
2/08:30	Maneuver vehicle to biased -ZLV, +YVV attitude.
2/08:30	SAM tape removal.
2/08:40	SAM detector, Station 2, BGO.
2/08:49	Initiate supply water dump.
2/08:55	Check humidity separation for water accumulation, then reconfigure humidity separation A to OFF, and B to ON.
2/09:20	Private medical conference.
2/09:27	Orbit 37 begins.
2/09:45	Terminate supply water dump.
2/09:55	SAM tape check.
2/09:55	Maneuver vehicle to IMU alignment attitude.
2/10:00	Crew begins presleep activities.
2/10:07	IMU alignment: ST.
2/10:15	Maneuver vehicle to -ZLV, +YVV attitude.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
2/11:03	Orbit 38 begins.
2/12:38	Orbit 39 begins.
2/13:00	Crew begins sleep period.
2/14:14	Orbit 40 begins.
2/15:50	Orbit 41 begins.
2/17:26	Orbit 42 begins.
2/19:03	Orbit 43 begins.
2/20:38	Orbit 44 begins.
2/21:00	Crew begins postsleep activities.
2/21:15	Maneuver vehicle to biased -ZLV, +YVV attitude.
2/21:33	Initiate supply water dump.
2/22:14	Orbit 45 begins.
2/22:30	Terminate supply water dump.
2/22:40	Maneuver vehicle to IMU alignment attitude.
2/22:58	IMU alignment: ST.
2/23:00	Maneuver and initiate gravity gradient.
2/23:40	P/TV06 setup (MODE).
2/23:50	Orbit 46 begins.
2/23:50	SAM tape turnover.
MET DAY THREE	
3/00:00	MODE FTA setup.
3/00:00	DSO 604--Visual vestibular integration OI-1.
3/00:00	RME III memory module replacement.
3/00:30	MODE FTA operations (spherical bottom, oil).

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
3/00:45	SAM tape check.
3/01:25	Orbit 47 begins.
3/02:20	MODE FTA operations (spherical bottom, water).
3/03:03	Orbit 48 begins.
3/03:10	MODE FTA operations (flat bottom, water).
3/03:30	DSO 602 don--Blood pressure variability.
3/03:50	Meal.
3/04:37	Orbit 49 begins.
3/05:00	MODE FTA operations (spherical bottom, water).
3/05:50	MODE FTA operations (spherical bottom, water).
3/06:14	Orbit 50 begins.
3/06:40	Terminate gravity gradient.
3/06:40	MODE FTA stow.
3/06:45	PARE observations.
3/06:55	Maneuver vehicle to biased -ZLV, +YVV attitude.
3/07:00	PAM off.
3/07:05	MODE STA operations: assemble baseline configuration.
3/07:50	Orbit 51 begins.
3/08:15	PCG cleaning/temperature check.
3/08:30	PAM on.
3/09:15	DTO 648--Electronic still camera.
3/09:25	Orbit 52 begins.
3/10:08	Initiate supply water dump.
3/10:15	SAM tape removal.
3/10:25	SAM detector move--Station 1, BGO.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
3/10:45	STA temporary stow.
3/11:00	Crew begins presleep activities.
3/11:00	Terminate supply water dump.
3/11:02	Orbit 53 begins.
3/11:10	Private medical conference.
3/11:25	Maneuver vehicle to IMU alignment attitude.
3/11:40	IMU alignment: ST.
3/11:40	SAM tape check.
3/11:45	Maneuver vehicle to -ZLV, +YVV attitude.
3/12:37	Orbit 54 begins.
3/14:00	Crew begins sleep period.
3/14:13	Orbit 55 begins.
3/15:49	Orbit 56 begins.
3/17:25	Orbit 57 begins.
3/19:01	Orbit 58 begins.
3/20:37	Orbit 59 begins.
3/22:00	Crew begins postsleep activities.
3/22:13	Orbit 60 begins.
3/22:45	Maneuver vehicle to biased -ZLV, +YVV attitude.
3/23:04	Initiate waste water dump.
3/23:15	SAM tape turnover.
3/23:48	Orbit 61 begins.
MET DAY FOUR	
4/00:00	Terminate waste water dump.
4/00:10	APU heater activation.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
4/00:15	Maneuver vehicle to IMU alignment attitude.
4/00:25	SAM tape check.
4/00:30	P/TV06 setup (MODE).
4/00:30	MODE STA unstow.
4/00:32	IMU alignment: ST.
4/00:35	Maneuver vehicle to -ZLV, +YVV attitude.
4/01:03	MODE STA operations--assemble alpha joint.
4/01:18	FCS checkout.
4/01:24	Orbit 62 begins.
4/02:35	P/TV03 setup (crew press conference).
4/02:40	RCS hot fire.
4/02:55	Maneuver vehicle to TDRS attitude.
4/03:01	Orbit 63 begins.
4/03:05	P/TV03 activation (crew press conference).
4/03:10	Conference audio/TV check.
4/03:30	MODE STA operations.
4/03:30	DSO 602 doff--Blood pressure variability.
4/03:30	APU cool off.
4/03:40	APU heater reconfiguration.
4/03:55	DTO 648--Electronic still camera.
4/04:30	P/TV03 activation (crew press conference).
4/04:37	Orbit 64 begins.
4/04:40	Crew press conference.
4/04:55	Maneuver vehicle to -ZLV, +YVV attitude.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
4/04:55	P/TV06 setup (MODE).
4/05:10	MODE STA operations--assemble alpha joint plus corner.
4/05:35	MODE STA temporary stow.
4/05:50	Meal.
4/06:13	Orbit 65 begins.
4/06:45	MODE STA unstow.
4/06:55	MODE STA operations.
4/07:04	PARE observations.
4/07:15	DSO 611--Air monitoring instrument evaluation and atmosphere characterization.
4/07:30	P/TV07 setup (PCG).
4/07:40	RME III memory module replacement.
4/07:48	Orbit 66 begins.
4/07:53	PCG deactivation.
4/08:00	Cabin stow.
4/08:30	MODE STA operations: add flex appendage.
4/08:40	MODE STA stow.
4/09:24	Orbit 67 begins.
4/10:00	Maneuver vehicle to biased -ZLV, +YVV attitude.
4/10:14	Initiate supply water dump.
4/10:20	Filter cleaning.
4/10:28	SAM deactivation/stow.
4/10:50	Ku-band antenna stow.
4/11:00	Orbit 68 begins.
4/11:00	Private medical conference.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
4/11:00	Crew begins presleep activities.
4/11:15	Terminate supply water dump.
4/11:25	Maneuver vehicle to IMU alignment attitude.
4/11:42	IMU alignment: ST.
4/11:45	Maneuver and initiate passive thermal conditioning.
4/12:36	Orbit 69 begins.
4/14:00	Crew begins sleep period.
4/14:12	Orbit 70 begins.
4/15:48	Orbit 71 begins.
4/17:23	Orbit 72 begins.
4/18:59	Orbit 73 begins.
4/20:35	Orbit 74 begins.
4/22:00	Crew begins postsleep activities.
4/22:12	Orbit 75 begins.
4/23:47	Orbit 76 begins.
MET DAY FIVE	
5/00:04	Terminate passive thermal conditioning.
5/00:15	Maneuver vehicle to IMU alignment attitude.
5/00:30	IMU alignment: ST.
5/00:35	Maneuver vehicle to -XSI attitude.
5/01:00	PARE observations.
5/01:00	Private medical conference.
5/01:00	Entry DSO preparation: Orthostatic function during entry, landing, and egress (DSO 603).
5/01:15	RME III stow.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
5/01:20	DSO 469--Radiation dose distribution deactivation.
5/01:23	Orbit 77 begins.
5/01:49	Begin deorbit preparation.
5/01:49	CRT timer setup.
5/01:50	Commander initiates coldsoak.
5/01:59	Stow radiators, if required.
5/02:17	Commander configures DPS for deorbit preparation.
5/02:20	Mission Control Center updates IMU star pad, if required.
5/02:29	MS configures for payload bay door closure.
5/02:50	Maneuver vehicle to IMU alignment attitude.
5/02:55	UASE powerdown.
5/02:57	MCC-H gives "go/no-go" command for payload bay door closure.
5/02:58	Orbit 78 begins.
5/03:05	Pilot and MS close payload bay doors.
5/03:15	IMU alignment: ST.
5/03:25	Commander and pilot configure dedicated displays for entry.
5/03:28	MCC gives the crew the go for OPS 3.
5/03:31	Maneuver vehicle to deorbit burn attitude.
5/03:35	Pilot starts repressurization of SSME systems.
5/03:40	Commander and pilot perform DPS entry configuration.
5/03:49	MS deactivates ST and closes ST doors.
5/03:51	All crew members verify entry payload switch list.
5/04:06	All crew members perform entry review.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
5/04:08	Crew begins fluid loading, 32 fluid ounces of water with salt over next 1.5 hours (2 salt tablets per 8 ounces).
5/04:21	Commander and pilot configure clothing.
5/04:35	Orbit 79 begins.
5/04:36	MS configure clothing.
5/04:46	Commander and pilot seat ingress.
5/04:48	Commander and pilot set up heads-up display (HUD).
5/04:50	Commander and pilot adjust seat, exercise brake pedals.
5/04:58	Final entry deorbit update/uplink.
5/05:04	OMS thrust vector control gimbal check is performed.
5/05:05	APU prestart.
5/05:20	Close vent doors.
5/05:24	MCC-H gives "go" for deorbit thrusting period.
5/05:30	Manuever vehicle to deorbit thrusting attitude.
5/05:31	MS ingress seats.
5/05:39	First APU is activated.
5/05:45	Deorbit thrusting period, approximately 4 minutes, 43 seconds in duration, at 544 fps, 302 by 306 nm.
5/05:50	Initiate post-deorbit thrusting period attitude.
5/05:54	Terminate post-deorbit thrusting attitude.
5/06:02	Dump forward RCS, if required.
5/06:10	Activate remaining APUs.
5/06:11	Orbit 80 begins.
5/06:27	Entry interface, 400,000 feet altitude.
5/06:30	Enter communication blackout.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
5/06:31	Automatically deactivate RCS roll thrusters.
5/06:39	Automatically deactivate RCS pitch thrusters.
5/06:45	Initiate first roll reversal.
5/06:48	Exit communications blackout.
5/06:49	Initiate second roll reversal.
5/06:49	Initiate air data system (ADS) probe deploy.
5/06:50	Initiate ammonia boilers.
5/06:50	Initiate FRCS test (DTO 249).
5/06:51	End FRCS test (DTO 249).
5/06:51	Initiate third roll reversal.
5/06:52	Begin entry/terminal area energy management (TAEM).
5/06:52	Initiate payload bay venting.
5/06:54	Automatically deactivate RCS yaw thrusters.
5/06:57	Begin TAEM/approach/landing (A/L) interface.
5/06:57	Initiate landing gear deployment.
5/06:58	Vehicle has weight on main landing gear.
5/06:58	Vehicle has weight on nose landing gear.
5/06:58	Initiate main landing gear braking.
5/06:59	Wheel stop.

GLOSSARY

AA	accelerometer assembly
ACS	active cooling system
ADS	air data system
AEM	animal enclosure module
A/L	approach and landing
AMOS	Air Force Maui optical site
APM	ascent particle monitor
APU	auxiliary power unit
BFS	backup flight control system
CLAES	cryogenic limb altitude eatlon spectrometer
COAS	crewman optical alignment sight
CREAM	cosmic radiation effects and activation monitor
CRT	cathode ray tube
C/W	caution/warning
DAP	digital autopilot
DPS	data processing system
DSO	detailed supplementary objective
DTO	development test objective
EAFB	Edwards Air Force Base
ECLSS	environmental control and life support system
EDO	extended duration orbiter
EMU	extravehicular mobility unit
EOM	end of mission
EPS	electrical power system
ESC	electronic still camera
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
HRA	helmet retention assembly
HRM	high-rate multiplexer
HUD	heads-up display

IFM	in-flight maintenance
IMU	inertial measurement unit
IPMP	investigations into polymer membrane processing
IV	intravehicular
JSC	Johnson Space Center
KSC	Kennedy Space Center
LCD	liquid crystal display
LES	launch escape system
LPS	launch processing system
LRU	line replaceable unit
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
MODE	middeck 0-gravity dynamics experiment
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
PARE	physiological and anatomical rodent experiment
PASS	primary avionics software system
PCG	protein crystal growth
PCMMU	pulse code modulation master unit
PCS	pressure control system
PEM	particle environment monitor
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
R/IM	refrigerator/incubator module
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
SAM	shuttle activation monitor
SM	statute miles
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
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
TV	television
UARS	upper atmosphere research satellite
UASE	UARS airborne support equipment
USAF	U.S. Air Force
VTR	videotape recorder
WCS	waste collection system

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