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STS-39 SPACE SHUTTLE MISSION REPORT

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STS-39

SPACE SHUTTLE

MISSION REPORT

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INTRODUCTION

The STS-39 Space Shuttle Program Mission Report contains a summary of the vehicle subsystem operations during the fortieth flight of the Space Shuttle and the twelfth flight of the Orbiter vehicle Discovery (OV-103). In addition to the Discovery vehicle, the flight vehicle consisted of an External Tank (ET) [(designated as ET-46 (LWT-39)], three Space Shuttle main engines (SSME's) (serial numbers 2026, 2030, and 2029 in positions 1, 2, and 3, respectively), and two Solid Rocket Boosters (SRB's) designated as BI-043.

The primary objective of this flight was to successfully perform the planned operations of the Infrared Background Signature Survey (IBSS), Air Force Payload (AFP) -675, Space Test Payload (STP) -1, and the Multipurpose Experiment Canister (MPEC) payloads.

The sequence of events for this mission is shown in table I. The report also summarizes the significant problems that occurred in the flight vehicle subsystems during the mission, and the official Orbiter problem tracking list is presented in table II. In addition, each Orbiter subsystem anomaly is discussed in the applicable subsystem section of the report and a reference to the assigned number is also provided.

The crew for this fortieth flight of the Space Shuttle vehicle was Michael L. Coats, Capt., USN, Commander; L. Blaine Hammond, Jr., Lt. Col., USAF, Pilot; Guion S. Bluford, Jr., Col., USAF, Mission Specialist 1; Richard J. Hieb, Mission Specialist 2; Charles L. Veach, Mission Specialist 3; Gregory J. Harbaugh, Mission Specialist 4; Donald R. McMonagle, Lt. Col., USAF, Mission Specialist 5. The STS-3 flight was the third Space Shuttle flight for the Commander and Mission Specialist 1, and the first Space Shuttle flight for the remaining five members of the crew.

SUMMARY

The STS-39 mission was planned for launch on April 23, 1991, but the countdown was scrubbed as a result of the failure of the transducer that measures main engine 3 high pressure oxidizer turbopump secondary seal cavity pressure. The failure was isolated to the transducer that was subsequently replaced, after which the vehicle was declared ready for launch.

The STS-39 mission was successfully launched from launch pad 39A on an inclination of 57 degrees at 118:11:33:14.018 G.m.t. (6:33:14 a.m. c.d.t.), on April 28, 1991. All subsystems operated nominally during ascent, and main engine cutoff (MECO) occurred at 118:11:41:48 G.m.t. An examination of prelaunch and flight data indicates that all Orbiter, Solid Rocket Booster, External Tank, and Space Shuttle main engine systems performed satisfactorily during the launch phase, and all launch objectives were accomplished.

During prelaunch operations, about 7 hours before launch, the flash evaporator feedline A system 2 heater failed. The system 1 heater was energized and nominal operations were noted. This anomaly did not impact mission operations.

Resumption of the launch countdown at T-9 minutes was delayed 32 minutes 14 seconds because of discussions concerning the unexpected operation of the OPS 2 recorder. Data indicated that the OPS 2 recorder was running and had switched to track 7, and no command had been given to initiate any recorder operation. Since no violation of the launch commit criteria had occurred and the condition was isolated to either the OPS 2 recorder or the payload (PL) 2 multiplexer/demultiplexer (MDM), the decision was made to resume the countdown.

About 15 minutes after MECO, data indicated that the APU 2 fuel pump/gas generator valve module (GGVM) coolant system A valve was not pulsing as designed. System B was activated and satisfactory cooling was obtained.

The first deployment of the Shuttle pallet satellite (SPAS) payload was delayed for 24 hours to enable more AFP-675 payload data to be obtained before the payload cryogenic supply was depleted. The SPAS/ Infrared Background Signature Survey (IBSS) payload was deployed at 121:08:18:00 G.m.t. The remote manipulator system (RMS) performed normally during the payload release and grapple activities.

The intense reaction control subsystem (RCS) and orbital maneuvering subsystem (OMS) maneuvering activities (41 RCS maneuver sets and 16 OMS maneuvers) were completed with excellent results. The crew completed the rendezvous with the SPAS, and the RMS was powered up. The payload was grappled and berthed successfully and the RMS was powered down at 122:23:15 G.m.t.

The rendezvous radar experienced intermittent losses of lock while operating in all modes except manual during the rendezvous activities with the SPAS. The temporary losses of lock did not impact rendezvous operations, although degraded relative navigation data were received during the periods of loss-of-lock.

The SPAS/IBSS was unberthed a second time at 05:02:36 mission elapsed time for an additional 30 hours of SPAS and RMS operations.

During the latter part of supply water dump 5, supply water dump nozzle temperatures experienced a rapid short-term drop of over 30 °F. The nozzle temperatures returned to normal before the end of the dump and all parameters were nominal for the remainder of the dump. Three additional supply water dumps were completed successfully, although momentary temperature drops were observed. In each case, the temperatures returned to normal after the momentary temperature drops.

Both AFP-675 recorders failed after the first usage. As a result, the crew performed an in-flight maintenance (IFM) procedure that enabled AFP-675 data to be transmitted over the ku-band antenna. The IFM was successfully completed and experiment data were successfully collected at the White Sands ground station for the remainder of the flight.

The flight control system (FCS) checkout was initiated at 125:16:25 G.m.t. Main engine 3 pitch actuator was repressurized and the actuator moved to the desired position properly after having drifted over 2 degrees from the restow position (based on commanded position). Auxiliary power unit (APU) 3 was operated for 5 minutes 8.53 seconds for the FCS checkout. Also, during the FCS checkout when the body flap auto/manual switch was depressed, the crew reported that contact 3 would only make when the push-button indicator was very firmly depressed.

The RCS hot-fire test was performed at 125:17:15 G.m.t., and all thrusters operated satisfactorily.

The crew completed all planned experiment operations, as well as entry preparations and stowage. Weather conditions (high winds) at Edwards Air Force Base resulted in a decision to land at Kennedy Space Center (KSC). All planning for the KSC landing was completed, and the deorbit maneuver was performed at 126:17:53:34.0 G.m.t. The maneuver was 143.0 seconds in duration and the differential velocity was 257.8 ft/sec. Entry interface occurred at 126:18:23:27 G.m.t. Data and voice communications through the Tracking and Data Relay Satellite (TDRS) were lost for approximately 12 minutes 40 seconds during entry because of blackout.

During entry, eight programmed test inputs (PTI's) were planned in support of development test objective (DTO) 242. Because of possible interference with required roll reversal maneuvers for landing at KSC, PTI's three through eight were deleted. Also during entry, APU 2 had lower than normal lubrication oil outlet pressure. All other APU 2 parameters were nominal.

Main landing gear touchdown occurred at 126:18:55:35 G.m.t. (May 6, 1991), on Shuttle Landing Facility runway 15 at KSC. Nose landing gear touchdown occurred 14 seconds later with wheels stop at 126:18:56:31 G.m.t. The rollout, during which the heavy braking DTO (519) was performed, was normal in all respects. The flight duration was 08:07:23:17. The APU's were shut down at 126:19:18 G.m.t., and the crew completed the required postflight reconfigurations and exited the vehicle at 126:20:01 G.m.t.

The postlanding inspection of the Orbiter tires revealed excessive wear with at least three plies of cords damaged on the right outboard main tire and one cord damaged on the right inboard main tire. The remaining tires showed the normal wear experienced with a concrete runway landing.

Nine DTO's were scheduled for this mission. Of these, six were completed, one was partially completed, and two were not performed. In addition, one unscheduled DTO was performed. Thirteen detailed supplementary objectives (DSO's) were scheduled. Twelve were completed as planned and DSO 0476 was only partially completed as the treadmill failed during the flight.

VEHICLE PERFORMANCE

The vehicle performance section of this report contains a discussion of the operation and performance of the major subsystems of the flight vehicle.

SOLID ROCKET BOOSTERS/REDESIGNED SOLID ROCKET MOTORS

All Solid Rocket Booster (SRB) systems performed as expected throughout ascent. The SRB prelaunch countdown was nominal. The redesigned Solid Rocket Motor (RSRM) propulsion performance was well within the required specification limits, and the propellant burn rate for each RSRM was normal. RSRM thrust differentials during the build-up, steady state and tailoff phases were well within specifications. All SRB thrust vector control (TVC) prelaunch conditions and flight performance requirements were met with ample margins. All electrical functions were performed properly. There were no SRB or RSRM Launch Commit Criteria (LCC) or Operations and Maintenance Requirements and Specifications (OMRS) violations during the launch countdown.

Power-up of all case/igniter and field joint heaters was accomplished routinely. All RSRM temperatures were maintained within acceptable limits throughout the countdown. Ground purges maintained the case/nozzle joint and flexible bearing temperature within the required LCC range.

Separation subsystem performance was normal, with all booster separation motors (BSM's) expended and all separation bolts severed. Nose cap jettison, frustum separation, and nozzle jettison occurred normally on each SRB. The entry and deceleration sequence was properly performed on both SRB's. RSRM nozzle jettison occurred after frustum separation, and the subsequent parachute deployments were successfully performed.

Both SRB's were successfully separated from the External Tank (ET) near the proper time. Both SRB's were recovered and returned to KSC for disassembly and refurbishment.

SRB structural response to the induced thermal environment during flight was as expected. Postflight inspection of the recovered hardware indicated that the SRB thermal protection system (TPS) performed properly during ascent, with very little TPS acreage ablation.

Postflight inspection of the right RSRM nozzle cowl and outer boot ring (OBR) showed wedgeouts that occurred during motor operation, and eroded wash areas in the insulation that were more extensive than commonly observed (Flight Problem STS-39-M-1). The cowl had erratic erosion, ply lifting, and atypical short ply wedgeouts that occurred during motor operation. This condition was expected, but not to the degree observed on this RSRM. The deep cowl wash/erosion areas resulted in two-sided heating of the OBR, causing unusual forward side wedgeouts. The wedgeouts showed evidence of erosion, confirming that the condition occurred during motor operation. Core samples revealed that the worst case washout erosion was 0.42 inch deep (located at 80 degrees), but still left a margin of safety of 0.15 above the required 1.5 factor of safety requirement.

EXTERNAL TANK

All objectives and requirements associated with the ET propellant loading and flight operations were met. The ET flight performance was excellent. All ET electrical equipment and instrumentation performed satisfactorily; however, the liquid oxygen ullage pressure transducer dropped from 6 to 0 psig for several minutes prior to the start of loading, but functioned normally thereafter. The operation of the ET heaters as well as the purges were monitored and all performed properly. No LCC or OMRSD violations were identified.

As expected, only the normal ice/frost formations for the April environment were observed during the countdown. No ice or frost was noted in the acreage areas of the ET. A small cone of frost developed in the close-out region at ET station 1130, approximately 70 degrees from the +Z axis. Normal quantities of ice or frost were present on the liquid oxygen and liquid hydrogen feedlines and on the pressurization line brackets. Frost was also present along the liquid hydrogen protruding air load ramps. All of these observations were acceptable in accordance with Space Shuttle Program documentation. Also, the ice/frost team reported that no anomalous thermal protection system conditions existed.

Propellant loading was completed as scheduled, and all prelaunch thermal requirements were met. No LCC or OMRSD violations occurred during the launch countdown.

The ET pressurization system functioned properly throughout engine start and flight. The minimum liquid oxygen ullage pressure experienced during the period of the ullage pressure slump was 15.7 psid.

The ET tumble system was deactivated for this flight. Main engine cutoff (MECO) occurred on time, ET separation and entry were verified to be as expected, and ET breakup occurred within the expected footprint. No significant ET problems were identified.

SPACE SHUTTLE MAIN ENGINES

All Space Shuttle main engine (SSME) parameters were normal throughout the prelaunch countdown and compared well with prelaunch parameters that occurred on previous flights. Engine-ready was achieved at the proper time, all LCC were met, and engine start and thrust build-up were normal.

Preliminary flight data indicate that SSME performance during thrust build-up, main stage, throttling, shutdown and propellant dump operations were well within specifications. High pressure oxidizer turbopump (HPOTP) and high pressure fuel turbopump (HPFTP) temperatures were well within specification throughout engine operation. The SSME controllers provided the proper control of the engines throughout powered flight, and no failures occurred during ascent. Engine dynamic data generally compared well with previous flight and test data. All on-orbit activities associated with the SSME's were accomplished successfully.

One anomaly was identified during the propellant loading phase of the first launch attempt on April 23, 1991. An LCC violation occurred on main engine 3 (E2029) HPOTP secondary seal cavity pressure measurement at channel A, and this resulted in scrubbing the first launch attempt. The HPOTP secondary seal cavity pressure sensor has qualification limits of 4-psia minimum and 20-psia maximum. Both channel A and B must remain within these limits before engine start can be given. Channel A drifted high and violated the 20-psia LCC limit during liquid hydrogen reduced fast fill. The hardware was removed and the failure was duplicated in a laboratory and isolated to the sensor. Disassembly of the sensor revealed a fracture in the resistor grid trace on the impedance board. The damage made the sensor vulnerable to the aft compartment environment. The failure was not generic in that 10 impedance boards were tested from various lots and no failures occurred. Additionally, the program history shows that this was the only impedance board failure of these transducers. New hardware was installed and checked out satisfactorily.

SSME 3 exhibited excessive drift following the ascent repositioning, and as a result, the engine was repositioned during the flight control system checkout.

SHUTTLE RANGE SAFETY SYSTEM

Shuttle range safety system (SRSS) closed-loop testing was completed as scheduled during the launch countdown. The SRSS safe and arm (S&A) devices were armed and all system inhibits were turned off at the appropriate times. All SRSS measurements indicated that the system performed as expected throughout the flight with system signal strength remaining above the minimum of -97 dBm at all times.

Prior to SRB separation, the SRB S&A devices were safed, and the SRB system power was turned off, as planned. The ET range safety system remained active until ET separation from the Orbiter.

ORBITER SUBSYSTEMS

Main Propulsion System

The overall performance of the main propulsion system (MPS) was excellent. Liquid oxygen and liquid hydrogen loading was performed as planned with no stop flows or reverts. There were no OMRSD violations.

Throughout the preflight operations, no significant hazardous concentrations were detected, and the maximum hydrogen level in the Orbiter aft compartment was approximately 210 ppm, which was acceptable based on data from previous flights of this Orbiter.

A slightly high helium concentration was observed in the aft compartment during propellant loading for the first launch attempt. Values as high as 12,000 ppm were noted early in the tanking sequence. The liquid hydrogen 4-inch disconnect boot was sealed with room temperature vulcanizing (RTV) during the turnaround operations between the scrub and launch. The helium concentration peaked at 11,000 ppm on flight day; however, the readings stabilized at approximately 7000 ppm, well below the LCC limit of 10,000 ppm.

A comparison of the calculated propellant loads at the end of replenish versus the inventory loads results in a loading accuracy of +0.0056 percent for hydrogen and +0.044 percent for oxygen.

Ascent MPS performance appeared completely nominal. Data indicate that the liquid oxygen and liquid hydrogen pressurization systems performed as planned and that all net positive suction pressure (NPSP) requirements were met throughout the flight.

STS-39 was the third flight of the step-one fixed-orifice configuration flow control valve and the pressurization data shows no anomalies.

Reaction Control Subsystem

The performance of the reaction control subsystem (RCS) was excellent A total of 41 maneuver sets were performed with the RCS in addition to the normal attitude control activities. These 41 sets of RCS maneuvers consisted of 59 different +Z, +X, and multi-axis translations (table III). The RCS was also used to perform two programmed test inputs (PTI's) during entry in support of DTO 0242. In addition to the 5743.2 lb of propellants used from the RCS tanks, the RCS used 23.05 percent of the orbital maneuvering subsystem (OMS) propellant from the left OMS tanks during left OMS interconnect operations and 22.09 percent of the right OMS propellant during right OMS interconnect operations.

One RCS anomaly was noted during the on-orbit phase of the mission. The vernier thruster F5R fuel injector temperature sensor appeared to be biased low (Flight Problem STS-39-V-03). During prelaunch operations, the fuel injector temperature was about 5 °F higher than the oxidizer injector temperature and this difference is considered nominal. After ascent, the fuel injector temperature was 10 °F higher than the oxidizer, and the differential temperature between the fuel and oxidizer increased with increasing temperature (50 °F at 250 °F). A table maintenance block update (TMBU) that would modify the deselect temperature of 130 °F to 90 °F was prepared, but was not required because the thruster temperature did not exceed the lower limit. The data from this thruster appeared similar to the STS-3, STS-4, and STS-6 mission data when poor thermal contact of the sensor existed.

Some instances of low chamber pressure (120 to 140 psia) were noted from the RCS thrusters during the periods of interconnect operations. The low chamber pressure was only present on minimum duration pulses (80 ms). Also, the low chamber pressure was only observed on the pod opposite the OMS pod that was supplying propellant during interconnect operation. The STS-39 data are consistent with the STS-38 and STS-37 low chamber pressure data. This low chamber-pressure condition during interconnect operations is now an explained condition.

Orbital Maneuvering Subsystem

The OMS performance was also excellent with a total of 16 OMS maneuvers being performed during the mission. No anomalies were noted during the mission. The OMS-2 and deorbit maneuvers were two-engine firings, and the remaining 14 maneuvers were single-engine firings (seven with the left engine, and seven with the right engine). The total firing time for the left engine was 382.0 seconds and 387.1 seconds for the right engine. A total of 13,109 lb of oxidizer and

7287 lb of fuel were used during OMS firings and RCS interconnect operations. The left OMS provided 23.05 percent of the propellant for use by the RCS during interconnect operations. The switchover to right OMS interconnect operations was performed at 121:22:16:50 G.m.t. A total of 22.09 percent of the right OMS propellant was provided to the RCS after the switchover.

After MECO and prior to the OMS 2 maneuver, the OMS aft crossfeed line temperature increased to 110 °F before cooling began. Temperatures as high as 110 °F have been observed on previous flights of OV-103 while operating on both heaters and no adverse effects were noted.

Power Reactant Storage and Distribution Subsystem

The power reactant storage and distribution (PRSD) subsystem performance was nominal throughout the mission with no anomalies noted. The Orbiter was flown in the four-tank-set configuration, and a total of 2115 lb (plus 77 lb for crew consumption) of oxygen and 266.4 lb of hydrogen were consumed. The consumables remaining at landing would have supported a mission extension of 63 hours at a 15.4 kW power level.

Fuel Cell Powerplant Subsystem

The fuel cell powerplant subsystem performance was nominal throughout the mission. During the mission, the total energy output was 3083 kWh at 15.4 kW. The fuel cells produced 2381 lb of water during the mission. No anomalies were noted during the 8-day mission, but three minor incidents occurred.

Following ascent, the temperature of the water relief line that runs between the relief valves and the relief nozzle dropped to 64 °F. Normal line temperature is 70 to 90 °F. The temperature recovered to 86 °F about 1.5 hours after the drop. This condition is a typical response to residual water flashing when exposed to a vacuum.

Approximately 2 hours after landing, the ground cooling system failed while the Orbiter was still on the runway. As a result of the lack of cooling, the fuel cells were shut down at 126:21:08 G.m.t., about 2 hours 15 minutes after landing.

Auxiliary Power Unit Subsystem

The performance of the auxiliary power unit (APU) subsystem was nominal during the STS-39 mission. One minor problem and two anomalies were identified during the mission, and none of these impacted the mission. The following table presents the cumulative run time and fuel consumption during the mission.

Flight Phase	APU 1 (S/N 203)		APU 2 (S/N 301)		APU 3 (S/N 304)	
	Time, min:sec	Fuel consumption, lb	Time, min:sec	Fuel consumption, lb	Time, min:sec	Fuel consumption, lb
Ascent	00:18:26	53	00:18:24	51	00:18:22	47
FCS checkout					00:05:08	12
Entry	01:29:29	207	01:07:26	146	01:07:25	157
Total[a]	01:47:55	260	01:25:50	197	01:30:55	216

[a] The total includes 22 minutes 26 seconds of APU operation after landing.

After APU 2 start for ascent, the exhaust gas temperature (EGT) 2 measurement indication was erratic. The transducer provided normal temperature indications during entry. This condition did not affect the mission.

Following APU shutdown after ascent, no cooling was noted on the APU 2 fuel pump/gas generator valve module (GGVM) while on the A cooling system (Flight Problem STS-39-V-02). Cooling system B was activated and cooling was nominal. All fuel pump/GGVM water valves were flying under exception EV2123R1 that extended the nine-month life limit an additional 45 days. This valve was not used during entry, and therefore, this anomaly did not impact entry operations.

The APU 2 lubrication oil outlet pressure ran low during the entire entry period (Flight Problem STS-39-V-11). The pressure ranged from 34 to 24 psia, compared to the normal 45 to 55 psia range, while the gearbox case pressure remained nominal throughout the entire entry phase. This low pressure violated the fault detection annunciator limit of 25 psia for the lubrication oil outlet pressure and also the flight rule requirement of 20 psid minimum between the lubrication oil outlet and gearbox case pressures. Throughout entry, the APU performance was nominal with gearbox bearing temperatures remaining within operational ranges. In-flight data did not show the cause of the anomaly; however, postflight checks revealed a lower amount of oil within the lubrication system than is required.

Hydraulics/Water Spray Boiler Subsystem

The hydraulics/water spray boiler (WSB) subsystem operated nominally throughout the mission with no anomalies identified. Circulation pump operation while on-orbit was minimal with a total of four periods of operation. Three of the periods of operation used circulation pump 1 and operation was required for thermal conditioning. Circulation pump 2 operated once for thermal conditioning and to recharge the system. Circulation pump 3 was not required to operate.

The SSME pitch actuator allowed engine 3 to drift beyond a maximum 2 degrees from the restow position based on commanded position. The drift reversed direction prior to restow, which was performed during the FCS checkout, and the engine was within 2 degrees of the commanded position after ascent (based on commanded position). The ground rules for measuring drift were changed during the mission to reflect a 2-degree movement from the actual actuator position versus the commanded position for post-ascent stow. Restowage was completed during the FCS checkout, and the indicated engine movement was 1.43 degrees.

Pyrotechnics Subsystem

The pyrotechnics subsystem performed properly with no identified anomalies.

Environmental Control and Life Support Subsystem

Performance of the environmental control and life support subsystem was nominal throughout the mission with two anomalies identified.

During prelaunch operations, several temperature transducers indicated that the feed water A line heater 2 failed and caused the fuse to open (Flight Problem STS-39-V-01). The most likely cause is a short in the system that resulted in the fuse in the aft load control assembly 2 opening. Heater 1 was activated and operated properly for the remainder of the mission.

The atmospheric revitalization subsystem performed normally and maintained the carbon dioxide partial pressure below 8.4 mm Hg. The cabin air temperature and relative humidity peaked at 82 °F and 45 percent, respectively. The avionics bay 1, 2, and 3 temperatures peaked at 109 °F, 107 °F, and 92 °F, respectively, while avionics bay 1, 2, and 3 water coldplate temperatures peaked at 92 °F, 93 °F, and 86 °F, respectively.

The supply water and waste management systems performed nominally throughout the mission. A total of 10 supply water dumps and 5 waste water dumps were completed during the mission. At 123:07:50 G.m.t., during supply water dump 5, the dump nozzle temperature rapidly decreased approximately 30 °F and shortly thereafter, the temperature returned to normal (Flight Problem STS-39-V-08). This condition occurred during three more supply water dumps. The condition could not be reproduced during turnaround testing at KSC. The cause of these short-period temperature variations is being analyzed.

The supply water system outlet pressure sensor was indicating higher-than-normal pressures. Nominal readings for this transducer are in the 18 to 20 psig range. During the mission, readings of 22 to 23 psig were noted while all other supply water transducers were indicating nominally. This 2 to 5 psig drift did not impact the flight nor did it require any special water management procedures.

The waste collection system performed normally; however, the crew reported during the postflight crew debriefings that a high-pitched whine was present when the fan separator was operating. This condition is being evaluated by the vendor.

Smoke Detection and Fire Suppression Subsystem

The smoke detection and fire suppression subsystem operated nominally throughout the mission. No anomalies were noted in the subsystem.

Airlock Support Subsystem

Operation of the airlock hardware was not required as there were no extravehicular activities (EVA's) planned or conducted.

Avionics and Software Subsystem

The performance of the avionics and software subsystem was satisfactory with one anomaly noted. The flight control system was used to perform two of the eight PTI's during entry in support of DTO 242. The remaining six PTI's were inhibited because of interference with the required roll reversal maneuvers for a landing at KSC.

Inertial measurement unit (IMU) and star tracker performance was nominal during the mission. The data processing system/flight software performance was nominal. A very low total of 99 soft errors were counted during the mission, as 20 soft errors per computer per day were predicted prior to the mission.

The OPS 2 recorder activated without commanding from the ground during the prelaunch activities. A repeat of this anomaly occurred at 125:15:21:19 G.m.t. (Flight Problem STS-39-V-04). Data show that the initial anomaly occurred while the backup flight system (BFS) was transitioning to OPS 2 and may have caused the recorder to activate. The BFS was not operating during the second occurrence, thus removing the BFS from consideration as a possible cause of the anomaly.

The electrical power distribution and control subsystem functioned properly. One anomaly was noted when several temperature transducers indicated that the flash evaporator system feedline A heater system 2 heater had failed during prelaunch operations (Flight Problem STS-39-V-01). This problem is discussed in the environmental control and life support subsection of this report.

The day before landing, at 125:23:28 G.m.t., a 25-ampere current spike was observed on fuel cell 3, and with normal load sharing, an additional 10 amperes were observed on fuel cells 1 and 2 for a total of 35 amperes with a duration of 20 milliseconds. Data review showed that two other current spikes occurred previously during the mission. Further review showed that the advance liquid feed experiment (ALFE) payload was enabled concurrent with each of these current spikes. The payload has a 28 Vdc to 115 Vac/60 Hertz inverter with an input capacitor bank. This configuration could have caused the current spike during power up as this condition is a normal characteristic of a power supply activation.

During the FCS checkout, the Commander reported at 125:16:38 G.m.t. that contact 3 on the left-hand body flap auto/manual pushbutton indicator would only make when firmly depressed (Flight Problem STS-39-V-10). Data analysis verifies that contact 3 was lagging. Postflight tests confirmed the data analysis and the switch was removed and replaced.

The Pilot reported during postflight debriefings that the rotational hand controller (RHC) rotated to the full aft position during entry and the adjust knob could not be moved (Flight Problem STS-39-V-14). This unexpected movement occurred after the Pilot had completed the entry flying assignment.

Communications and Tracking Subsystem

The communications and tracking subsystem performed in a normal manner, and 586 pages were received by the text and graphics system (TAGS). The TAGS had a false developer over-temperature indication. Troubleshooting indicated that the condition did not exist, and further troubleshooting resulted in recovery of the TAGS. A TAGS false jam was also indicated. The TAGS operated properly for the remainder of the mission.

The closed circuit television (CCTV) had a loss of data and/or video on four occasions (Flight Problem STS-39-V-07). The crew recycled the power switch on the video control unit or camera power to restore video operation. Also, the camera A pan and tilt controller position angles could not be reset to zero-zero by the crew or the ground controllers. This problem did not affect the ability to pan or tilt the camera. The problem was cleared when the crew cycled the power switch and the problem did not impact the mission.

The Ku-Band rendezvous radar experienced several dropouts during rendezvous operations (Flight Problem STS-39-V-06). These dropouts occurred in all modes except manual, which was not used. The dropouts caused some degradation of the navigation data, but the effects on rendezvous operations were not significant.

The S-band operations were satisfactory; however, a co-orbiting radio frequency interference (RFI) source that affected the S-band return link through the TDRS was reported by Goddard Space Flight Center on orbits 77, 93, 109, and 125. Analysis of this condition continues.

The crew reported that the "no video" light indication was observed when operating camera C on video tape recorder (VTR) 2. The crew was instructed to use VTR 1 with camera C for the remainder of the mission and all indications were normal. Both VTR 1 and 2 are Office of Aeronautics and Space Technology (OAST) recorders.

Performance of the S-band antennas and transponders was nominal; however, the S-band/TDRS RF communications link was lost for approximately 12 minutes 40 seconds during entry (Flight Problem STS-39-V-13). The loss of communications was caused by the high inclination (57 degree) orbit flown on this mission that resulted in the TDRS seeing the side of the plasma sheath instead of the aft opening of the sheath as seen on 28-degree inclination orbits. In addition, a lower antenna was selected, whereas an upper antenna would have been a more desirable transmitting element.

Operational Instrumentation

The operational instrumentation performed nominally during the STS-39 mission with no data lost and no problems that had a mission impact. Two anomalies were noted.

The OPS 2 recorder went to the run state and switched tracks uncommanded at approximately L-20 minutes (Flight Problem STS-39-V-04). Data review showed that the recorder had begun recording on track 7 at 118:10:32:31 G.m.t., and was commanded to stop at 118:10:35:55 G.m.t., with track 7 being 19 percent full. Data from subsystems that could have caused this change of state were reviewed and analyzed with the most probable source being the payload 2 MDM, which commands the tape recorder. The OPS 2 recorder malfunctioned again on flight day 7 at 125:15:21:19 G.m.t., when the recorder was again noted to change speed, track, and mode without a command. Other than these two uncommanded operations, the OPS 2 recorder operated as designed throughout the mission.

During the preparations for the OMS 2 maneuver, the modular auxiliary data system (MADS) frequency division multiplexer (FDM) multiplexer (MUX) 1 and 2 bite status indicated a failure (Flight Problem STS-39-V-05). The two MUX's are powered from one power supply. In-flight analysis indicated that much of the data on the 28 tracks may have been lost; however, only a few seconds of the OMS 2 maneuver data were lost.

Structures and Mechanical Subsystems

All structures and mechanical subsystems operated nominally during the mission. The postflight inspection revealed that the left-hand ET/Orbiter separation device hole plugger did not fully seat because the plunger was obstructed by a pyrotechnic cartridge fragment.

The postflight inspection also revealed that the right main outboard tire had excessive wear with three plies showing (Flight Problem STS-39-V-12). Landing/deceleration data are being analyzed in an effort to determine the cause of the excessive tire wear.

Main landing gear touchdown occurred at a speed of 221 keas (ground speed 210.4 knots), and Orbiter data show that the right main gear touched down 345 feet past the runway threshold and the left main gear touched 653 feet past the runway threshold, with winds at 12 knots and gusts to 16 knots from 155 degrees. Nose gear touchdown occurred at a ground speed of 159.8 knots and braking was initiated at a ground speed of 136.5 knots. Wheel stop was 9320 feet from the runway threshold. The sink rate at touchdown was approximately 2 ft/sec, and the pitch rate at nose gear touchdown was 2.52 deg/sec.

The maximum brake pressures during rollout ranged from 1295 psia to 1335 psia on the left main gear and 1374 psia to 1573 psia on the right main gear. Brake energies were 29.64 million ft-lb on the left outboard brake, 30.39 million ft-lb on the left inboard brake, 37.28 million ft-lb on the right inboard brake, and 36.36 million ft-lb on right outboard brake. The Orbiter weighed 210,811 lb at landing.

Remote Manipulator System

The remote manipulator system (RMS) performance was nominal and all mission objectives were accomplished with no anomalies identified.

A standard RMS checkout was performed on the first day. A concern was raised when the shoulder brace indicated a released condition 1 second after the command. A typical time for the release indication on previous missions has been 8 seconds, but the Flight Data File procedures do not specify an expected time. Also, the command duration was only 6 seconds rather than 10 seconds. The crew commanded the additional 4 seconds and RMS driving was nominal, indicating the shoulder brace was fully retracted.

The shoulder brace is designed to reduce launch loads on the RMS shoulder pitch joint and once the shoulder brace is released during a mission, it is not relatched. An investigation into KSC records shows that the shoulder brace may not have been latched properly during preflight preparations of the vehicle. The only impact of this failure to latch before flight is an RMS life issue, which is being evaluated. A direct drive test of the shoulder pitch joint was successfully performed at the end of all RMS mission operations to confirm the health of the RMS for the next mission.

Following the checkout, the RMS was first used on flight day 3 to observe a stuck gimbal on an infrared background signature survey (IBSS) experiment and later to assist in tail observations for the Glow experiment. The arm was uncradled for the third time on flight day 3 to unberth and deploy the IBSS/SPAS as a free-flying payload. The payload was released at 02:20:44:38 mission elapsed time (MET).

On flight day 4, the RMS was maneuvered away from its cradle position to avoid contamination by gases released from the payload bay during an experiment observed by the IBSS. On flight day 5, the IBSS/SPAS payload was retrieved with the RMS and berthed. The payload was captured by the RMS end effector at 04:10:52:20 MET.

A 23-hour series of IBSS observations with the payload attached to the RMS was begun when the SPAS was unlatched from the payload bay at 05:02:32:22 MET. The IBSS was positioned for data gathering in both manual, computer-supported RMS modes and by premission designed RMS automatic sequences. During the mission, the published Flight Plan timeline was continually modified and updated due to the payload troubleshooting and changing mission objectives. Premission development of the Flight Data File alternate RMS procedures made the continual activity changes feasible. At 06:01:08:46 MET, the IBSS was berthed and latched. The RMS was used to make a final camera survey of the bay, and the direct drive test of the shoulder pitch joint was performed before the RMS was cradled, latched, and stowed.

Aerodynamics

The ascent and entry aerodynamics were nominal for the STS-39 mission. The first two PTI's were executed for DTO 242, and the final six PTI's were inhibited because of maneuvering required to land at KSC.

Thermal Control Subsystem

The thermal control subsystem (TCS) performed nominally, and all temperatures were maintained within acceptable limits during the mission.

At 118:11:58 G.m.t., the fault detection and annunciation (FDA) alarm was triggered by the aft OMS fuel high-point bleed line heater temperature sensor (V43T6238), which had reached 110 °F on the first heater cycle before cooling began. This temperature level was caused by simultaneous operation of the A and B heater systems. The crew selected the A heater and nominal operation was observed. The problem had no effect on the mission.

The supply water dump nozzle temperature during the fifth supply water dump experienced a rapid decrease of approximately 30 °F and then returned to normal (Flight Problem STS-39-V-08). This condition is discussed in more detail in the Environmental Control and Life Support Subsystem portion of this report.

The APU 2 exhaust gas temperature (EGT) sensor failed during ascent, and this failure had no impact on the successful completion of this mission.

Aerothermodynamics

The acreage heating was nominal except for the leeside structural temperature rise which was above normal, but within limits. Initial analysis indicates that the lower angle of attack flown during the period of peak heating may have caused this condition. Local heating was nominal; however, several slumped tiles were noted behind the nose cap and wing leading edge tiles.

Thermal Protection Subsystem

The thermal protection subsystem (TPS) performed as designed, although some damage from ascent and entry were noted. The postflight inspection revealed surface overheating conditions in the chin area (tiles between the nosecap and nose landing gear door), nose landing gear door edge repairs, leading edge, and left chine area of the vehicle. No structural temperature violations were recorded. Analysis of the flight data indicated higher-than-normal structural temperature rise, which indicates higher heat loads, in the forward region of the Orbiter lower surface and the forward RCS module sides. Entry parameters included a high inclination orbit (57 degrees), a heavyweight vehicle (213,000 lb), descending node entry, and a forward center of gravity (c.g.) (1083 in.). Flight data also showed an angle of attack reduction to 38 degrees at 1050 seconds after entry interface, which returned to normal 67 seconds later. The overall boundary layer transition from laminar flow to turbulent flow was nominal, occurring 1235 seconds after entry interface. A reduction in the angle of attack increases the nose reference heating, as well as the leading edge shock interaction region reference heating. Nevertheless, it is not believed that the change in angle of attack alone had a significant impact on the TPS. After the analysis, the interpretation of all the flight data and observations, the performance of the TPS can be correlated to a typical high inclination, heavy weight, forward c.g. entry. Therefore, the performance of the TPS is considered nominal for entry.

Debris impact damage was minimal. A cluster of debris impacts was noted just above and aft of the left-hand ET door. The base heat shield peppering was moderate.

A postlanding inspection of the thermal protection subsystem revealed a total of 124 hits of which 11 had a major dimension of one inch or greater. Of these, the lower surface had 114 hits and 10 of the hits had a major dimension of one inch or greater. A comparison of the hits on this mission with the results from 26 previous missions shows that the overall number of hits (124) is greater than average, whereas the number of hits with a dimension of one inch or greater was less than average.

Overall, all reusable carbon carbon parts looked well. The left-hand RCC panel 8 had a surface repair discrepancy. The panel will be removed, repaired and reinstalled. The nose landing gear door thermal barrier was in nominal condition, except for two minor frayed areas. The forward RCS thermal barrier was in good condition. All the protective thermal barrier room temperature vulcanizing (RTV) coating was completely burned off due to the increased heating. The main landing gear door thermal barriers were in nominal condition except for some damage in both outboard edges. The left-hand main landing gear door corner tile broke during door opening as experienced in past landings. The ET door thermal barriers looked nominal. The engine-mounted heat shield thermal curtains were in fair condition, with some damage noted on all three engines. Orbiter windows 3 and 4 were lightly hazed.

Overall, the upper surface TPS was in good condition with minor blanket damage. The OMS pod TPS was in good condition, except for an observed area of damage to an advanced felt reusable surface insulation (AFRSI) blanket on the right pod "Y" web door. Also, two of the rudder speed brake trailing edge tiles were cracked.

FLIGHT CREW EQUIPMENT

All flight crew equipment performance was nominal except for the treadmill that failed during flight day 6 (Flight Problem STS-39-V-09). The pilot reported hearing a snap after which the treadmill resistance increased to infinity. Use of the treadmill was lost for the remainder of the mission.

PAYLOADS

AIR FORCE PROGRAM 675

The purpose of the Air Force Program (AFP) 675 was to analyze and record data relating to the near Earth space envelope and celestial targets. The data recorders that were to be used by these experiments failed early in the flight, and some data collection periods early in the flight were lost. AFP-675 consisted of five experiments which were:

a. Cryogenic Infrared Radiance Instrumentation for Shuttle (CIRRIS)

b. Far Ultraviolet (Far UV)

c. Uniformly Redundant Array (URA)

d. Horizon Ultraviolet Program (HUP)

e. Quadrupole Ion Neutral Mass Spectrometer (QINMS)

Although the CIRRIS on-orbit cryogenic usage rate was higher than predicted, the CIRRIS experiment completed 15 scheduled and one unscheduled category 1 observations plus three category 2 observations. These observations included auroral, earthlimb, and celestial targets. The occurrence of highly excited aurora during periods of data gathering was extremely beneficial to investigators. The CIRRIS also observed a chemical release observation (CRO) release with the SPAS II.

The far UV experiment completed all planned objectives (two category 2 and six category 3 observations).

A power supply failure degraded the URA experiment hardware after four experiment observations were completed. However, the primary objective of URA, to provide proof of concept, was successfully completed.

The payload recorder failures discussed previously caused the loss of much of the observations for the HUP and QINMS experiments. The crew performed an in-flight maintenance (IFM) procedure that was developed by ground personnel and regained the ability to route data from the HUP and QINMS experiments to the ground personnel using the Ku-Band antenna.

Following the successful completion of the IFM procedure, the HUP operated continuously in parallel with other payload observations. In addition, two periods of dedicated observation time were accomplished. During these two periods, data were obtained that had been missed earlier in the flight.

Although the recorder failures minimized early data collection for the QINMS experiment, all four category 3 objectives were successfully completed.

INFRARED BACKGROUND SIGNATURE SURVEY

The purpose of the infrared background signature survey (IBSS) experiment was to collect multispectral signatures from various natural and induced backgrounds including plumes generated by the OMS and RCS, the Earth limb, chemicals released into space, the Earth, the Orbiter environment, and various calibration sources.

The SPAS II was deployed from the Orbiter and separated from the Orbiter to various distances from where the orbital ballet resulting from the OMS and RCS maneuvers was monitored very successfully. The SPAS II completed all OMS/RCS plume firing objectives on three far-field maneuvers (plus six null maneuvers) and two near-field maneuvers (plus four null maneuvers). These plume observations were the first from outside the Earth atmosphere (exoatmospheric). The SPAS II also observed two auroras while deployed and one aurora while operating on the RMS.

All three chemical release observation (CRO) canisters were successfully deployed and observed by Vandenburg Air Force Base as well as by the SPAS II (two observed while deployed, and one was observed while on the RMS). One of the observations was accomplished simultaneously by SPAS II and CIRRIS .

The release of four gases from critical ionization velocity (CIV) canisters was observed by the SPAS II while deployed as well as while operating on the RMS. Additionally, one of the releases was observed jointly with the QINMS.

SPACE TEST PROGRAM 1

The Space Test Program (STP) 1 payload consisted of five experiments, and included instrument electronics and control systems mounted on a hitchhiker-M bay carrier. These experiments were:

a. Advanced liquid feed experiment (ALFE)

b. Shuttle kinetic infrared test (SKIRT)

c. Ultraviolet limb measurement (UVLIM)

d. Data system experiment (DSE)

e. Ascent particle monitor (APM)

Several Freon tank transfers were accomplished for the ALFE. These included one phase A (calibration) transfer, three phase B (low rate) transfers, one phase C (high rate) transfer, and one phase D (settling) transfer.

Canister door openings and closings of the SKIRT payload permitted completion of two anti-velocity vector glow plate observations and several simultaneous observations with the AFP-675 experiments. The gaseous luminosity optical surface operated nominally throughout the mission.

The canister door on the UVLIM was successfully operated several times. Observations completed include four earth-limb scans and 2 1/2 orbits of imaging scans.

The DSE software checkout was performed as well as two robotic operations.

No reports or data have as yet been received, but it is assumed that the APM operated satisfactorily throughout the ascent phase.

MULTIPURPOSE EXPERIMENT CANISTER

The purpose of the Multipurpose Experiment Canister (MPEC) was to eject the experiment contained in the MPEC. The objective was successfully accomplished on flight day 8 when the experiment was successfully deployed.

CLOUDS - 1A

The objective of the Clouds - 1A experiment was to obtain photographic sequences of certain types of cloud fields. There were many opportunities to obtain data for this experiment. The postflight evaluation will provide data on the relative success of this experiment.

RADIATION MONITORING EXPERIMENT

The purpose of the Radiation Monitoring Experiment (RME) was to measure and record ionizing radiation exposure to the crew in the Orbiter cabin and time-tag the exposure with mission elapsed time. Four memory modules of radiation data (approximately 42 hours each tape) were gathered during the mission.

PHOTOGRAPHIC AND TELEVISION ANALYSIS

On launch day, 24 of the planned 25 video tapes were screened and no anomalies were noted. Cloud cover obscured the view of the vehicle on several of the tracking cameras during the roll maneuver; however, this condition did not cause any problem in determining that no anomalies occurred during this phase of the flight. Also, 70 of the expected 73 launch films were reviewed and no significant observations were made. No Castglance film of the SRB recovery was obtained.

After ET separation, the crew obtained 10 pictures of the ET, and thereby provided data for development test objective 312, which was not planned for the STS-39 mission. This unexpected data provided good coverage of the ET, and the results will be collated with the previous flight results.

Five landing video views plus NASA Select were received at JSC for analysis. The vehicle was not seen until approximately 20 seconds before landing. This late acquisition as well as the small size of the vehicle in the field-of-view hindered the analysis. No anomalies were detected during the analysis of the landing video tapes.

The film and video analysis provided some significant findings which are presented in the following paragraphs.

a. Film from nine of the long-range tracking cameras showed dark discolorations and an orange brightening in the SRB plumes. Analysis showed this discoloration to be similar to that seen on previous flights.

b. Two video cameras showed white debris (ice) falling from both umbilical areas at SSME ignition. None of the debris appeared to strike the vehicle.

c. One video camera showed vapors coming from the ET/Orbiter 17-inch flange near the time of lift-off. The STS-39 views were compared with views from four previous launches from the same camera. It was concluded that the vapors had occurred on previous missions, but were more visible on STS-39 because the field of view for the camera had been changed.

DEVELOPMENT TEST OBJECTIVES AND DETAILED SUPPLEMENTARY OBJECTIVES

Nine DTO's were scheduled for this mission. Six of the nine were completed, one DTO was partially completed, and two DTO's were not performed. In addition, the crew performed one DTO that was not scheduled when the ET was documented after separation.

DEVELOPMENT TEST OBJECTIVES

DTO 242 - Entry Aerodynamic Control Surfaces Test (Part 7) - Eight programmed test inputs (PTI's) were planned to fulfill the requirements for this DTO. However, because of interference with the roll reversal maneuvers required for the landing at KSC, the last six PTI's were inhibited. The data are being analyzed by the sponsor.

DTO 301D - Ascent Structural Capability - The data were successfully collected and are being analyzed by the sponsor.

DTO 305D - Ascent Compartment Venting Evaluation - The data were successfully collected and are being analyzed by the sponsor.

DTO 306D - Descent Compartment Venting Evaluation - The data were successfully collected and are being analyzed by the sponsor.

DTO 307D - Entry Structural Capability - The data were collected and are being evaluated by the sponsor.

DTO 308D - Vibration and Acoustic Evaluation - The data were successfully collected and are being analyzed by the sponsor.

DTO 312 - ET TPS Performance (Method 2) - This DTO was not scheduled, but the crew had the photographic gear available and photographed the ET. Ten good photographs were obtained and a preliminary analysis of these photographs has been made by the sponsor. The detailed analysis is continuing.

DTO 517 - Hot Nosewheel Steering Runway Evaluation - this DTO was not performed since it was incompatible with DTO 519.

DTO 519 - Carbon Brake Systems Test (Condition 3) - This DTO was accomplished successfully. The anti-skid system engaged because the shredded tire was slick. No engagement of the anti-skid system was planned for the landing at KSC. The sponsor was satisfied with the results, and this DTO will now be closed as a completed DTO.

DTO 805 - Crosswind Landing Performance - This DTO was not performed due to the lack of sufficient crosswinds.

DETAILED SUPPLEMENTARY OBJECTIVES

Thirteen detailed supplementary objectives (DSO) were assigned to the STS-39 mission. Data were obtained on all DSO's with one DSO not being completed.

DSO 0466 - Variations in Supine and Standing Heart Rate, Blood Pressure and Cardiac Size as a Function of Space Flight Duration and Time Postflight - Data were collected for this experiment and are being analyzed by the sponsor.

DSO 0476 - Inflight Aerobic Exercise - During DSO operations on the treadmill at 124:02:00 G.m.t., the crew member using the treadmill reported hearing a "snap" sound after which the treadmill resistance increased markedly. Attempts to vary the resistance using normal procedures were unsuccessful. The crew was no longer able to perform physical conditioning or complete the treadmill DSO.

DSO 0601 - Changes in Baroreceptor Reflex Function - Data were collected for this DSO and are being analyzed by the sponsor.

DSO 0602 - Blood Pressure Variability During Space Flight - Data were collected for this DSO and are being analyzed by the sponsor.

DSO 0603 - Orthostatic Function During Entry, Landing and Time Postflight - Data were collected for this DSO and are being analyzed by the sponsor.

DSO 0604 - Visual-Vestibular Integration as a Function of Adaptation - Data were collected for this DSO and are being evaluated by the sponsor.

DSO 0605 - Postural Equilibrium Control During Landing/Egress - Data were collected after landing and egress from the Orbiter and are being analyzed by the sponsor.

DSO 0607 - Lower Body Negative Pressure Following Space Flight - Data were collected during postflight testing and are being analyzed by the sponsor.

DSO 0608 - Effects of Space Flight Aerobic and Anaerobic Metabolism at Rest and During Exercise: The Role of Body Composition - Data were collected for this DSO and are being analyzed by the sponsor.

DSO 0613 - Changes in Endocrine Regulation Orthostatic Tolerance Following Space Flight - Data were collected for this DSO and are being analyzed by the sponsor.

DSO 0901 - Documentary Television - A vast amount of documentary television data was collected during flight and are being evaluated by the sponsor.

DSO 0902 - Documentary Motion Picture Photography - Much valuable motion picture photography was taken during the flight, and these films are being evaluated by the sponsor.

DSO 0903 - Documentary Still Photography - Many photographs were taken during the mission and these are being evaluated by the sponsor.

TABLE I.- STS-39 SEQUENCE OF EVENTS

Event	Description	Actual time, G.m.t.
APU activation	APU-1 GG chamber pressure	118:11:28:24.39
	APU-2 GG chamber pressure	118:11:28:27.01
	APU-3 GG chamber pressure	118:11:28:28.77
SRB HPU activation	LH HPU system A start command	118:11:32:46.199
	LH HPU system B start command	118:11:32:46.359
	RH HPU system A start command	118:11:32:46.479
	RH HPU system B start command	118:11:32:46.599
Main propulsion System start	Engine 3 start command accepted	118:11:33:07.468
	Engine 2 start command accepted	118:11:33:07.592
	Engine 1 start command accepted	118:11:33:07.705
SRB ignition command (lift-off)	SRB ignition command to SRB	118:11:33:14.018
Throttle up to 100 percent thrust	Engine 3 command accepted	118:11:33:17.789
	Engine 2 command accepted	118:11:33:17.792
	Engine 1 command accepted	118:11:33:17.785
Throttle down to 94 percent thrust	Engine 3 command accepted	118:11:33:33.469
	Engine 2 command accepted	118:11:33:33.473
	Engine 1 command accepted	118:11:33:33.466
Throttle down to 70 percent thrust	Engine 3 command accepted	118:11:33:39.869
	Engine 2 command accepted	118:11:33:39.873
	Engine 1 command accepted	118:11:33:39.866
Maximum dynamic pressure (q)	Derived ascent dynamic pressure	118:11:34:21
Throttle up to 104 percent thrust	Engine 3 command accepted	118:11:34:11.390
	Engine 2 command accepted	118:11:34:11.394
	Engine 1 command accepted	118:11:34:11.387
Both SRM's chamber pressure at 50 psi	LH SRM chamber pressure mid-range select	118:11:35:13.659
	RH SRM chamber pressure mid-range select	118:11:35:12.899
End SRM action	LH SRM chamber pressure mid-range select	118:11:35:16.019
	RH SRM chamber pressure mid-range select	118:11:35:15.009
SRB separation command	SRB separation command flag	118:11:35:19
SRB physical separation	SRB physical separation	118:11:35:18.739
Throttle down for 3g acceleration	Engine 3 command accepted	118:11:40:45.485
	Engine 2 command accepted	118:11:40:45:446
	Engine 1 command accepted	118:11:40:45.476
3g acceleration	Total load factor	118:11:40:45
MECO	MECO command flag	118:11:41:49
	MECO confirm flag	118:11:41:48
ET separation	ET separation command flag	118:11:42:06

* = loss of signal

TABLE I.- CONTINUED

Event	Description	Actual time, G.m.t.
OMS-1 ignition	Left engine bi-prop valve position	N/A
	Right engine bi-prop valve position	Not performed - direct insertion trajectory flown
OMS-1 cutoff	Left engine bi-prop valve position	N/A
	Right engine bi-prop valve position	Not performed - direct insertion trajectory flown
APU deactivation	APU-1 GG chamber pressure	118:11:46:49.93
	APU-2 GG chamber pressure	118:11:46:50.57
	APU-3 GG chamber pressure	118:11:46:50.59
OMS-2 ignition	Left engine bi-prop valve position	118:12:09:21.5
	Right engine bi-prop valve position	118:12:09:21.5
OMS-2 cutoff	Left engine bi-prop valve position	118:12:11:30.9
	Right engine bi-prop valve position	118:12:11:30.9
Payload bay door open	PBD right open 1	118:13:00:04
	PBD left open 1	118:13:00:04
OMS-3 ignition	Left engine bi-prop valve position	N/A
	Right engine bi-prop valve position	121:21:29:59.4
OMS-3 cutoff	Left engine bi-prop valve position	N/A
	Right engine bi-prop valve position	121:21:30:19.4
OMS-4 ignition	Left engine bi-prop valve position	121:21:34:59.4
	Right engine bi-prop valve position	N/A
OMS-4 cutoff	Left engine bi-prop valve position	121:21:35:20.4
	Right engine bi-prop valve position	N/A
OMS-5 ignition	Left engine bi-prop valve position	N/A
	Right engine bi-prop valve position	121:22:38:00.4
OMS-5 cutoff	Left engine bi-prop valve position	N/A
	Right engine bi-prop valve position	121:22:38 20.2

TABLE I.- CONTINUED

Event	Description	Actual time, G.m.t.
OMS-6 ignition	Left engine bi-prop valve position	121:22:42:59.4
	Right engine bi-prop valve position	N/A
OMS-6 cutoff	Left engine bi-prop valve position	121:22:43:18.0
	Right engine bi-prop valve position	N/A
OMS-7 ignition	Left engine bi-prop valve position	N/A
	Right engine bi-prop valve position	121:22:04:00.4
OMS-7 cutoff	Left engine bi-prop valve position	N/A
	Right engine bi-prop valve position	121:22:04:20.4
OMS-8 ignition	Left engine bi-prop valve position	121:22:09:00.4
	Right engine bi-prop valve position	N/A
OMS-8 cutoff	Left engine bi-prop valve position	121:22:09:18.7
	Right engine bi-prop valve position	N/A
OMS-9 ignition	Left engine bi-prop valve position	N/A
	Right engine bi-prop valve position	122:07:55:00.5
OMS-9 cutoff	Left engine bi-prop valve position	N/A
	Right engine bi-prop valve position	122:07:55:20.0
OMS-10 ignition	Left engine bi-prop valve position	122:08:00:00.5
	Right engine bi-prop valve position	N/A
OMS-10 cutoff	Left engine bi-prop valve position	122:08:00:19.0
	Right engine bi-prop valve position	N/A
OMS-11 ignition	Left engine bi-prop valve position	N/A
	Right engine bi-prop valve position	122:08:29:00.4

TABLE I.- CONTINUED

Event	Description	Actual time, G.m.t.
OMS-11 cutoff	Left engine bi-prop valve position	N/A
	Right engine bi-prop valve position	122:08:29:20.1
OMS-12 ignition	Left engine bi-prop valve position	122:08:34:00.4
	Right engine bi-prop valve position	N/A
OMS-12 cutoff	Left engine bi-prop valve position	122:08:34:18.5
	Right engine bi-prop valve position	N/A
OMS-13 ignition	Left engine bi-prop valve position	N/A
	Right engine bi-prop valve position	123:10:38:49.5
OMS-13 cutoff	Left engine bi-prop valve position	N/A
	Right engine bi-prop valve position	123:10:38:59.8
OMS-14 ignition	Left engine bi-prop valve position	123:11:27:34.4
	Right engine bi-prop valve position	N/A
OMS-14 cutoff	Left engine bi-prop valve position	123:11:27:44.8
	Right engine bi-prop valve position	N/A
OMS-15 ignition	Left engine bi-prop valve position	N/A
	Right engine bi-prop valve position	123:23:13:14.5
OMS-15 cutoff	Left engine bi-prop valve position	N/A
	Right engine bi-prop valve position	123:23:13:21.4
OMS-16 ignition	Left engine bi-prop valve position	123:23:58:06.2
	Right engine bi-prop valve position	N/A
OMS-16 cutoff	Left engine bi-prop valve position	123:23:58:12.9
	Right engine bi-prop valve position	N/A

TABLE I.- CONTINUED

Event	Description	Actual time, G.m.t.
Payload bay door close	PBD right close 1	126:16:08:27
	PBD left close 1	126:16:08:28
Flight control system checkout		
APU start	APU-3 GG chamber pressure	125:16:25:18.89
APU stop	APU-3 GG chamber pressure	125:16:30:27.42
APU activation for entry	APU-1 GG chamber pressure	126:17:48:31.49
	APU-2 GG chamber pressure	126:18:10:34.82
	APU-3 GG chamber pressure	126:18:10:36.55
Deorbit maneuver ignition	Left engine bi-prop valve position	126:17:53:34.0
	Right engine bi-prop valve position	126:17:53:34.0
Deorbit maneuver cutoff	Left engine bi-prop valve position	126:17:55:57 0
	Right engine bi-prop valve position	126:17:55:57.0
Entry interface (400k)	Current orbital altitude above reference ellipsoid	126:18:23:27
Blackout ends	Data locked at high sample rate	
Terminal area energy management	Major mode change (305)	126:18:49:07
Main landing gear contact	LH MLG tire pressure	126:18:55:35
	RH MLG tire pressure	126:18:55:36
Main landing gear weight on wheels	LH MLG weight on wheels	126:18:55:37.9
	RH MLG weight on wheels	126:18:55:37.0
Nose landing gear contact	NLG tire pressure	126:18:55:49
Nose landing gear weight on wheels	NLG WT on Wheels -1	126:18:55:50
Wheels stop	Velocity with respect to runway	126:18:56:31
APU deactivation	APU-1 GG chamber pressure	126:19:17:59.70
	APU-2 GG chamber pressure	126:19:18:00.60
	APU-3 GG chamber pressure	126:19:18:01.16

TABLE II.- STS-39 PROBLEM TRACKING LIST

Number	Title	Reference	Comments
STS-39-V-01	Flash Evaporator System Feedline A System 2 Heater Failed	118:06:00 G.m.t. Prelaunch IM39RF01 IPR 48V-0002	During prelaunch operations, flash evaporator system feedwater A line heater 2 failed, most likely because of a short, which caused the fuse to open. Heater 1 was activated for the remainder of the mission. Verified zero volts at ALCA 2, further troubleshooting in work.
STS-39-V-02	APU 2 Fuel Pump/GGVM Coolant System A Valve Did Not Operate	118:11:50 G.m.t. IM 39RF022 IPR-48V-0009	After APU shutdown, no cooling was noted on APU 2 Fuel Pump/GGVM while on System A. System B was successfully activated to cool the fuel pump/GGVM. Valve was flying under time/life exception EV2123R1. All valves flying under exception to be removed and replaced.
STS-39-V-03	Thruster F5R Fuel Injector Temperature Low	118:15:14 G.m.t. IM 39RF03	Thruster F5R fuel injector temperature was 30 to 40 °F lower than the oxidizer injector temperature. A GMEM was ready for uplink that would lower the RM limit down to 90 °F, if necessary. This condition has been seen on previous flights. The thruster will be flown as is.
STS-39-V-04	OPS 2 Recorder Uncommanded Reconfiguration Before Launch	118:10:36 G.m.t. Prelaunch IM39RF04 IPR 48V-0004 FIAR BFCE 029 F035	OPS 2 recorder was found to be recording just after the BFS OPS 1 transition. Recorder was commanded off, then used nominally through ascent. Second recurrence at 125:14:21:18 G.m.t. while in PASS and GPC-4. The recorder changed speed, stopped, started and jumped tracks and went to serial. Bite status read not performed. PF2 MDM to be removed and replaced.
STS-39-V-05	MADS FDM Bites	118:12:08 G.m.t. IM39RF05 IPR 48V-0012	The MADS FDM 2 MUX 1 and 2 BITE indications were annunciated when MADS was powered up to capture the OMS-2 data. The BITE indications indicate that the data may be lost. BITES showed good at 124:06:55 G.m.t. MADS dump completed and OMS-2 data on MUX 2 were lost. Remove and replace FDM 2.
STS-39-V-06	Rendezvous Radar Loss of Lock	121:20:46 G.m.t. IM39RF06	Radar lost lock a number of times in all modes of operation except manual, which was not tried.
STS-39-V-07	CCTV Intermittent Telemetry Freeze and Video Loss (GFE)	A. 121:12:30 G.m.t. B. 123:02:46 G.m.t. C. 124:00:46 G.m.t.	A. Crew attempted to reset pan/tilt angles on camera A with no joy. Cleared with several power cycles of CCTV Controller Unit power. B. S76 Communications message annunciated and all camera telemetry frozen. Restored with VCU power cycle. No image from end effector camera noted by crew. Restored with power cycle of VCU. Chit J3574 spells out troubleshooting plan.
STS-39-V-08	Supply Water Dump Nozzle Temperature Drop	123:07:50 G.m.t. IM39RF07 IPR 48V-0011	During supply water dump 5, temperature of nozzle dropped rapidly decreasing by as much as 30 degrees and then recovered to the normal temperatures. Three subsequent recurrences. One occurred after heater start, before water flow. Could not reproduce problem at KSC. Proceeding with wire wiggle tests.
STS-39-V-09	GFE: Treadmill Exhibited Excessive Resistance	124:01:39 G.m.t. FIAR BFCE 213 F007	While using the treadmill, the Pilot reported an audible snap and the treadmill resistance increased to almost infinite.
STS-39-V-10	Left-Hand Body Flap Auto/Man PBI Contact 3 Hard to Make (S9 Panel F2)	125:16:38 G.m.t. IM39RF08 IPR 48V-0010	During FCS checkout, the Commander reported that contact 3 would only make when firmly depressed. Data review verifies contact 3 not made and/or lagging. Confirmed switch problem on ground. Remove and replace switch.

TABLE II.- STS-39 PROBLEM TRACKING LIST

Number	Title	Reference	Comments
STS-39-V-11	APU 2 Lubrication Oil Outlet Pressure Low	126:18:11 G.m.t. IM39RF09 IPR 48V-00707	APU 2 lubrication oil outlet pressure was lower than normal during entry. Ran as low as 25 psia. No visual indication of leak. Ullage test and catch bottle inspection in work.
STS-39-V-12	Right Outboard Main Tire Excessive Wear	Landing IM39RF10	Right outboard tire appeared to have shredded three plies during landing. No KSC action other than normal processing. Outboard tire expedited to vendor.
STS-39-V-13	Loss of S-Band Downlink and Uplink on Entry.	126:18:29 G.m.t. IM39RF11	Lost S-Band two-way communications for 12 minutes 40 seconds during entry. No KSC action required other than normal processing.
STS-39-V-14	Pilot's Rotational Hand Controller Traveled to Full Aft Position and Adjust Knob Could Not be Moved.	Entry IM39RF13	Pilot reported that when he was done flying his portion of the HAC and Commander took control, the Pilots rotational hand controller rotated to the full aft position. The Pilot tried to readjust the rotational hand controller, but the adjust know could not be moved. KSC found knob to be full open and movable.

TABLE III.- RCS TRANSLATION MANEUVER SUMMARY

Maneuver no.	Designation	Time, G.m.t.	Axis	Thrusters
1	Separation burn	121:08:24	+Z	F3U, L1U, R1U
2	MC1 FF	121:08:54	-X	F1F, F3F
3	MC2 FF	121:09:34	+X	L3A, R3A
4	NFF	121:09:54	M/A[1]	F3U, F1F, F2F, L1U, R1U
5	TFF1	121:11:19	M/A	F4R, R3R, R1U, L1U, F3U, L3D, R3D
6	No designation	121:12:19	+Z	L1U, R1U, F3U
7	NC1	121:16:34	M/A	L3D, L1U, L3A, R3D, R3A, R1U
8	NC2	121:18:53	M/A	L3A, R3A, L1L, L1U, L3D, R1U, R3D
9	TFF1	121:20:23	+Z	L1U, R1U, F3U
10	MCFF1	121:21:05	+X	R3A, L3A
11	MCP1	121:21:47	M/A	L1U, R1U, F3U, F3D, F4D
12	VNP1	121:21:57	M/A	L3A, R3A, R1U, L1U, F3U
13	MCP	121:22:21	M/A	
14	VNP	121:22:31	M/A	L3A, R3A, L1U, R1U, F3U
15	RCSP	121:22:38	M/A	
16	NRCS	121:22:39	M/A	
17	NCSK3	122:02:02	+X	L3A, R3A
18	NCCNF	122:05:32	+X	L3A, R3A
19	TNF	122:06:28	M/A	L3A, R3A, L1U, R1U, R3D, L3D
20	MC1 NF	122:06:53	M/A	L3A, R3A, R3R, F4R
21	PN1	122:07:04	M/A	L3D, R3D, L1U, R1U, R3R, L1L
22	MC2 NF	122:07:18	+X	L3A, R3A
23	MC3 NF	122:07:33	M/A	F1U, R3D, F3L, L1L, F3U, L1U, R1U
24	NNF	122:07:48	M/A	L3A, L1L, L1U, L3D, F1F, F2F, F3L, R3A, R3D, R2D
25	MCP4	122:08:12	M/A	R1U plus verniers
26	VNP4	122:08:22	M/A	L3A, R3A, R3R, R1U, F4R, F3U, L3L
27	MCP5	122:08:46		Loss of signal - no data
28	NSR5	122:08:56	M/A	L3A, R3A, L1U, R1U, F4R, R2D, R3D
29		122:13:43	+X	L3A, R3A
30	NOPC	122:15:20		
31	NCC	122:19:37	+X	L3A, R3A
32	TI	122:20:33	M/A	L3A, R3A, L1U, R1U, F3U
33	PN2	122:21:06	M/A	L1L, F3L, F4R, plus verniers
34	MC2	122:21:XX		Loss of signal - no data
35	MC3	122:21:30	M/A	L3A, R3A, R1U, L1U, F3U
36	MC4	122:21:40	+X	L3A, R3A
37	Manual phase	122:21:44	M/A	L3A, R3A, R1U, L1U, F3U, F1F, F2F
38	8-second burn	125:15:53	+Z	L1U, R1U, F3U
39	RCS hot fire	125:17:15-20		Each thruster one time
40	5-second burn	125:22:26:46	+X	L3A, R3A
41	RCS burn	126:08:55	+X	L3A, R3A

Note:
[1]M/A = Multiple axes