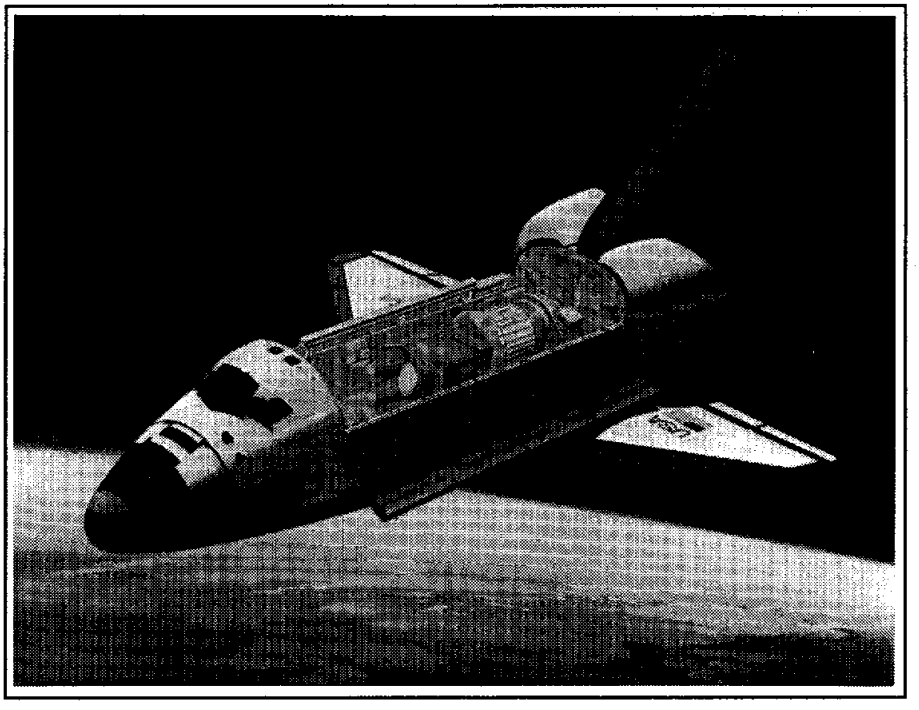

STS-54

MISSION STATISTICS

PRELAUNCH COUNTDOWN TIMELINE

MISSION TIMELINE

January 1993

Rockwell International
Space Systems Division

Office of External Communications &
Media Relations

CONTENTS

MISSION OVERVIEW

This is the 3rd flight of Endeavour and the 53rd for the space shuttle.

The flight crew for the six-day STS-54 mission is commander John H. Casper; pilot Donald (Don) R. McMonagle; and mission specialists Gregory (Greg) J. Harbaugh, Susan J. Helms, and Mario Runco, Jr.

STS-54's first primary mission objective is to successfully deploy NASA's Tracking and Data Relay Satellite (TDRS)-F using the Air Force's Inertial Upper Stage (IUS) booster.

TDRS-F is the sixth communications satellite launched in the process of assembling the Tracking and Data Relay Satellite System (TDRSS). TDRSS will provide a high-capacity communication and data link with the shuttle as well as other spacecraft and launch vehicles. The nominal IUS/TDRS-F deployment opportunity occurs on Orbit 5, 60 minutes prior to node 6A (ascending) at 0/06:13 Mission Elapsed Time (MET). Backup deploy opportunities occur prior to nodes 7A and 16A. A contingency opportunity occurs 60 minutes prior to node 8D (descending).

The IUS is a two-stage solid rocket, inertially stabilized upper stage that will place TDRS-F in a geosynchronous orbit. The IUS ignites its first stage (SRM-1) at the 6A node for transfer orbit insertion.

The second primary objective of STS-54 is the on-orbit payload operations of the Diffuse X-ray Spectrometer (DXS). DXS is designed to observe X-rays emitted in the Milky Way galaxy near the solar system. The DXS can detect the wavelength and intensity of the strongest galactic X-rays emitted by the hot gas believed to occupy most of the interstellar medium. Two DXS instruments, each composed of a lead-stearate (PbSt) Bragg spectrometer, are affixed to the shuttle payload of opportunity carrier (SPOC) plates and mounted on the getaway special adapter beams on each side of the payload bay. An across-bay cable electronically connects the port-side DXS instrument with the controlling hitchhiker avionics on the starboard side. During orbit night, the instruments oscillate about axes parallel to the shuttle's X-axis in synchronized operation, observing X-ray emissions from a specified region of interstellar space. When there is no atomic oxygen flow above the X-Y plane, no electron contamination, and if the instruments are scanning above 200 km altitude, during orbit night, DXS is collecting "good" data.

STS-54 secondary objectives include the Chromosome and Plant Cell Division in Space (CHROMEX); Commercial Generic Bioprocessing Apparatus (CGBA) A; Physiological and Anatomical Rodent Experiment (PARE) 02; and Solid Surface Combustion Experiment (SSCE).

CHROMEX is designed to determine the effects of microgravity on Arabidopsis thalina. These plants will be flown in the plant growth unit. Post-flight, data will be compared to that of similar plants grown at 1g on Earth. Activities consist of crew verification and logging of nominal operations each flight day during the experiment's day cycle.

CGBA consists of a generic bioprocessing apparatus (GBA), two refrigeration/incubation modules (CR/IMs), and a stowage locker. The GBA module is a self-contained mixing and heating module used to process biological fluid samples in microgravity. Activities consist of crew mixing of samples, incubation in the GBA, and data transfer to the PGSC.

PARE is being conducted to study acute adaptation of bone to spaceflight and the effects of microgravity on the skeletal system. The equipment consists of one animal enclosure module (AEM), which contains six rodents. The payload requires 28V dc power and daily housekeeping and observation by the crew.

SSCE consists of two polymethyl methacrylate (PMMA) samples internally mounted in a pressurized chamber. While the samples are burned, documentary photography of the front and side of the sample is taken. In addition, measurements are made of chamber temperature, chamber pressure, and middeck air temperature. The experiment must be run during a period of low orbiter accelerations.

Fourteen development test objectives and 12 detailed supplementary objectives are scheduled to be flown on STS-54, including DTO 1210--EVA operations procedures/training, which will include a spacewalk to prepare for future spacewalks necessary for construction of Space Station Freedom and repair of the Hubble Space Telescope; and DSO 802--Educational activities, which will include live lessons on the physics of toys.

MISSION STATISTICS

Vehicle: Endeavour (OV-105), 3rd flight

Launch Date/Time:

1/13/93 8:52 a.m., EST
7:52 a.m., CST
5:52 a.m., PST

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

Launch Window: 2 hours, 30 minutes

Mission Duration: 5 days, 23 hours, 32 minutes (if launch occurs after 10:04 a.m., EST, the mission may be extended to 7 days if DXS requires additional time to achieve mission success, since the capability exists for a 7-day mission plus 2 additional days for contingency operations and weather avoidance).

Landing: Nominal end-of-mission landing on orbit 96

1/19/93 8:24 a.m., EST
7:24 a.m., CST
5:24 a.m., PST

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

Transatlantic Abort Landing: Banjul, The Gambia; alternates: Moron, Spain; Ben Guerir, Morocco

Return to Launch Site: KSC

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

Inclination: 28.45 degrees

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

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

Altitude: 160 nautical miles (184 statute miles) circular orbit

Space Shuttle Main Engine Thrust Level During Ascent: 104 percent

Space Shuttle Main Engine Locations:

No. 1 position: Engine 2019
No. 2 position: Engine 2033
No. 3 position: Engine 2018

External Tank: ET-51

Solid Rocket Boosters: BI-056

Mobile Launcher Platform: 2

Editor's Note: The following weight data are current as of January 5, 1993.

Total Lift-off Weight: Approximately 4,522,692 pounds

Orbiter Weight, Including Cargo, at Lift-off: Approximately 259,264 pounds

Orbiter (Endeavour) Empty and 3 SSMEs: Approximately 172,840 pounds

Payload Weight Up: Approximately 46,643 pounds

Payload Weight Down: Approximately 9,068 pounds

Orbiter Weight at Landing: Approximately 197,778 pounds

Payloads--Payload Bay (* denotes primary payload): Tracking and Data Relay Satellite (TDRS)-F/Inertial Upper Stage (IUS)*, Diffuse X-ray Spectrometer

Payloads--Middeck: Chromosome and Plant Cell Division in Space (CHROMEX); Commercial Generic Bioprocessing Apparatus (CGBA) A; Physiological and Anatomical Rodent Experiment (PARE) 02; Solid Surface Combustion Experiment (SSCE)

Flight Crew Members:

Commander: John H. Casper, space shuttle flight
Pilot: Donald (Don) R. McMonagle, space shuttle flight
Mission Specialist 1: Mario Runco, Jr., space shuttle flight
Mission Specialist 2: Gregory (Greg) J. Harbaugh, space shuttle flight
Mission Specialist 3: Susan J. Helms, space shuttle flight

Ascent Seating:

Flight deck, front left seat, commander John H. Casper
Flight deck, front right seat, pilot Donald R. McMonagle
Flight deck, aft center seat, mission specialist Gregory J. Harbaugh
Flight deck, aft right seat, mission specialist Mario Runco, Jr.
Middeck, mission specialist Susan J. Helms

Entry Seating:

Flight deck, front left seat, commander John H. Casper
Flight deck, front right seat, pilot Donald R. McMonagle
Flight deck, aft center seat, mission specialist Gregory J. Harbaugh
Flight deck, aft right seat, mission specialist Susan J. Helms
Middeck, mission specialist Mario Runco, Jr.

Extravehicular Activity Crew Members, If Required:

Extravehicular (EV) astronaut 1: mission specialist Gregory J. Harbaugh
EV-2: mission specialist Mario Runco, Jr.

Intravehicular Astronaut: mission specialist Susan J. Helms

STS-54 Flight Directors:

Ascent: J. W. (Jeff) Bantle
Orbit 1 Team: C. W. (Chuck) Shaw
Orbit 2 Team/Lead: P. L. (Phil) Engelauf
Planning Team: J. F. (John) Muratore
Entry: R. D. (Rich) Jackson

Entry: Automatic mode until subsonic, then control stick steering

Notes:

. The remote manipulator system MPM's are installed in Endeavour's payload bay for this mission.

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

. STS-54 marks the first qualification flight of the extended duration orbiter (EDO) waste collection system (WCS), developed as part of the EDO program to accommodate longer missions (the current WCS is limited to approximately 98 man-days of use, enough to accommodate a seven-person crew for up to 14 days). The EDO WCS enhancements will be directly applicable to Space Station Freedom.

The qualification unit to fly aboard STS-54 as DTO 662 was built and certified for five flights, has a 100-mission design life, and is life-tested for 20 missions of use.

The EDO WCS is "user-friendly," incorporating numerous system improvements:

. Intuitive operations and automatic start-up
. Unlimited capacity with canister changeout
. An opening twice the diameter of the original WCS
. Elimination of vacuum drying of wastes
. Brushless dc motors with higher torque, a new labyrinth seal, a new impeller wheel, and a new bowl divider, all designed to eliminate fan separator failures
. Separate airflow paths for urinal and commode, to ensure adequate airflow during all modes of operation
. In-vehicle servicing capability.

The EDO WCS weighs approximately 250 pounds and operates on 350 watts of power.

Major elements of the urine system include a funnel and flexible hose (unchanged from the original WCS); a urine diverter valve, which provides selection between fan separators and an air/liquid connection for the urine monitoring system; redundant fan separators; an odor/bacteria filter that cleanses air prior to exhausting it back into the crew cabin; and redundant check valves through which liquids are pumped to the waste water tank.

The commode system features a single-use porous bag that is installed in a transport tube. All solid waste and wipes are placed in the bag. A commode fan provides transport airflow, while an odor/bacteria filter cleanses the air prior to exhausting it back into the crew cabin. Following use, a plastic lid is placed on the bag, and a compactor forces the bag, lid, and waste to the bottom of the canister. A new bag is then installed for the next user. When the canister is full (approximately 30 uses), it is removed, capped with an air-permeable odor/bacteria filter, stored in a locker, and a new canister installed for use.

MISSION OBJECTIVES

. Primary objective
 - Tracking and Data Relay Satellite (TDRS)-F/Inertial Upper Stage (IUS) deployment
. Secondary objectives
 - Payload bay
  . Diffuse X-ray Spectrometer (DXS) operations
 - Middeck
  . Chromosome and Plant Cell Division in Space (CHROMEX)
  . Commercial Generic Bioprocessing Apparatus (CGBA) A
  . Physiological and Anatomical Rodent Experiment (PARE)
  . Solid Surface Combustion Experiment (SSCE)
. 14 development test objectives/12 detailed supplementary objectives

FLIGHT ACTIVITIES OVERVIEW

Flight Day 1

Launch
OMS-2
Payload bay doors open
DXS activation
Unstow cabin
"Hot mike" audio configuration
IUS predeploy checkout
IUS direct check (HTS)
CHROMEX/PARE operations
Tilt table to 29 degrees
TDRS direct check (GDX)
TDRS-F/IUS deploy
RCS-1 burn
OMS-3 separation burn
TDRS-F SRM-1 ignition
Lymphocyte locomotion activation (DSO 322)
Commercial generic bioprocessing apparatus (CGBA) operations (sets 5-10, 20)
First diffuse X-ray spectrometer (DXS) scan

Flight Day 2

CGBA operations (sets 11-19, 21, 22, 24)
Electronic still camera checkout
Priority Group B powerdown
Visual vestibular tests (DSO 604)
Rower exercise
CGBA termination (set 11)
OMS-4 circularization burn
CGBA termination (set 12)
CHROMEX/PARE status check
Bioreactor test 1 (DSO 316)
CGBA termination (set 5)
GBA activation/begin set 1
Frequency interference measurement activation (DSO 321)
DXS operations

Flight Day 3

Frequency interference measurement deactivation
Bioreactor test 2
Solid surface combustion experiment (SSCE) operations (burn 1)
Rower exercise
Cabin depressurization to 10.2 psi
CGBA end set 1/begin set 2
Educational activities (DSO 802)
Bioreactor deactivation
"Physics of toys" R/T downlink (schools) (DSO 802)
CHROMEX/PARE status check
CGBA termination (sets 6, 13, 14)
GBA end set 2/begin set 3
SSCE operations (burn 2)
DXS operations

Flight Day 4

CGBA initiation (set 23)
EVA preparation
CGBA termination (sets 7, 15, 16)
Rower exercise
EMU checkout
GBA end set 3/PGSC data transfer
GBA begin set 4
Educational activities
Frequency interference measurement activation
CHROMEX/PARE operations

Flight Day 5

Frequency interference measurement deactivation
EVA preparation
Airlock depressurization
EVA--DTO 1210 (approximately 5 hours)
Airlock repressurization
Post EVA activity
EMU maintenance recharge
Manual fuel cell purge
Cabin repressurization initiation to 14.7 psi
CGBA termination (sets 8, 17)
CHROMEX/PARE status check
Frequency interference measurement activation
DXS operations

Flight Day 6

Terminate DXS operations
Frequency interference measurement deactivation
Fuel cell 2 shutdown (DSO 412)
FCS checkout
Visual vestibular tests
RCS hot fire
Post EVA entry preparation
GBA end (set 4)
GBA data transfer
GBA deactivation
CGBA termination (sets 9, 10, 18-24)
Cabin stow
Fuel cell 2 restart
CHROMEX/PARE operations

Flight Day 7

DXS deactivation
CHROMEX/PARE status check
DSO entry preparation
Priority Group B power-up
Deorbit preparation
Deorbit burn
Landing

Note:

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

CREW ASSIGNMENTS

Commander: (John H. Casper)

Overall mission decisions
DTOs/DSOs--DTOs 312, 521, 520, 805, 700-3, 662; DSOs 605, 604

Pilot: (Donald R. McMonagle)

DTOs/DSOs--DTOs 412, 656, 700-3, 662; DSOs 605, 604
Other--IFM, medic, Earth observations

Mission Specialist 1: (Mario Runco, Jr.)

Payload--TDRS, CHROMEX, PARE
DTOs/DSOs--DTOs 210, 312, 648, 662; DSOs 321, 322, 316, 605, 604
Other--EV2, IFM, Earth observations

Mission Specialist 2: (Gregory J. Harbaugh)

Payload--DXS, CHROMEX, CGBA, SSCE
DTOs/DSOs--DTOs 210, 662; DSOs 322, 316, 802, 604
Other--EV1, photo/TV

Mission Specialist 3: (Susan J. Helms)

Payload--TDRS, DXS, CGBA, PARE, SSCE
DTOs/DSOs--DTOs 656, 662; DSOs 321, 802
Other--IVA, medic, photo/TV

DEVELOPMENT TEST OBJECTIVES/DETAILED SUPPLEMENTARY OBJECTIVES

DTOs

. Ascent structural capability evaluation (DTO 301D)
. Ascent compartment venting evaluation (DTO 305D)
. Descent compartment venting evaluation (DTO 306D)
. Entry structural capability evaluation (DTO 307D)
. ET TPS performance, methods 1 and 3 including the 2X converter (DTO 312)
. Fuel cell on-orbit shutdown/restart (fuel cell 2) (DTO 412)
. Edwards lakebed runway bearing strength assessment for orbiter landings (DTO 520)
. Orbiter drag chute system (DTO 521)
. Electronic still photography (no downlink) (DTO 648)
. PGSC single-event upset monitoring (DTO 656)
. Extended duration orbiter WCS evaluation (DTO 662)
. Atmospheric effects on star tracker performance (DTO 700-3)
. Crosswind landing performance (DTO 805)
. EVA operations procedures/training (DTO 1210)

DSOs

. Bioreactor/flow and particle trajectory in microgravity (DSO 316)
. Frequency interference test (DSO 321)
. Human lymphocyte locomotion in microgravity (DSO 322)
. In-flight aerobic exercise (rower) (DSO 476*)
. Immunological assessment of crew members (DSO 487*)
. Orthostatic function during entry, landing, and egress (DSO 603B*)
. Visual-vestibular integration as a function of adaption (DSO 604*)
. Postflight recovery of postural equilibrium control (DSO 605*)
. Educational activities (objective 1 and 2: physics of toys) (DSO 802)
. Documentary television (DSO 901)
. Documentary motion picture photography (DSO 902)
. Documentary still photography (DSO 903)

* EDO buildup medical evaluation

STS-54 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-54 MISSION HIGHLIGHTS TIMELINE

Editor's Note: This timeline lists selected highlights only. For full detail, please refer to the NASA Mission Operations Directorate STS-54 Flight Plan, Ascent Checklist, Post Insertion Checklist, Deorbit Prep Checklist, Entry Checklist, and IUS 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, wings level.
0/00:00:19	Roll maneuver ends.
0/00:00:26	All three SSMEs throttle down from 100 to 70 percent for maximum aerodynamic load (max q).
0/00:00:56	All three SSMEs throttle to 104 percent.
0/00:01:02	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.
0/00:03:58	Negative return. The vehicle is no longer capable of return-to-launch site abort at Kennedy Space Center runway.
0/00:07:02	Single engine press to main engine cutoff (MECO).
0/00:08:26	All three SSMEs throttle down to 67 percent for MECO.
0/00:08:29	MECO occurs at approximate velocity 25,875 feet per second, 36 by 158 nautical miles (41 by 182 statute miles).
0/00:08:36	Zero thrust.
0/00:08:47	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.
0/00:39	OMS-2 thrusting maneuver is performed, approximately 2 minutes, 26 seconds in duration, at 221 fps, 162 by 160 nautical miles.
0/00:51	Commander closes all current breakers, panel L4.
0/00:53	Mission specialist (MS) seat egress.
0/00:54	Commander and pilot configure GPCs for OPS-2.
0/00:57	MS configures preliminary middeck.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
0/00:59	MS configures aft flight station.
0/01:00	MS unstows, sets up, and activates PGSC.
0/01:04	Pilot activates payload bus (panel R1).
0/01:07	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.
0/01:18	If go for payload bay door operations, MS configures for payload bay door operations.
0/01:28	MS opens payload bay doors.
0/01:30	Mission specialist loads payload data interleaver decommutator format/DXS telemetry format load.
0/01:33	Commander switches star tracker power 2 (panel 06) to ON.
0/01:35	Mission Control Center (MCC), Houston (H), informs crew to "go for orbit operations."
0/01:35	DXS activation.
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.
0/01:51	MS activates teleprinter (if flown).

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
0/01:53	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.
0/01:59	Pilot closes main B supply water dump isolation circuit breaker, panel ML86B, opens supply water dump isolation valve, panel R12L.
0/02:00	MS reloads orbit telemetry format load.
0/02:02	MS activates and checks out power control panel/controller interface unit/standard switch panel.
0/02:03	Pilot activates auxiliary power unit steam vent heater, panel R2, boiler controller/heater, 3 to A, power, 3 to ON.
0/02:08	MS performs IUS and TDRS specifications checkout.
0/02:10	Commander configures vernier controls.
0/02:12	Commander, pilot configure controls for on-orbit.
0/02:21	MS enables hydraulic thermal conditioning.
0/02:26	MS resets caution/warning (C/W).
0/02:28	Pilot plots fuel cell performance.
0/02:30	Actuator engagement (IUS deployment).
0/02:30	"Hot mike" audio configuration.
0/02:30	P/TV 02 activation (predeploy checkout).
0/02:40	IUS predeploy checkout.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
0/02:43	Orbit 3 begins.
0/02:55	IUS direct check (HTS).
0/03:05	IUS payload interrogator check.
0/03:15	TDRS command check (MIL).
0/03:25	TDRS payload interrogator check.
0/03:35	CHROMEX/PARE status check.
0/04:05	Maneuver vehicle to TDRS direct check attitude.
0/04:13	Orbit 4 begins.
0/04:20	P/TV 03 activation (TDRS deployment).
0/04:30	Tilt table to 29 degrees (TDRS deployment).
0/04:41	TDRS direct check (GDX).
0/04:55	IUS/payload interrogator lock (TDRS-East).
0/05:30	Maneuver to TDRS deploy attitude.
0/05:40	TDRS deploy countdown begins.
0/05:40	P/TV03 activation (TDRS deployment).
0/05:44	Orbit 5 begins.
0/06:13	TDRS-F/IUS deployment (58 degrees).
0/06:14	RCS SEP-1 burn.
0/06:20	Lower tilt table to negative 6 degrees (TDRS).
0/06:28	OMS-3 separation burn.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
0/07:13	TDRS-F/IUS injection (SRM-1) (node 6A).
0/07:14	Orbit 6 begins.
0/07:15	Lymphocyte locomotion activation (DSO 322).
0/07:20	CGBA activities (initialize sets 5-10, 20).
0/07:30	Crew begins presleep activities.
0/07:40	Ku-band antenna deployment.
0/07:50	Ku-band antenna activation.
0/08:00	VTR playback--TDRS deployment.
0/08:45	Orbit 7 begins.
0/10:08	First DXS scan.
0/10:16	Orbit 8 begins.
0/10:30	Crew begins sleep period.
0/11:46	Orbit 9 begins.
0/13:17	Orbit 10 begins.
0/14:48	Orbit 11 begins.
0/16:18	Orbit 12 begins.
0/17:49	Orbit 13 begins.
0/18:30	DSO 476--aerobics (pulse rate monitoring).
0/18:30	Crew begins postsleep activities.
0/19:20	Orbit 14 begins.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
0/20:00	DTO 656--PGSC upset monitoring initiation.
0/20:50	Orbit 15 begins.
0/21:30	CGBA activities (initialize sets 11-19, 21, 22, 24).
0/21:30	Electronic still camera checkout (DTO 648).
0/21:30	Priority Group B powerdown.
0/21:45	Visual vestibular tests (DSO 604).
0/22:21	Orbit 16 begins.
0/23:00	Exercise--rower (DSO 476).
0/23:15	CGBA termination (set 11).
0/23:52	Orbit 17 begins.
MET DAY ONE	
1/01:22	Orbit 18 begins.
1/01:35	P/TV04 activation (flight deck).
1/02:09	OMS-4 circularization burn.
1/02:15	CGBA termination (set 12).
1/02:40	CHROMEX/PARE status check.
1/02:40	P/TV05 activation (middeck).
1/02:52	Orbit 19 begins.
1/03:05	Bioreactor test 1 (DSO 316).
1/03:35	Exercise (DSO 476).

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
1/04:23	Orbit 20 begins.
1/05:40	CGBA termination (set 5).
1/05:53	Orbit 21 begins.
1/05:55	CGBA activities (GBA begin set 1).
1/06:00	DTO 656--PGSC upset monitoring termination (PADM powerdown.
1/06:20	Frequency interference measurement activation (DSO 321).
1/06:30	Crew begins presleep activities.
1/07:23	Orbit 22 begins.
1/08:54	Orbit 23 begins.
1/09:30	Crew begins sleep period.
1/10:25	Orbit 24 begins.
1/11:55	Orbit 25 begins.
1/13:25	Orbit 26 begins.
1/14:55	Orbit 27 begins.
1/16:26	Orbit 28 begins.
1/17:30	Crew begins postsleep activities.
1/17:30	DSO 476--aerobics (pulse monitoring).
1/17:56	Orbit 29 begins.
1/18:30	Frequency interference measurement deactivation.
1/18:40	DTO 656--PGSC upset monitoring initiation (PADM setup).

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
1/19:27	Orbit 30 begins.
1/20:30	Bioreactor test 2.
1/20:57	Orbit 31 begins.
1/21:20	P/TV05 activation (middeck).
1/21:30	SSCE burn 1.
1/21:55	Exercise--rower (DSO 476).
1/22:27	Orbit 32 begins.
1/22:30	Prepare for 10.2 psi cabin depressurization.
1/22:40	10.2 psi cabin depressurization.
1/23:55	CGBA activities (GBA end set 1/begin set 2).
1/23:58	Orbit 33 begins.
MET DAY TWO	
2/01:28	Orbit 34 begins.
2/01:45	P/TV06 activation (DSO 802).
2/01:45	Educational activities (DSO 802).
2/02:58	Orbit 35 begins.
2/03:10	Bioreactor deactivation.
2/03:25	"Physics of Toys" R/T downlink (DSO 802).
2/04:05	CHROMEX/PARE status check.
2/04:29	Orbit 36 begins.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
2/04:30	CGBA termination (sets 6, 13, 14).
2/04:50	CGBA activities (GBA end set 2/begin set 3).
2/04:55	P/TV05 activation (middeck).
2/05:05	SSCE burn 2.
2/05:30	Crew begins presleep activities.
2/05:59	Orbit 37 begins.
2/07:30	Orbit 38 begins.
2/08:30	Crew begins sleep period.
2/09:00	Orbit 39 begins.
2/10:30	Orbit 40 begins.
2/12:01	Orbit 41 begins.
2/13:31	Orbit 42 begins.
2/15:02	Orbit 43 begins.
2/16:30	DSO 476--aerobics (pulse rate monitoring).
2/16:30	Crew begins postsleep activities.
2/16:32	Orbit 44 begins.
2/18:03	Orbit 45 begins.
2/19:30	CGBA activities (initialize set 23).
2/19:30	EVA equipment preparation/EMU checkout.
2/19:33	Orbit 46 begins.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
2/19:45	Exercise--rower (DSO 476).
2/19:45	CGBA termination (sets 7, 15, 16).
2/20:00	EMU checkout (2 EMUs).
2/20:25	P/TV05 activation (middeck).
2/21:03	Orbit 47 begins.
2/21:20	CGBA activities (GBA end set 3/PGSC data transfer).
2/21:30	DTO 656 PADM powerdown.
2/22:33	Orbit 48 begins.
2/23:05	GBA begin set 4.

MET DAY THREE

3/00:04	Orbit 49 begins.
3/00:30	P/TV06 activation (DSO 802).
3/00:30	Educational activities (DSO 802).
3/00:30	DTO 656--PADM setup.
3/01:34	Orbit 50 begins.
3/03:05	Orbit 51 begins.
3/03:55	DTO 656--PADM powerdown.
3/04:20	Frequency interference measurement activation.
3/04:30	Crew begins presleep activities.
3/04:30	CHROMEX/PARE status check.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
3/04:35	Orbit 52 begins.
3/06:05	Orbit 53 begins.
3/07:30	Crew begins sleep period.
3/07:35	Orbit 54 begins.
3/09:05	Orbit 55 begins.
3/10:36	Orbit 56 begins.
3/12:06	Orbit 57 begins.
3/13:36	Orbit 58 begins.
3/15:07	Orbit 59 begins.
3/15:30	Crew begins postsleep activities.
3/15:30	DSO 476--aerobics (pulse rate monitoring).
3/16:37	Orbit 60 begins.
3/17:05	Frequency interference measurement deactivation.
3/17:15	DTO 656--PADM setup.
3/17:45	EVA preparation.
3/18:07	Orbit 61 begins.
3/19:38	Orbit 62 begins.
3/20:00	Terminate DXS operations.
3/20:00	Airlock depressurization.
3/20:08	EVA (DTO 1210--approximately 5 hours).

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
3/21:08	Orbit 63 begins.
3/22:38	Orbit 64 begins.
MET DAY FOUR	
4/00:08	Orbit 65 begins.
4/01:00	Airlock repressurization.
4/01:15	Post EVA activity.
4/01:30	DXS operations reinitiation.
4/01:39	Orbit 66 begins.
4/01:55	EVA evaluation.
4/01:55	P/TV08 activation (CGBA).
4/02:00	Manual fuel cell purge.
4/02:45	14.7 psi cabin repressurization.
4/03:10	Orbit 67 begins.
4/03:20	CGBA termination (sets 8, 17).
4/03:30	DTO 656--PADM powerdown.
4/03:35	CHROMEX/PARE status check.
4/03:50	Frequency interference measurement activation.
4/04:00	Crew begins presleep activities.
4/04:40	Orbit 68 begins.
4/06:10	Orbit 69 begins.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
4/07:00	Crew begins sleep period.
4/07:41	Orbit 70 begins.
4/09:11	Orbit 71 begins.
4/10:42	Orbit 72 begins.
4/12:12	Orbit 73 begins.
4/13:42	Orbit 74 begins.
4/15:00	Crew begins postsleep activities.
4/15:00	DSO 476--aerobics (pulse rate monitoring).
4/15:13	Orbit 75 begins.
4/15:30	Last DXS scan.
4/16:00	Frequency interference measurement deactivation.
4/16:10	DTO 656--PADM setup.
4/16:20	DTO 700-3--atmospheric effects on star tracker performance.
4/16:43	Orbit 76 begins.
4/18:00	Fuel cell 2 shutdown (DSO 412).
4/18:13	Orbit 77 begins.
4/18:15	FCS checkout.
4/18:15	Visual vestibular tests (DSO 604).
4/19:15	DSO 476--aerobics.
4/19:35	RCS hot fire.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
4/19:43	Orbit 78 begins.
4/21:00	Post EVA entry preparation.
4/21:14	Orbit 79 begins.
4/21:15	CGBA activities (GBA end set 4).
4/21:25	DTO 656--PADM powerdown.
4/21:40	CGBA activities (data transfer).
4/22:25	DTO 700-3.
4/22:25	CGBA activities (GBA deactivation).
4/22:35	Rower stow.
4/22:35	P/TV07 activation (crew press conference).
4/22:44	Orbit 80 begins.

MET DAY FIVE

5/00:10	Crew press conference.
5/00:14	Orbit 81 begins.
5/00:25	CGBA termination (sets 9, 10, 18-24).
5/01:00	Cabin stow.
5/01:45	Orbit 82 begins.
5/03:15	Orbit 83 begins.
5/03:20	Ku-band antenna stow.
5/03:30	Fuel cell 2 power-up (DTO 412).

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
5/03:35	CHROMEX/PARE status check.
5/04:25	DTO 700-3.
5/04:45	Orbit 84 begins.
5/06:16	Orbit 85 begins.
5/07:00	Crew begins sleep period.
5/07:46	Orbit 86 begins.
5/09:16	Orbit 87 begins.
5/10:47	Orbit 88 begins.
5/12:17	Orbit 89 begins.
5/13:48	Orbit 90 begins.
5/15:00	Crew begins postsleep activities.
5/15:00	DSO 476--aerobics (pulse rate monitoring).
5/15:18	Orbit 91 begins.
5/16:30	DTO 700-3.
5/16:48	Orbit 92 begins.
5/17:10	DXS deactivation.
5/17:20	CHROMEX/PARE status check.
5/18:00	DSO entry preparation (DSO 603B).
5/18:00	Priority Group B power-up.
5/18:18	Orbit 93 begins.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
5/18:30	Begin deorbit preparation.
5/18:30	Priority Group B power-up.
5/18:32	CRT timer setup.
5/18:37	Commander initiates coldsoak.
5/18:46	Stow radiators, if required.
5/19:04	Commander configures DPS for deorbit preparation.
5/19:07	Mission Control Center updates IMU star pad, if required.
5/19:16	MS configures for payload bay door closure.
5/19:27	MCC-H gives "go/no-go" command for payload bay door closure.
5/19:37	Maneuver vehicle to IMU alignment attitude.
5/19:49	Orbit 94 begins.
5/19:52	IMU alignment/payload bay door operations.
5/20:15	MCC gives the crew the go for OPS 3.
5/20:22	Pilot starts repressurization of SSME systems.
5/20:26	Commander and pilot perform DPS entry configuration.
5/20:35	MS deactivates ST and closes ST doors.
5/20:37	All crew members verify entry payload switch list.
5/20:52	All crew members perform entry review.
5/20:54	Crew begins fluid loading, 32 fluid ounces of water with salt over next 1.5 hours (2 salt tablets per 8 ounces).

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
5/21:05	DSO 603B--LES don.
5/21:07	Commander and pilot configure clothing.
5/21:15	STL entry preparation.
5/21:19	Orbit 95 begins.
5/21:22	MS/PS configure clothing.
5/21:33	Commander and pilot seat ingress.
5/21:35	Commander and pilot set up heads-up display (HUD).
5/21:37	Commander and pilot adjust seat, exercise brake pedals.
5/21:45	Final entry deorbit update/uplink.
5/21:51	OMS thrust vector control gimbal check is performed.
5/21:52	APU prestart.
5/22:07	Close vent doors.
5/22:11	MCC-H gives "go" for deorbit burn period.
5/22:17	Maneuver vehicle to deorbit burn attitude.
5/22:20	MS/PS ingress seats.
5/22:27	First APU is activated.
5/22:32	Deorbit burn.
5/22:35	Initiate post-deorbit burn period attitude.
5/22:39	Terminate post-deorbit burn attitude.
5/22:47	Dump forward RCS, if required.

T+ (PLUS) DAY/ HR:MIN:SEC	EVENT
5/22:49	Orbit 96 begins.
5/22:55	Activate remaining APUs.
5/23:01	Entry interface, 400,000 feet altitude.
5/23:06	Automatically deactivate RCS roll thrusters.
5/23:13	Automatically deactivate RCS pitch thrusters.
5/23:16	Initiate first roll reversal.
5/23:20	Initiate second roll reversal.
5/23:21	TACAN acquisition.
5/23:23	Initiate air data system (ADS) probe deploy.
5/23:24	Initiate third roll reversal.
5/23:25	Begin entry/terminal area energy management (TAEM).
5/23:26	Initiate payload bay venting.
5/23:28	Automatically deactivate RCS yaw thrusters.
5/23:30	Begin TAEM/approach/landing (A/L) interface.
5/23:31	Initiate landing gear deployment.
5/23:32	Vehicle has weight on main landing gear.
5/23:32	Vehicle has weight on nose landing gear.
5/23:32	Initiate main landing gear braking.
5/23:33	Wheel stop.

GLOSSARY

A/G	air-to-ground
AG	airglow
AA	accelerometer assembly
ACS	active cooling system
ADS	air data system
AEM	animal enclosure module
AFB	Air Force base
A/L	approach and landing
AOS	acquisition of signal
APC	autonomous payload controller
APCS	autonomous payload control system
APU	auxiliary power unit
ASE	airborne support equipment
ASPEC	application specific preprogrammed experiment culture system (Physics of Toys)
BBXRT	broad band X-ray telescope
BFS	backup flight control system
CCD	charge-coupled device
CCDS	Center for the Commercial Development of Space
CDMS	command and data management subsystem
CELSS	controlled ecological life support system
CGBA	commercial generic bioprocessing apparatus
CHROMEX	chromosome and plant cell division in space experiment
COAS	crewman optical alignment sight
CRIM	commercial refrigeration/incubation module
CRT	cathode ray tube
C/W	caution/warning
DACA	data acquisition and control assembly
DA	detector assembly
DC	detector controller
DAP	digital autopilot
DOD	Department of Defense
DPS	data processing system
DSO	detailed supplementary objective
DTO	development test objective
DXS	diffuse X-ray spectrometer

EAFB	Edwards Air Force Base
ECLSS	environmental control and life support system
EDO	extended duration orbiter
EDOMP	extended duration orbiter medical project
EHF	extremely high frequency
ELV	expendable launch vehicle
EMP	enhanced multiplexer/demultiplexer pallet
EMU	extravehicular mobility unit
EOM	end of mission
EPS	electrical power system
ESC	electronic still camera
ESA	European Space Agency
ESS	equipment support section
ET	external tank
ETR	Eastern Test Range
EV	extravehicular
EVA	extravehicular activity
FC	fuel cell
FCP	fuel cell power plant
FCS	flight control system
FDF	flight data file
FES	flash evaporator system
FPA	fluid processing apparatus
FPS	feet per second
FRCS	forward reaction control system
GAP	group activation pack
GAS	getaway special experiment
GBA	generic bioprocessing apparatus
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
HRM	high-rate multiplexer
HUD	heads-up display
IFM	in-flight maintenance
IMU	inertial measurement unit
I/O	input/output
IR	infrared
IUS	inertial upper stage

IV	intravehicular
JSC	Johnson Space Center
KEAS	knots equivalent air speed
KSC	Kennedy Space Center
LBNP	lower body negative pressure
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
MPESS	mission-peculiar equipment support structure
MPM	manipulator positioning mechanism
MPS	main propulsion system
MS	mission specialist
MSFC	Marshall Space Flight Center
NCC	corrective combination maneuver
NH	differential height adjustment
NMI	nautical miles
NOR	Northrup Strip
NPC	plane change maneuver
NRL	Naval Research Laboratory
NSR	coelliptic maneuver
NTIA	National Telecommunications and Information Administration
O&C	operations and checkout
OAA	orbiter access arm
OCP	Office of Commercial Programs
OG	orbiter glow
OMS	orbital maneuvering system
OPF	orbiter processing facility
OTC	orbiter test conductor

PAO	public affairs officer
PARE	physiological and anatomical rodent experiment
PASS	primary avionics software system
PC	proportional counter
PCMMU	pulse code modulation master unit
PCS	pressure control system
PDU	playback/downlink unit
PGC	plant growth chamber
PGSC	payload and general support computer
PGU	plant growth unit
PI	payload interrogator
PIC	pyro initiator controller
PMMA	polymethyl methacrylate
POCC	Payload Operations Control Center
PRCS	primary reaction control system
PRD	payload retention device
PRLA	payload retention latch assembly
PRSD	power reactant storage and distribution
PS	payload specialist
PTI	preprogrammed test input
P/TV	photo/TV
RAAN	right ascension of the ascending node
RCRS	regenerable carbon dioxide removal system
RCS	reaction control system
RF	radio frequency
RGA	rate gyro assembly
RMS	remote manipulator system
ROEU	remotely operated electrical umbilical
RPM	revolutions per minute
RSLS	redundant-set launch sequencer
RSS	range safety system
RTLS	return to launch site
S&A	safe and arm
SA	solar array
SAF	Secretary of the Air Force
SHF	superhigh frequency
SM	statute miles
SPASP	small payload accommodations switch panel
SPOC	shuttle payload of opportunity carrier
SRB	solid rocket booster
SRM	solid rocket motor
SRSS	shuttle range safety system

SSCE	solid surface combustion experiment
SSME	space shuttle main engine
SSP	standard switch panel
SSPP	Shuttle Small Payload Project
SSPP	solar/stellar pointing platform
ST	star tracker
STA	structural test article
STS	Space Transportation System
SURS	standard umbilical retraction/retention system
TAEM	terminal area energy management
TAGS	text and graphics system
TAL	transatlantic landing
TDRS	tracking and data relay satellite
TDRSS	tracking and data relay satellite system
TFL	telemetry format load
TI	thermal phase initiation
TIG	time of ignition
TPS	thermal protection system
TSM	tail service mast
TT&C	telemetry, tracking, and communications
TV	television
TVC	thrust vector control
UHF	ultrahigh frequency
VRCS	vernier reaction control system
VTR	videotape recorder
WCCS	wireless crew communication system
WCS	waste collection system