NSTS-37406

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STS-75 SPACE SHUTTLE MISSION REPORT

April 1996

National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas

NOTE

The STS-75 Space Shuttle Mission Report was prepared from inputs received from the Space Shuttle Vehicle Engineering Office as well as other organizations. The following personnel may be contacted should questions arise concerning the technical content of this document.

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STS-75

SPACE SHUTTLE

MISSION REPORT

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May 1996

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INTRODUCTION

The STS-75 Space Shuttle Program Mission Report summarizes the Payload activities as well as the Orbiter, External Tank (ET), Solid Rocket Booster (SRB), Reusable Solid Rocket Motor (RSRM), and the Space Shuttle main engine (SSME) systems performance during the seventy-fifth flight of the Space Shuttle Program, the fiftieth flight since the return-to-flight, and the nineteenth flight of the Orbiter Columbia (OV-102). In addition to the Orbiter, the flight vehicle consisted of an ET that was designated ET-76; three SSMEs that were designated as serial numbers 2029, 2034, and 2017 in positions 1, 2, and 3, respectively; and two SRBs that were designated BI-078. The RSRMs, designated RSRM-53, were installed in each SRB and the individual RSRMs were designated as 360W53A for the left SRB, and 360W053B for the right SRB.

The STS-75 Space Shuttle Program Mission Report fulfills the Space Shuttle Program requirement as documented in NSTS 07700, Volume VII, Appendix E. The requirement stated in that document is that each organizational element supporting the Program will report the results of their hardware (and software) evaluation and mission performance plus identify all related in-flight anomalies.

The primary objectives of this flight were to perform the operations necessary to fulfill the requirements of the Tethered Satellite System-1R (TSS-1R), and the United States Microgravity Payload-3 (USMP-3). The secondary objectives were to complete the operations of the Orbital Acceleration Research Experiment (OARE), and to meet the requirements of the Middeck Glovebox (MGBX) facility and the Commercial Protein Crystal Growth (CPCG) experiment.

The STS-75 mission was planned as a 14-day flight plus 2 days for TSS-1R contingency operations, if required, plus 2 contingency days, which were available for weather avoidance or Orbiter contingency operations. The sequence of events for the STS-75 mission is shown in Table I, and the Space Shuttle Vehicle Engineering In-Flight Anomaly (IFA) list is shown in Table II. The Government Furnished Equipment/Flight Crew Equipment (GFE/FCE) IFA list is shown in Table III. Appendix A lists the sources of data, both formal and informal, that were used to prepare this report. Appendix B provides the definition of acronyms and abbreviations used throughout the report. All times during the flight are given in Greenwich mean time (G.m.t.) and mission elapsed time (MET).

The seven-person crew for STS-75 consisted of Andrew M. Allen, Lt. Col., U. S. Marine Corp, Commander; Scott J. "Doc" Horowitz, Ph. D., Lt. Col., U. S. Air Force, Pilot; Jeffrey A, Hoffman, Civilian, Ph. D., Mission Specialist 1; Maurizio Cheli, Lt. Col. Italian Air Force, Mission Specialist 2; Claude Nicollier, Captain, Swiss Air Force, Mission Specialist 3; Franklin R. Chang-Diaz, Civilian Ph.D., Payload Commander, Mission Specialist 4; and Umberto Guidoni, Civilian, Ph.D., Payload Specialist. STS-75 was the third space flight for the Commander; the fifth space flight for Mission Specialist 1 and Mission Specialist 4, the third space flight for Mission Specialist 3, and the first space flight for the Pilot, Mission Specialist 2, and Payload Specialist. Each crewmember is credited with 367 hours 40 minutes and 21 seconds of space flight for this mission.

MISSION SUMMARY

The STS-75 mission was launched at 053:20:18:00.004 G.m.t. (February 22, 1996) following a countdown that had no unplanned holds. The ascent phase was completed without significant problems, and the Orbiter was satisfactorily inserted into the planned orbit.

Two Orbiter problems occurred during ascent and caused concern; however, these problems had no effect on the ascent phase. These two problems are discussed in the following two paragraphs.

Approximately six seconds after liftoff, the crew reported that the left main engine chamber pressure (Pc) tape meter was reading incorrectly. The meter was indicating approximately 40-percent thrust instead of 104-percent thrust prior to throttle down (Flight Problem STS-75-V-01). After ascent, the crew stated that the meter tracked the other Pc meters throughout ascent, but had a bias of approximately 60 percent. The meter went to zero during the throttle-down for the throttle bucket, and then returned to 40 percent at throttle-up after the period of maximum dynamic pressure. Downlink showed no discrepant engine parameters, and the engine correctly responded to all throttle commands throughout ascent.

Also at six seconds after liftoff, all four primary avionics software system (PASS) general purpose computers (GPCs) annunciated a left main engine command path failure message, which was accompanied by an illuminated left engine status light on the control panel. Downlink telemetry indicated that commands had been properly executed by the main engine controller. A flight software user note (DR 37594) documents a condition in which the acknowledgment to a GPC command may be missed, causing the command path message. This condition was unrelated to the Pc meter anomaly.

An evaluation of the vehicle acceleration and preflight propulsion prediction data showed that the SRB, RSRM and SSME performance during ascent was satisfactory. The average flight-derived engine specific impulse (Isp) for the period between SRB separation and the start of 3g throttling was 452.23 seconds as compared to the main propulsion system (MPS) tag value of 452.67 seconds.

The RSRMs performed satisfactorily. The postflight inspection showed that all J-joints (igniter and field) performed as designed. All components (case, seals and insulation) performed as expected throughout the flight. Gas paths were observed through the polysulfide on both nozzle-to-case joints (Flight Problem STS-75-M-01). The polysulfide in the gas paths was soft and heat affected. The left and right wiper O-rings had heat effects and erosion at the gas path locations. The left wiper O-ring had 0.016-inch depth erosion (worst case for this flight, but within the flight history). There was no evidence of blow-by past the O-ring in either nozzle, and no evidence of communication between the dual gas paths.

At 053:20:57:52.3 G.m.t. (00:00:39:52.3 MET), the orbital maneuvering subsystem (OMS) 2 maneuver was performed to circularize the orbit at approximately 160 nmi. The firing was 144.2 seconds in duration, and the differential velocity (ΔV) was 221.9 ft/sec. OMS operation was nominal throughout the firing.

The auxiliary power unit (APU) 1 fuel-pump inlet-pressure decreased below the expected minimum of 150 psia to approximately 38 psia (Flight Problem STS-75-V-02). This condition was caused by a slight leak past the fuel pump seal and into the seal cavity drain system. The pressure remained steady until the fuel isolation valve was opened when APU 1 was used to support flight control system (FCS) checkout. During FCS checkout and entry, APU 1 performance was nominal. However, the fuel pump seal leak recurred following each run. This condition did not cause a mission impact.

Data review confirmed that the closed indication for the LH_2 engine 2 recirculation valve (PV15) was not received when the valve was commanded closed at T-9.5 seconds. Using engine inlet and LH_2 manifold pressures, the valve was verified to be closed after main engine cutoff (MECO) (Flight Problem STS-75-V-03). The LH_2 recirculation valve is only critical in the event of an engine-out situation when trapped LH_2 in the feed system must be contained. The condition did not affect the mission.

While H_2 tanks 4 and 5 were supplying reactant to the fuel cells, the quantities of H_2 tanks 4 and 5 diverged from each other, eventually resulting in as much as a 20-percent quantity difference. The cause of the difference was determined to be a failure of the tank 4 A heater (Flight Problem STS-75-V-04). The failure occurred between 055:10:12 G.m.t. (01:13:54 MET) and 055:10:27 G.m.t. (01:14:09 MET), based on correlation between heater ON/OFF discretes and the fuel cell 2 (B heaters) and fuel cell 3 (A heaters) currents. In OV-102, the H_2 tanks 4 and 5 heaters share a heater controller, and as a result the tank heaters were cycling on and off simultaneously.

Activation of the TSS-1R systems began shortly after 053:20:18 G.m.t. (00:02:00 MET). During the data acquisition and control assembly (DACA) power-up at approximately 053:23:48 G.m.t. (00:03:30 MET), the tether length initialized at 23 meters instead of zero. Evaluation of the encoder-generated telemetry during and after boom extension indicated proper functioning, and this allowed a deployment using nominal procedures. During the initial activation of the data display control system (DDCS), performance indicators showed significantly low performance. Good performance was recovered when the data cable was replaced. Beginning early in the mission, the smart flex multiplexer/demultiplexer (SFMDM) experienced numerous core swaps and warm-starts. These core swaps and warm starts cause an interruption in payload telemetry while recovery procedures were implemented. The uncertainty of satisfactory performance of the SFMDM was a major factor in the decision to delay the planned deployment for 24 hours.

Deployment (fly-away) occurred at 056:20:45 G.m.t. (03:00:27 MET) after a successful umbilical separation, deployment-boom extension, and initiation of satellite internal power. All mechanisms functioned as planned and very little dynamics were seen as the tether was deployed to a length of 19695.2 meters. At 057:01:29:35 G.m.t. (03:05:11:35 MET), without warning, the tether broke inside the deployment boom, and the TSS separated rapidly from the Orbiter with a ΔV of approximately 80 ft/sec. The experiments onboard the satellite as well as the TSS GN_2 system were safed shortly after separation. Following the tether break, the remaining tether was rewound and the deployment boom was retracted, stowed, and latched at approximately 057:18:58 G.m.t. (03:22:40 MET). The planned post-retrieval science operations of the instruments in the payload bay began immediately after the boom was stowed and continued through approximately 062:10:48 G.m.t. (08:14:30 MET). In the crew cabin, the Tether Optical Phenomenon (TOP) operations continued through flight day 14. Consideration was given to a rendezvous and possible retrieval of the free-flying satellite; however, insufficient propellant quantities were projected, and no plans were implemented.

Although all science objectives were not fully met, all science instruments were operating and gathering data during the 5-hour period prior to the tether break. Valuable data were also obtained after the tether break by implementing a new free-flying satellite science mission that was replanned after the tether break. Initial data analysis indicates that significant contributions were made toward meeting the primary mission objectives.

In support of the United States Microgravity Payload-3 (USMP-3), a total of 10 primary reaction control subsystem (RCS) maneuvers were satisfactorily performed during the course of the mission.

A flash evaporator system (FES) water dump was initiated at 062:08:04 G.m.t. (08:11:46 MET) (Flight Problem STS-75-V-05). Upon initiation, the FES shut down without reaching the control band. The FES was successfully restarted on the primary A controller. However, approximately one and a half hours later, at 062:09:40 G.m.t. (08:13:22 MET), the FES shut down again. At 062:09:52 G.m.t. (08:13:34 MET), the FES was configured to the primary B controller, and a FES startup was initiated with no response. A second attempt at starting the FES on the primary B controller was performed five minutes later, and the FES responded initially but shut down before stabilized cooling was established. Icing was the cause of the shutdowns. The FES core-flush procedure was successfully performed to remove ice from the FES topper core.

It was initially believed that the FES icing was caused by the shutdown experienced at the start of the FES dump. This shutdown was caused by a thermal transient seen at the FES during start-up. To troubleshoot the FES freeze-up, a second supply water dump through the FES using the primary A controller was initiated at 065:09:13 G.m.t. (011:11:02 MET). The dump was terminated at 065:09:13 G.m.t. (011:12:55 MET) when the FES core once again froze up. To eliminate the ice that was formed, the FES core-flush was performed at 065:12:56 G.m.t. (011:16:38 MET). The supply water dump using the FES primary B system was started at 065:18:44 G.m.t. (011:22:26 MET) and ended at 065:21:46 G.m.t. (012:01:28 MET). The data indicate that the performance of the primary B system was nominal.

The FES was switched to the primary A controller at 066:17:44 G.m.t. (012:21:26 MET) in an effort to validate the primary A controller operation in the supplemental cooling mode. This mode had been used without incident prior to the freeze-up on the A system. FES operation was nominal. The FES was configured back to the primary B controller at 067:16:42 G.m.t. (013:20:24 MET). The FES operated satisfactorily until the radiator coldsoak was initiated for entry on the first landing-opportunity day. During the coldsoak, the FES shut down on the primary B controller. The core-flush procedure was performed, and the ice was removed. Operations on the FES were reinitiated, and the FES operated properly throughout entry and landing.

Data review indicated that the inertial measurement unit (IMU) 3 y-axis gyro was drifting at a higher-than-expected rate (Flight Problem STS-75-V-06). Four uplink compensations were made to this IMU, and the observed drift rate did not stabilize. The excessive drift signature is similar to that of an IMU gyro experiencing a lubrication problem and the internal heat of the IMU causes a further breakdown of the lubricating properties. As a result, the IMU was powered down at 064:00:12 G.m.t. (010:03:54 MET) and this removed the power from the internal heaters. The reduction of the lubricant temperature was expected to preserve acceptable performance of the gyro to support the end-of-mission requirements. By powering down the IMU, it was anticipated that the gyro drift would resume at approximately the pre-shutdown value when it was subsequently powered up for entry.

A two-engine OMS maneuver was performed at 067:10:21 G.m.t. (03:14:03 MET). The maneuver was 30 seconds in duration and imparted a ΔV of 49.5 ft/sec to the vehicle.

The FCS checkout was performed. During the checkout, a failure was noted in the flight control channel 1 aerosurface tests (Flight Problem STS-75-V-07). Port moding of flight critical aft (FA) 1 multiplexer/demultiplexer (MDM), and power cycles of FA1 MDM and aerosurface servo-amplifier (ASA) 1 did not recover the channel. The aerosurfaces responded nominally to commands in the other three channels. In-flight troubleshooting isolated the problem to a failure in the analog output differential (AOD) card 0 of MDM FA1. An additional power cycle of FA1 was unsuccessful in recovering the failed card.

In support of the FCS checkout, APU 1 was started at 067:11:20:45 G.m.t. (013:15:02:45 MET), and the APU ran for approximately 25 minutes and 25 seconds during which time 53 lb of fuel were used. The long run-time resulted from the troubleshooting that was being performed on the flight control channel 1 failure. APU performance was nominal. Hydraulic cooling was required, and cooling was initiated at 067:11:28:54 G.m.t. (013:15:10:45 MET) at a nominal lubrication oil return temperature of 247 °F.

The RCS hot-fire test was initiated at 067:12:55 G.m.t. (013:16:37 MET). The firing sequence was performed twice, and all thruster data were nominal.

At 068:00:48 G.m.t. (014:04:30 MET), IMU 3 was powered on and commanded to standby as part of the recovery of the IMU for entry. After the IMU reached thermal equilibrium, it was commanded to the operate mode at 068:01:48 G.m.t. (014:05:30 MET). IMUs 2 and 3 were aligned with IMU 1 at 068:01:57 G.m.t. (014:05:39 MET). The IMU recovery was satisfactory and IMU 3 operated nominally with no built in test equipment (BITE) messages.

Forward link communications to the vehicle were lost at Tracking and Data Relay Satellite-West (TDRS-W) when the S-band system was placed back in the TDRS mode at 068:07:59 G.m.t. (014:11:41 MET) (Flight Problem STS-75-V-08). Communications were re-established at 068:08:49 G.m.t. (014:12:31 MET) via ultrahigh frequency (UHF) radio. The S-band system was reconfigured from string 2 to string 1 and S-band communications were also re-established. During subsequent troubleshooting of the forward link problem, string 2 performed nominally.

The USMP-3 systems were activated shortly after 053:20:18 G.m.t. (00:02:00 MET). The carrier systems and experiment instruments operated well throughout the mission with no anomalies. A total of 2340 commands were sent to the USMP-3 experiment equipment.

The Space Acceleration Measurement System (SAMS) and the OARE operated well throughout the flight. The SAMS and OARE personnel, working as a team, provided critical acceleration data to the USMP-3 microgravity experiments.

The MGBX payload operated satisfactorily without any significant anomalies throughout the mission operations. Benefiting from the extension day, the MGBX completed 129 percent of the preflight-planned science. In addition, the crew performed activities which enabled ground personnel to complete an unscheduled facility checkout and evaluation. Data from this operation has proven valuable in understanding the distinguishing characteristics of MGBX components in the operating environment of microgravity.

The Commercial Protein Crystal Growth (CPCG) Block IV payload experiment was activated at 054:01:43 G.m.t. (00:05:25 MET) and deactivated at 068:09:21 G.m.t. (014:13:03 MET). The Block IV hardware, which was designed, built, tested and flown in approximately 12 months, operated nominally throughout the mission.

All entry stowage and deorbit preparations were completed in anticipation of entry and landing. The payload bay doors were successfully closed and latched at 068:12:04.4 G.m.t. (014:15:46:04 MET). The first-day landing opportunities were waved off because of forecasted cloud coverage at Kennedy Space Center (KSC), and landing was replanned for KSC on the first contingency-landing day. The payload bay doors were reopened at 068:15:06:47 G.m.t. (014:18:48:47 MET). IMU 3 was again taken to off to preserve its operating time.

IMU 3 was powered up prior to the landing on the first contingency day, and performance was satisfactory for the remainder of the mission. The payload bay doors were closed for the second time at 069:08:44:16 G.m.t. (015:12:26:16 MET) in preparation for the landing. The first landing opportunity at KSC on the first contingency day was waved off because of cloud coverage. The deorbit maneuver for the second landing opportunity at the KSC Shuttle Landing Facility (SLF) was performed on orbit 251 at 069:12:55:43 G.m.t. (015:16:37:43 MET), and the maneuver was 214 seconds in duration with a ΔV of 359.8 ft/sec.

Entry was completed satisfactorily, and main landing gear touchdown occurred on SLF concrete runway 33 at 069:13:58:21 G.m.t. (015:17:40:21 MET) on March 9, 1996. The Orbiter drag chute was deployed at 069:13:58:28 G.m.t., and the nose gear touchdown occurred 8 seconds later. The drag chute was jettisoned at 069:13:58:52 G.m.t. with wheels stop occurring at 069:13:59:26 G.m.t. The rollout was normal in all respects. The flight duration was 15 days 17 hours 40 minutes and 21 seconds. The APUs were shut down 17 minutes 47 seconds after landing.

During the final approach to the runway, the microwave scanning-beam landing system (MSBLS) 2 failed to lock on in range (Flight Problem STS-75-V-09). Azimuth and elevation data for this unit were nominal, as was performance of all parameters on MSBLS units 1 and 3.

During the post-landing walk-around video, it was noted that the blade valve mechanism at the left-hand aft structural-attach point did not completely close (Flight Problem STS-75-V-10).

PAYLOADS

The STS-75 mission began as planned on February 22, 1996 with the launch from Kennedy Space Center at 053:20:18:00.004 G.m.t. Ascent performance was nominal and the Orbiter was inserted into a 161 by 160 nautical mile orbit. Cryogenic consumables remained at the levels required to maintain the planned 14+2+2 day duration capability. Prior to the planned Tethered Satellite System-1R (TSS-1R) deployment, an extension day was approved to allow for a 24-hour delay in deployment of the TSS. However, TSS operations ended in accordance with the preflight timeline and negated the need for the extension day. Later in the flight, an extension day was approved for the United States Microgravity Payload-3 (USMP-3), resulting in the planned landing on March 8, 1996; however, an additional day was added because of weather conditions at KSC. The landing was completed on March 9, 1996 at 7:59 a.m. c.s.t.

TETHERED SATELLITE SYSTEM-1R

Operations Summary

Activation of the TSS-1R systems began shortly after 053:20:18 G.m.t. (00:02:00 MET). During the data acquisition and control assembly (DACA) power-up at approximately 053:23:48 G.m.t. (00:03:30 MET), the tether length initialized at 23 meters instead of zero. Evaluation of the encoder-generated telemetry during and after boom extension indicated proper functioning, and this allowed a deployment using nominal procedures. During the initial activation of the data display control system (DDCS), performance indicators showed significantly low performance. Good performance was recovered when the data cable was replaced. Beginning early in the mission, the smart flex multiplexer/demultiplexer (SFMDM) experienced numerous core swaps and warm-starts. These core swaps and warm starts caused an interruption in payload telemetry while recovery procedures were implemented. The uncertainty of satisfactory performance of the SFMDM was a major factor in the decision to delay the planned deployment for 24 hours.

Deployment (fly-away) occurred at 056:20:45 G.m.t. (03:00:27 MET) after a successful umbilical separation, deployment-boom extension, and initiation of satellite internal power. All mechanisms functioned as planned and very little dynamics were seen as the tether was deployed to a length of 19695.2 meters. At 057:01:29:35 G.m.t. (03:05:11:35 MET), without warning, the tether broke inside the deployment boom, and the TSS separated rapidly from the Orbiter with a ΔV of approximately 80 ft/sec. The experiments onboard the satellite as well as the TSS GN_2 system were safed shortly after separation. Following the tether break, the remaining tether was rewound and the deployment boom was retracted, stowed, and latched at approximately 057:18:58 G.m.t. (03:22:40 MET). The planned post-retrieval science operations of the instruments in the payload bay began immediately after the boom was stowed and continued through approximately 062:10:48 G.m.t. (08:14:30 MET). In the crew cabin, the Tether Optical Phenomenon (TOP) operations continued through flight day 14. Consideration was given to a rendezvous and possible retrieval of the free-flying satellite; however, insufficient propellant quantities were projected and no plans were implemented.

A plan was developed to send commands to the TSS from an antenna located at the Electronics Signal Test Laboratory (ESTL) at Johnson Space Center (JSC). The first TSS pass with command capability occurred at approximately 058:16:08 G.m.t. (04:19:50 MET). At that time, the satellite was recovered from the safed/low-power mode, which had been commanded immediately after tether separation. Science was repowered and began collecting data, which was sent to the ground through various ground sites. Telemetry from the satellite sensors indicated that the tether and satellite system had stabilized with a relatively straight tether oriented along the Z-axis below the satellite with the satellite spinning at approximately 0.6 revolutions per minute (r/min) in yaw. Part of the initial satellite reconfiguration included troubleshooting the GN_2 valve positions and performing several attempts to reinitialize the data handling (DH) microprocessor, none of which were successful. In spite of the verified completion of safing steps which close all valves after tether separation, the main isolation and in-line valves were found in the open state and the GN_2 depleted. Additionally, the skew gyro, which was powered according to the last available telemetry after the tether separation, was found in the unpowered state and this was corrected via ground command. It is suspected that some sort of electrical anomaly affected the telemetry, tracking and command (TT&C) decoder and DH microprocessor, causing the DH microprocessor to hang and the latching valves to enable commanding via the decoder.

TSS telemetry was transmitted and/or recorded via nine ground stations over the almost four and one-half day free flight. Overall, approximately 200 commands were sent to the satellite during the free flight to configure systems and collect science from the Tether Magnetometer (TEMAG), the Research on Orbital Plasma Electrodynamics (ROPE), the Research on Electrodynamic Tether Effects (RETE), the Satellite Linear Acceleration (SLA), and the Satellite Ammeter (SA). The satellite was placed in the low-power mode from 059:22:00 G.m.t. (06:01:42 MET) to 060:15:58 G.m.t. (06:19:40 MET) to allow the satellite to survive until the close approach with the Orbiter at 061:05:10 G.m.t. (07:08:52 MET). The satellite was reactivated at 060:15:58 G.m.t. (06:19:40 MET) for a final day of science collection before the batteries were exhausted.

The final commanding of the satellite was conducted while the Orbiter and TSS were in close proximity. During the 50 minutes of payload interrogator (PI) coverage, commands were sent via the Orbiter to collect additional payload bay/satellite interactive science. During the pass, the crew observed the satellite/tether and confirmed that the tether orientation was aligned below the satellite as the telemetry had indicated. The last and very weak carrier signal, without telemetry, was detected by the Bermuda ground station at 061:11:44 G.m.t. (07:15:26 MET). Overall, during the TSS operations, approximately 6,500 commands were sent to the payload, including those sent to the free-flying satellite.

Science Summary

Although all science objectives were not fully met, all science instruments were operating and gathering data during the 5-hour period prior to the tether break. Valuable data were also obtained after the tether break by implementing a new free-flying satellite science mission that was replanned after the tether break. Initial data analysis indicates that significant contributions were made toward meeting the primary mission objectives and these are summarized in the following paragraphs.

Data reflects that the current collected by the satellite at different voltages during the deployment was significantly greater than theoretical predictions. For example, at 057:00:54 G.m.t. (03:04:36 MET), with the satellite deployed to 16.1 kilometers and a tether electromotive force (emf) of 2862 V, a current of 470 mA was collected with the Deployer Core Experiment (DCORE) Electron Generator Assembly (EGA) firing. Theoretical models predicted a current of only 270 mA for the same conditions. This may suggest the presence of ionization in the satellite's plasma sheath, a process not accounted for in the theoretical models.

The Shuttle Potential and Return Electron Experiment (SPREE) detected Orbiter charging of negative 1 kV with the Shuttle Electrodynamic Tether System (SETS) 25 kilo-ohm resistor in the circuit and a current of only 20 mA. The Orbiter's ability to discharge itself may have been affected by Orbiter thruster firings which inhibited charge collection by the engine bells.

The TEMAG investigation detected an enhancement of the Z-component of the magnetic field at the satellite that was consistent with the measured current.

The SETS and TOP cooperated to provide observations of electron beam impingement on the Orbiter. The measurement should provide information on surface doping by nitrous oxide and on-beam dispersion.

The ROPE investigation observed energetic electrons, whose energy ranged up to 10 kiloelectronvolts (keV), coincident with current flow in the tether. Note that the energy of the electron beam at the time was 1 kV or less. These data suggest possible energization by wave-particle interaction.

Multiple electron and ion populations were observed by the ROPE instrumentation with ions apparently being deflected around the satellite and possibly being ejected from the satellite sheath after ionization.

Data were gathered and impounded to aid in determining the cause of the tether break. An investigation board was formed under the leadership of Kenneth J. Szalai, Director of Dryden Flight Research Center, who was named board chairman.

UNITED STATES MICROGRAVITY PAYLOAD -3

The USMP-3 systems were activated shortly after 053:20:18 G.m.t. (00:02:00 MET). The carrier systems and experiment instruments operated well throughout the mission with no anomalies. A total of 2340 commands were sent to the USMP-3 experiment equipment.

Advanced Automated Directional Solidification Furnace

After the initial delay in the start-up of the Advanced Automated Directional Solidification Furnace (AADSF) because of the difference in the recalescence signal, all of the operations were just as expected. All three crystal growths were completed in their planned Orbiter orientations. The unexpected free-drift during the first run provided a marker in the growth of the crystal that the Principal Investigator (PI) hopes will provide significant unplanned scientific return. The experiment team believes that the microgravity conditions were excellent for AADSF; however, the final proof will be determined during the postflight analysis of the samples.

Isothermal Dendritic Growth Experiment

The Isothermal Dendritic Growth Experiment (IDGE) collected information on over 120 separate dendritic growth experiments during the 14-day mission. The experimenter team collected over 450 electronic and photographic images which were transmitted to the ground experiment team. These data were analyzed and intrepreted in near-real-time for many midcourse corrections, improvements, and alterations of the experiment. This real-time materials science-in-space experiment already shows IDGE scientists that variations reported in the microgravity acceleration environment aboard the Orbiter were not responsible for the observed variations in dendritic crystal growth speeds.

The IDGE also benefited by providing a path-finding operational test of commanding space instruments from a remote site located on the campus of Rensselaer Polytechnic Institute. Remote operations such as this will open the way for International Space Station Alpha (ISSA) experiments, where operations will span months, even years, at a time.

Material pour L'Etude des Phenomenes Interessant la Solidification sur Terre et en Orbite Experiment

The Material pour L'Etude des Phenomenes Interessant la Solidification sur Terre et en Orbite (MEPHISTO) experiment operated nominally throughout the mission. Experimenters accomplished science operations with respect to six planned Orbiter primary RCS thruster firings and one planned OMS firing. As a result of the extension day, three additional primary RCS thruster firings were completed.

The experimenters have correlated for the first time the effects of microgravity perturbations on the homogeneity of the samples. Preliminary analysis indicates that the influence of thruster firings is extremely direction-dependent, and this provides a new consideration for International Space Station Alpha (ISSA) furnace design and experiment planning. The second area studied is related to the structural change of the solid-liquid interface as the growth velocity is increased. The experimenters' ability to monitor the changing interface composition in real-time, using advanced measurement techniques, allows the experimenters to make important decisions during the experiment operations. Telescience operations allowed for real-time data acquisition, analysis, and reprogramming.

In summary, MEPHISTO data collected during USMP-3 operations will include results on metallurgical alloy structure formation, compositional variations in the crystals, and the accurate determination of the transition point for structural changes.

Critical Fluid Light Scattering Experiment

The Critical Fluid Light Scattering Experiment (Zeno) instrument performed well throughout the flight. After nearly 14 days of preparation -- with a series of slow ramps in temperature and long pauses for fluid density equilibration and dynamic light scattering sampling -- a final ramp, performed at 100 microKelvin/hour, successfully brought the xenon sample to the critical temperature (Tc). The sample displayed this unique condition with maximum light scattering, followed by a steady decrease as the temperature moved below Tc, and a sudden increase in turbidity (sample transmission). This signature was much more distinctive than observed during the previous (USMP-2) mission and proved to be nearly 2.5 milliKelvin lower in temperature than measurements made prior to this flight. The transition appears sharp enough to locate the transition to ± 10 microKelvin, which is unprecedented precision.

ORBITAL ACCELERATION RESEARCH EXPERIMENT

The Space Acceleration Measurement System (SAMS) and the Orbital Acceleration Research Experiment (OARE) operated well throughout the flight. The SAMS and OARE personnel, working as a team, provided critical acceleration data to the USMP-3 microgravity experiments. A series of tests were performed that monitored activity such as crew movement, opening and closing lockers, galley operations, Middeck Glovebox (MGBX) operations, etc. Using ground equipment plus special onboard displays enabled these operations to be monitored and characterized to determine the impact on this mission as well as future microgravity missions.

MIDDECK GLOVEBOX

The MGBX payload operated satisfactorily without any significant anomalies throughout the mission operations. Benefiting from the extension day, the MGBX completed 129 percent of the preflight-planned science. In addition, the crew performed activities which enabled ground personnel to complete an unscheduled facility checkout and evaluation. Data from this operation has proven valuable in understanding the distinguishing characteristics of MGBX components in the operating environment of microgravity.

The three combustion experiments conducted in the MGBX [Forced-Flow Flame-spreading Test (FF), Comparative Soot Diagnostics (CSR), and Radiate Ignition and Transition to Spread Investigation (RITES)] studied the effects of very low-speed air-flows on radiate ignition, flame spreading, and initial fuel temperature on flame propagation. The results indicated that the small thermocouples had strong effects on microgravity flames near the flammability limit. Other results showed marked differences between flame size, growth rate, and color with variations in flow velocity and fuel temperature. Both smoke detectors responded to smoke from all samples. A new phenomena was observed that is described as "tunneling" flames. These flames propagated along a narrow path instead of fanning out from the ignition site. Another interesting result was bifurcating cellular smoldering combustion, which appeared as an ember eating a worm-like path across the sample and separating into two or more embers that went on different paths.

COMMERCIAL PROTEIN CRYSTAL GROWTH

The Commercial Protein Crystal Growth (CPCG) Block IV payload experiment was activated at 054:01:43 G.m.t. (00:05:25 MET) and deactivated at 068:09:21 G.m.t. (014:13:03 MET). The Block IV hardware, which was designed, built, tested and flown in approximately 12 months, operated nominally throughout the mission. Postflight analysis was progressing as this report was written. Results will be documented in a separate report by the experiment sponsor.

The CPCG Block IV payload contained 128 samples. Among these were samples from the first joint U. S. - Latin America experiment in protein crystal growth. The project will result in the crystallization in microgravity of ultra-pure samples of Tripanothione Reductase, a DNA-grown protein expressing key features of the Tripanosoma Cruzi, the parasite that causes Chagas disease, which currently affects 15 million people in Central and South America. In addition to this protein, CPCG carried proteins which are potential targets for the development of new therapeutic treatments for infections, human cancers and diseases caused from hormone disorders.

VEHICLE PERFORMANCE

SOLID ROCKET BOOSTERS

Data analysis showed that all Solid Rocket Booster (SRB) systems functioned nominally, and first stage ascent performance was satisfactory. The SRB prelaunch countdown was normal, and no SRB Launch Commit Criteria (LCC) or Operational Maintenance Requirements and Specification Document (OMRSD) violations occurred.

For this flight, the low-pressure heated ground purge in the SRB aft skirt was used to maintain the case/nozzle joint temperatures within the required LCC ranges. At T -15 minutes, the purge was changed to high pressure to inert the SRB aft skirt.

Both SRBs satisfactorily separated from the External Tank (ET) at liftoff plus 126.32 seconds, and entry, deceleration, and water impact were nominal. Reports from the recovery area indicate that the deceleration subsystems performed as designed. Both SRBs were returned to Kennedy Space Center for disassembly and refurbishment.

REUSABLE SOLID ROCKET MOTORS

The Reusable Solid Rocket Motors (RSRMs) performed satisfactorily. The RSRM prelaunch countdown was normal and no LCC or OMRSD violations occurred.

Power up and operation of all igniter and field joint heaters was accomplished routinely. All RSRM temperatures were maintained within acceptable limits throughout the countdown. Data indicate that the flight performance of both RSRMs was well within the allowable performance envelopes, and was typical of the performance observed on previous flights. The RSRM propellant mean bulk temperature (PMBT) was 62 °F at liftoff. The maximum trace-shape variation of pressure versus time was calculated to be 0.5 percent at 79.5 seconds on the left motor and 1.3 percent at 80.0 seconds on the right motor. Both values were within the 3.2 percent allowable limits.

The motor performance parameters for this flight were within the contract end item (CEI) specification limits. Propulsion performance data are presented in the table on the following page.

The postflight inspection showed that all J-joints (igniter and field) performed as designed. All components (case, seals and insulation) performed as expected throughout the flight. Gas paths were observed through the polysulfide on both nozzle-to-case joints (Flight Problem STS-75-M-01). The polysulfide in the gas paths was soft and heat affected. The left and right wiper O-rings had heat effects and erosion at the gas path locations. The left wiper O-ring has 0.016 inch depth erosion (worst case for this flight, but within the flight history). There was no evidence of blow-by past the O-ring in either nozzle, and no evidence of communication between the dual gas paths.

RSRM PROPULSION PERFORMANCE

Parameter	Left motor, 62 °F		Right motor, 62 °F	
	Predicted	Actual	Predicted	Actual
Impulse gates				
I-20, 10^6 lbf-sec	64.52	64.06	64.55	64.44
I-60, 10^6 lbf-sec	172.51	172.42	172.58	173.17
I-AT, 10^6 lbf-sec	297.08	296.62	297.109	297.54
Vacuum Isp, lbf-sec/lbm	268.4	268.0	268.4	268.8
Burn rate, in/sec @ 60 °F at 625 psia	0.3664	0.3670	0.3665	0.3672
Burn rate, in/sec @ 62 °F at 625 psia	0.3669	0.3675	0.3670	0.3677
Event times, seconds[a]				
Ignition interval	0.232	N/A	0.232	N/A
Web time[b]	111.6	111.2	111.6	111.0
50 psia cue time	121.5	121.5	121.5	120.9
Action time[b]	123.6	123.6	123.6	123.0
Separation command	126.4	126.4	126.4	126.4
PMBT, °F	62	62	62	62
Maximum ignition rise rate, psia/10 ms	90.4	N/A	90.4	N/A
Decay time, seconds (59.4 psia to 85 K)	2.8	3.0	2.8	2.8
Tailoff Imbalance Impulse	Predicted		Actual	
differential, Klbf-sec	N/A		520.8	

Impulse Imbalance = Integral of the absolute value of the left motor thrust minus right motor thrust from web time to action time.

[a] All times are referenced to ignition command time except where noted by a [b].

[b] Referenced to liftoff time (ignition interval).

EXTERNAL TANK

Data analysis show that the flight performance of the ET was excellent. All objectives and requirements associated with the ET propellant loading and flight were met. All ET electrical equipment and instrumentation operated satisfactorily. The ET purge and heater operations were monitored and all performed properly. No ET LCC or OMRSD violations were identified nor were any in-flight anomalies noted.

The Ice/Frost Red Team reported that no anomalous thermal protection system (TPS) conditions existed based on their inspection and analysis. No unexpected ice/frost formations were observed on the ET during the countdown, nor was any ice observed in the acreage areas of the ET. Less than normal quantities of ice or frost were present on the LO_2 and LH_2 feed-lines, the pressurization-line brackets, and along the protuberance air load (PAL) ramps. All of the observations concerning ice and frost were acceptable according to the controlling documentation (NSTS 08303).

The ET pressurization system functioned properly throughout the engine start and flight. The minimum LO_2 ullage pressure experienced during the ullage pressure slump was 14.5 psid.

ET separation was satisfactory. ET entry and breakup were within the predicted footprint, with the postflight predicted ET-intact impact point being approximately 75 nmi. uprange of the preflight prediction.

SPACE SHUTTLE MAIN ENGINES

All Space Shuttle main engine (SSME) parameters were within the normal range throughout the prelaunch countdown and were typical of the same parameters observed on earlier flights. Engine Ready was achieved at the proper time, all LCC were met, and engine start and thrust buildup were satisfactory.

Approximately six seconds after liftoff, the crew reported an anomalous condition with the chamber pressure tape meter for SSME 2. Postflight analysis and troubleshooting has shown this condition was caused by an anomalous output from MDM FF2, and the SSME was providing the requested amount of thrust. This anomaly is discussed in more detail in the Displays and Controls section of this report.

Postflight analysis has shown that the SSME performance during main stage, throttling, shutdown and propellant dump operations was normal. The high-pressure oxidizer turbopump (HPOTP) and high-pressure fuel turbopump (HPFTP) performed within the specifications throughout the engine operation. MECO occurred at 508.0 seconds, and no failures or significant problems were found.

SHUTTLE RANGE SAFETY SYSTEM

The Shuttle Range Safety System (SRSS) performed satisfactorily throughout the ascent phase of flight, as determined from the analysis of system data.

The SRSS closed-loop testing was completed as scheduled during the launch countdown. All SRSS safe and arm (S&A) devices were armed and systems inhibits were turned off at the prescribed times.

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

ORBITER SUBSYSTEM PERFORMANCE

Main Propulsion System

The overall performance of the main propulsion system (MPS) was as expected during the prelaunch countdown and throughout the flight. Propellant loading was completed as planned with no stop-flows or reverts. Also, no LCC or OMRSD violations were identified.

Throughout the preflight operations period, no significant hazardous gas concentrations were detected. The maximum hydrogen concentration level in the Orbiter aft compartment occurred shortly after the start of fastfill operations and was 120 ppm, which compares quite favorably with data from previous flights of this vehicle.

A comparison of the calculated propellant loads at the end of replenish versus the inventory (planned) loads results in a loading accuracy of -0.02 percent for the LH_2 and 0.02 percent for the LO_2. The loading accuracy of both LH_2 and LO_2 was well within the required accuracy of $\pm$ 0.43 percent.

Data review confirmed that the closed indication for the LH_2 engine 2 recirculation valve (PV15) was not received when the valve was commanded closed at T-9.5 seconds (Flight Problem STS-75-V-03). Using engine inlet and LH_2 manifold pressures, the valve was verified as closed after MECO. This valve is only critical in the event of an engine-out situation when trapped LH_2 in the feed system must be contained. This condition did not affect the mission. KSC troubleshooting indicates that the valve did close and it was not leaking. Also, the valve's closed indication functioned properly. The valve was replaced.

Ascent MPS performance was normal. Data indicate that the LO_2 and LH_2 pressurization systems performed nominally, and that all net positive suction pressure (NPSP) requirements were met throughout the flight. The minimum LO_2 ullage pressure experienced during the period of ullage pressure slump was 14.5 psid. The ullage pressure exceeded historical limits by as much as 0.5 psia from approximately liftoff plus 75 seconds to 300 seconds, and tracked the upper limit for most of the remainder of ascent. The pressure, however, was within the Interface Control Document (ICD) limits. The GH_2 pressurization system functioned nominally during ascent. Data review verified satisfactory operation of all flow control valves (FCVs) with no evidence of sluggish performance.

Approximately 6 seconds after liftoff the crew reported that the left main engine chamber pressure (Pc) tape meter was reading incorrectly. The meter was indicating approximately 40-percent thrust instead of 104-percent thrust prior to throttle down (Flight Problem STS-75-V-01). A more detailed discussion of this anomaly is contained in the Displays and Controls section of this report.

Also at six seconds after liftoff, all four primary avionics software system (PASS) general purpose computers (GPCs) annunciated a left main engine command path message, which was accompanied by a lit engine status light on the control panel. Downlink telemetry indicated that commands had been properly executed by the main engine controller. A flight software user note (DR37594) documents a condition in which the engine interface unit (EIU) acknowledgment to a GPC command may be missed, causing the command path message.

Performance analysis of the propulsion systems during start, mainstage, and shutdown operations indicated that performance was nominal, and all requirements were satisfied. The MPS helium system performed nominally and met all requirements during powered flight and the propellant dump and vacuum inerting operations.

Reaction Control Subsystem

The reaction control subsystem (RCS) performed nominally throughout the STS-75 mission, and no in-flight anomalies were identified during the flight or data review. The RCS consumed 4624.8 lbm of propellants from the RCS tanks during the mission. In addition, the RCS consumed 2,296.21 lbm (17.73 percent) of OMS propellants during interconnect operations. Postlanding inspection revealed a yellowish contamination on and around RCS thruster F1D that was sampled and sent to a laboratory for material analysis. In addition, the inspection revealed several areas of severe ablation in the room temperature vulcanizing (RTV)-coated thruster impingement area on the right-hand upper body flap. This ablation was attributed to the high heat input resulting from the heavy usage of the RCS aft down-firing thrusters.

At 059:11:05:41 G.m.t. (05:14:47:41 MET) and again at 062:02:27:52 G.m.t. (08:06:09:52 MET), the vernier thruster F5L injector temperature dropped below the 130 °F leak detection limit because of the cold attitude, and the thruster was deselected. After the first instance thruster F5L was deselected, the thruster was fired continuously for 15 seconds to raise the temperature to greater than 130 °F. During the second incident, the thruster temperature only fell to 125 °F and a series of short thruster firings (pulses) were used to warm the thruster. The lowest temperatures reached were 123 °F and 125 °F, respectively, on the oxidizer injector.

Several RCS maneuvers were performed in support of the USMP and all were nominal. At 059:18:03 G.m.t. (05:21:45 MET) the 25-second primary reaction control subsystem (PRCS) 1 maneuver was performed, using primary RCS thrusters L1U, R1U, and F3U.

The PRCS 2 maneuver was initiated at 059:20:18 G.m.t. (06:00:00 MET) using primary RCS thrusters F3U, L1U, R1U, L3D and R3D.

The PRCS 3 maneuver was performed at 060:18:28 G.m.t. (06:22:10 MET) with firings by thrusters L1U, R1U and F3U.

The PRCS 4 maneuver was performed at 060:20:43 G.m.t. (07:00:25 MET) with firings by thrusters L3A and R3A for 10 seconds and F5L, F5R and R5R each for 2 seconds.

The PRCS 5 maneuver was performed at 064:08:48 G.m.t. (10:12:30 MET). It was a 10-second +Z firing and used PRCS thrusters F3U, L1U, and R1U. Thrusters L3D and R3D also fired to provide attitude correction.

The -Z axis PRCS 5D maneuver was performed to support payload operations (MEPHISTO) at 066:08:43 G.m.t. (012:12:25 MET). PRCS thrusters L2D, L3D, R2D, R3D, F3D and F4D were fired for 15 seconds, imparting a 6.94 ft/sec ΔV to the vehicle.

The +Y axis PRCS 5C1 maneuver was performed to support MEPHISTO operations at 066:10:43 G.m.t. (012:14:25 MET). PRCS thrusters F3L, L1L, L1U, and R3D were fired for 15 seconds, imparting a ΔV of 2.7 ft/sec to the vehicle. PRCS thrusters F3U and L3D were also used for attitude control.

The -Y axis PRCS 5C2 maneuver was performed to support MEPHISTO operations at 066:10:46 G.m.t. (012:14:28 MET). PRCS thrusters F4R, L3D, R1U, and R3R were fired for 15 seconds, imparting a ΔV of 2.65 ft/sec to the vehicle. PRCS thrusters F3U, L3D, and R3D were used to control attitude.

The PRCS 5E maneuver was performed at 066:12:48 G.m.t. (12:16:30 MET). PRCS thrusters F3D, F3L, F3U, F4D, F4R, L1L, L1U, L3D, R1U, R2D, R3D, and R3R were pulsed to impart a 1 deg/sec rotation about the X-axis for a total rotation of 360 degrees.

The PRCS 6 maneuver, a +Z axis RCS maneuver, was performed at 067:09:08 G.m.t. (013:12:50 MET). Thrusters L1U, R1U, and F3U were fired for 15 seconds imparting a 4.80 ft/sec ΔV to the vehicle.

The RCS hot-fire test was initiated at 067:12:55 G.m.t. (013:16:37 MET). The firing sequence was performed twice, and all thruster data were nominal.

Orbital Maneuvering Subsystem

The orbital maneuvering subsystem (OMS) performed nominally during the OMS maneuvers and the interconnect operation with the RCS. A total of 17,418.2 lbm of propellants was consumed from the OMS tanks, and of that total, 2,296.21 lbm (17.73 percent) was consumed by the RCS during interconnect operations. The table on the following page presents pertinent data concerning the three OMS maneuvers.

OMS FIRINGS

OMS firing	Engine	Ignition time, G.m.t./MET	Firing duration, seconds	ΔV, ft/sec
OMS-2	Both	053:20:57:52 G.m.t. 00:00:39:52 MET	144	222
OMS-3	Both	067:10:21:00 G.m.t. 03:14:03:00 MET	31	50
Deorbit	Both	069:12:55:43 G.m.t. 015:16:37:43 ET	214	360

Power Reactant Storage and Distribution Subsystem

The power reactant storage and distribution (PRSD) subsystem performance was nominal. The PRSD subsystem supplied the fuel cells 4326 lbm of oxygen and 545 lbm of hydrogen for the production of 6291 kWh of electrical energy. In addition, the PRSD subsystem supplied 156 lbm of oxygen for the environmental control and life support system (ECLSS). The oxygen and hydrogen remaining in the PRSD tanks at landing were 1551 lbm and 267 lbm, respectively, which provided a mission-extension capability of 94 hours with oxygen being the limiting reactant. Tanks 4, 5, 6, and 7 were depleted to residual quantities during the mission.

While H_2 tanks 4 and 5 were supplying reactant to the fuel cells, the quantities of H_2 tanks 4 and 5 diverged from each other, eventually resulting in as much as a 20-percent quantity difference. The cause of the difference was determined to be a failure of the tank 4 A heater (Flight Problem STS-75-V-04). The failure occurred between 055:10:12 G.m.t. (01:13:54 MET) and 055:10:27 G.m.t. (01:14:09 MET), based on correlation between heater ON/OFF discretes and the fuel cell 2 (B heaters) and fuel cell 3 (A heaters) currents. In OV-102, the H_2 tanks 4 and 5 heaters share a heater controller, and as a result the tank heaters were cycling on and off simultaneously. H_2 tanks 4 and 5 were configured for use with only the B heaters at 060:21:14 G.m.t. (07:00:56 MET). As the tanks emptied, the quantities converged until almost no difference in H_2 tank 4 and 5 quantities existed when the two tanks were depleted to 1.5 and 1.1 percent, respectively. Postflight testing determined that a fuse in the heater controller had failed. The failure was caused by thermal cycles and not excessive current. The fuse was replaced.

Another instance of quantity divergence occurred when the hydrogen tanks 8 and 9 showed as much as a 14 percent difference while the tanks were being depleted simultaneously. This divergence was caused by a greater heat leak into hydrogen tank 8 (0.061 lbm/hr) versus hydrogen tank 9 (0.051 lbm/hr). However, because the tank heaters are controlled individually, there was no concern regarding the ability to deplete the lagging tank.

Fuel Cell Powerplant Subsystem

Performance of the fuel cell powerplant (FCP) subsystem was nominal, and the average electrical power level and load were 16.7 kW and 544 amperes. The fuel cells produced 4871 lb of potable water and 6291 kWh of electrical energy during the mission. Hydrogen and oxygen consumption by the fuel cells is shown in the Power Reactant Storage and Distribution section of this report.

Six purges of the fuel cells using both the automatic and manual modes were performed. The fuel cell voltages at the end of the mission were 0.10 Vdc above the predicted value for fuel cell 1, 0.05 Vdc below the predicted value for fuel cell 2, and 0.20 Vdc above the predicted value for fuel cell 3.

The fuel cell 3 cell performance monitor (CPM) stopped performing the self-test function on all three channels; however, other functions of the CPM were operating properly. The self-test function was restored during entry at 069:13:18 G.m.t. (15:17:00 MET). No bus-tie procedure was required, since the CPM output data continued to be valid.

Postlanding, leakage from the oxygen purge port was traced to fuel cell 3, indicating oxygen regulator leakage. As a result, this fuel cell was removed and sent to the vendor for troubleshooting and repair, including the replacement of the CPM.

Auxiliary Power Unit Subsystem

The auxiliary power unit (APU) performance was nominal throughout the flight with one in-flight anomaly recorded against the APU system. The following table presents the run times and serial numbers of the APUs that were flown.

APU RUN TIMES AND FUEL CONSUMPTION

Flight phase	APU 1 (S/N 203)		APU 2 (S/N 308)		APU 3 (S/N 304)	
	Time, min:sec	Fuel consumption, lb	Time, min:sec	Fuel consumption, lb	Time, min:sec	Fuel consumption, lb
Ascent	19:15	47	19:33	51	19:51	48
FCS checkout	25:24	53				
Entry[a]	61:55	118	85:08	176	62:44	116
Total	106:34	218	104:41	227	82:35	164

[a]The APUs ran 17 minutes and 35 seconds after touchdown.

The exhaust gas temperature (EGT) measurement on APU 2 was erratic for approximately one minute prior to launch, and then the measurement operated nominally throughout ascent operations. This same signature was observed during the APU confidence run prior to flight as well as during entry. This erratic measurement did not impact the mission. The transducer was replaced.

The APU 2 injector temperature experienced intermittent incorrect readings at approximately 053:20:43:46 G.m.t. (00:00:25:46 MET), which was 11 minutes after APU shutdown. This condition did not affect normal mission operations. Postflight testing failed to reproduce the condition, and the APU will be flown as-is on the next mission of this vehicle.

The APU 1 fuel-pump inlet-pressure decreased below the expected minimum of 150 psia to approximately 22 psia in four hours (Flight Problem STS-75-V-02). During the same period, the drain line pressure increased approximately 0.5 psi. This condition was caused by a slight leak past the fuel pump seal and into the seal cavity drain system. The pressure remained steady until the fuel isolation valve was opened when APU 1 was used to support FCS checkout. During FCS checkout and entry, APU 1 performance was nominal. However, the fuel pump seal leak was again seen following each run. This condition did not cause a mission impact. KSC drained approximately 98cc of liquid from the catch bottle. The decision was made to fly the APU as-is on the next mission of this vehicle.

Hydraulics/Water Spray Boiler Subsystem

The overall subsystem performance was nominal with the exception of a slight under-cooling condition (271 °F) and two minor over-cooling conditions on water spray boiler (WSB) 3 during entry. Also, hydraulic system 1 did not achieve heat exchanger mode during entry or postlanding. None of these conditions impacted the mission.

During FCS checkout, APU 1 ran for approximately 25.5 minutes in support of the on-going investigation of the flight control channel 1 problem encountered during FCS checkout. The hydraulic pump was cycled between normal pressure and low pressure at various times during the operation of the APU to conserve fuel. Lubrication oil spraying was achieved during this extended operational period. This FCS channel 1 problem is discussed in greater detail in the Avionics and Software Subsystems section of this report.

Electrical Power Distribution and Control Subsystem

The electrical power distribution and control (EPDC) subsystem performed nominally throughout the mission with one exception. A failed 5-ampere fuse in a heater controller caused the failure of the PRSD H_2 tank 4 A heater (Flight Problem STS-76-V-04). This problem is discussed in the Power Reactant Storage and Distribution section of this report.

At 068:12:49 G.m.t. (014:16:31 MET), circuit breaker (CB) 59 on panel MA73C tripped (Flight Problem STS-75-F-04). The short circuit was caused by an overload at the output of connector J31 on panel ML85E. The thermal impulse printer system (TIPS), which is powered through this circuit breaker, was being deactivated for entry at the time that the CB tripped. The TIPS will be tested postflight.

Environmental Control and Life Support System

The ECLSS performed satisfactorily except for the flash evaporator system (FES) anomaly, which is discussed in this subsection.

The redundant component checkout was performed nominally with the cabin temperature controller reconfigured to controller 2 at 060:18:51 G.m.t. (06:22:33 MET), and the regenerative CO_2 removal system (RCRS) reconfigured to controller 2 at 060:19:34 G.m.t. (06:23:16 MET).

A FES water dump was initiated at 062:08:04 G.m.t. (08:11:46 MET). Upon initiation, the FES shut down without reaching the control band. The FES was successfully restarted on the primary A controller. However, approximately one and a half hours later, at 062:09:40 G.m.t. (08:13:22 MET), the FES shut down again. At 062:09:52 G.m.t. (08:13:34 MET), the FES was configured to the primary B controller, and a FES startup was initiated with no response. A second attempt at starting the FES on the primary B controller was performed five minutes later and the FES responded initially, but shut down before stabilized cooling was established (Flight Problem STS-75-V-05). Icing was determined to be the cause of the shutdowns. The FES core-flush procedure was performed to remove ice from the FES topper core.

It was initially believed that the FES icing was caused by the shutdown experienced at the start of the FES dump. This shutdown was caused by a thermal transient seen at the FES during start-up. To troubleshoot the FES freeze-up, a second supply water dump through the FES using the primary A controller was initiated at 065:09:13 G.m.t. (011:11:02 MET). The dump was terminated at 065:09:13 G.m.t. (011:12:55 MET) when the FES core once again froze up. To eliminate the ice that was formed, the FES core-flush was performed at 065:12:56 G.m.t. (011:16:38 MET). A supply water dump using the FES primary B system was subsequently started at 065:18:44 G.m.t. (011:22:26 MET) and ended at 065:21:46 G.m.t. (0123:01:28 MET). The data indicate that the performance of the primary B system was nominal.

The FES was switched to the primary A controller at 066:17:44 G.m.t. (12:21:26 MET) in an effort to validate the primary A controller operation in the supplemental cooling mode. Note that this mode had been used prior to the freeze-up on the A system. FES operation was nominal. The FES was configured back to the primary B controller at 067:16:42 G.m.t. (013:20:24 MET). The FES operated satisfactorily until the radiator coldsoak was initiated for entry on the first landing day. During the coldsoak, the FES shut down on the primary B controller. The core-flush procedure was performed, and the ice was removed. Operations on the FES were reinitiated, and the FES operated properly during the extension day and throughout entry and landing. Postflight troubleshooting lead to the removal of the system A and B topping spray valves. The valves were sent to the vendor for testing.

The supply water and waste management systems performed nominally throughout the mission. Supply water was managed through the use of the FES and overboard dump systems. A total of 27 supply water dumps (four simultaneous with waste water dumps) was performed nominally at an average dump rate of 1.54 percent/minute (2.54 lb/min). The line heater maintained the supply water dump line temperature within satisfactory limits throughout the mission.

Waste water was gathered at approximately the predicted rate. Seven waste water dumps (four simultaneous with supply water) were performed at an average rate of 1.96 percent/minute (3.23 lb/min). All line and nozzle temperatures were maintained within satisfactory limits throughout the mission.

The atmospheric revitalization pressure control system (ARPCS) performed normally throughout the duration of the flight. Both the primary and alternate systems were exercised successfully during the mission.

The waste collection system (WCS) performed nominally throughout the mission.

Smoke Detection and Fire Suppression Subsystem

The smoke detection subsystem showed no indications of smoke generation during the mission. Use of the fire suppression subsystem was not required during the mission.

Airlock Support System

Use of the airlock support components was not required because there was no extravehicular activity (EVA). The active system parameters that were monitored indicated normal operation throughout the flight.

Avionics and Software Support Subsystems

The avionics and software support systems experienced two anomalies, which are discussed in this subsection. Significant events involving the avionics and software support systems are detailed in the following paragraphs.

Six seconds after liftoff, all four primary avionics software system (PASS) general purpose computers (GPCs) annunciated a left main engine command path failure message, which was accompanied by a illuminated left engine status light on the control panel. Downlink telemetry indicated that commands had been properly executed by the main engine controller. A flight software user note (DR37594) documents a condition in which the EIU acknowledgment to a GPC command may be missed, causing the command path message. In this scenario, the failure clears upon subsequent engine commands, and this condition is consistent with the signature observed this flight. As a result, no KSC troubleshooting of this condition was required.

Data review during the flight indicated that the inertial measurement unit (IMU) 3 y-axis gyro was drifting at a higher-than-expected rate (Flight Problem STS-75-V-06). Four uplink compensations were made to this IMU, and the observed drift rate did not stabilize. The excessive drift signature is similar to that of an IMU gyro experiencing a lubrication problem and the internal heat of the IMU causes a further breakdown of the lubricating properties. As a result, the IMU was powered down at 064:00:12 G.m.t. (10:03:54 MET). This action also removed the power from the internal heaters. The reduction of the lubricant temperature was expected to preserve acceptable performance of the gyro to support the end-of-mission requirements. By powering down the IMU, it was anticipated that the gyro drift would be at approximately the pre-shutdown value, once the IMU was operating for entry.

At 068:00:48 G.m.t. (014:04:30 MET), IMU 3 was powered on and commanded to standby. After the IMU reached thermal equilibrium, it was commanded to the operate mode at 068:01:48 G.m.t. (014:05:30 MET). IMUs 2 and 3 were aligned with IMU 1 at 068:01:57 G.m.t. (014:05:39 MET). The IMU recovery was satisfactory and IMU 3 operated nominally with no built in test equipment (BITE) messages. Following the waved-off landing attempts, the IMU was again taken to off to preserve its operating time. IMU 3 was powered up prior to the subsequent landing, and performance was satisfactory for the remainder of the mission. The IMU was briefly operated in the vehicle postflight to determine its condition prior to shipment to the manufacturer for failure analysis and repair.

During the FCS checkout, a failure was noted in the channel 1 aerosurface tests. Port moding of flight critical aft (FA) 1 multiplexer/demultiplexer (MDM), and power cycles of FA1 MDM and aerosurface servo-amplifier (ASA) 1 did not recover the channel. The aerosurfaces responded nominally to commands in the other three channels. In-flight troubleshooting isolated the problem to the analog output differential (AOD) card 0 of MDM FA1 (Flight Problem STS-75-V-07). An additional power cycle of FA1 was unsuccessful in recovering the failed card. The MDM was replaced. Troubleshooting isolated the problem to a failure in the power supply for the AOD card.

Displays and Controls Subsystem

Approximately six seconds after liftoff, the crew reported that the left main engine chamber pressure (Pc) tape meter was reading incorrectly. The meter was indicating approximately 40-percent thrust instead of 104-percent thrust prior to throttle down (Flight Problem STS-75-V-01). After ascent, the crew stated that the meter tracked the other Pc meters throughout ascent, but had a bias of approximately 60 percent. The meter went to zero during the throttle-down for the throttle bucket, and then returned to

40 percent at throttle up after the period of maximum dynamic pressure. Downlink showed no discrepant engine parameters, and the engine correctly responded to all throttle commands throughout ascent. Troubleshooting on the vehicle and at the NASA Shuttle Logistics Depot (NSLD) failed to identify a problem with the Pc meter. Additional testing on the vehicle repeated the anomaly, and isolated the failure to MDM FF2. The MDM was replaced.

When the forward floodlights initially were powered at 055:01:20 G.m.t. (01:05:02 MET), there were indications of arcing and that a remote power controller (RPC) had tripped. The crew confirmed that neither the forward port nor forward starboard floodlights were illuminated. The data review indicated that the forward starboard floodlight tripped the RPC, and the forward port floodlight was arcing. Both floodlights were turned off, and the starboard floodlight was considered failed for the flight. At approximately 056:17:40 G.m.t. (02:21:22 MET), the crew successfully repowered the forward-port payload-bay floodlight. During TSS operations, the floodlights in use were cycled as required by the crew and functioned nominally. The forward floodlights were replaced postflight.

When the payload bay floodlights were turned on for reopening payload bay doors at 068:14:52 G.m.t. (014:18:34 MET), a current signature indicative of an RPC trip was observed on the mid main A bus. The forward port and aft starboard floodlights are powered by mid main A bus. Current data and crew observations confirmed that the forward port floodlight was illuminated. Crew observations were inconclusive as to whether the aft starboard floodlight was illuminated. The aft starboard floodlight was not used for the remainder of the mission. Postflight testing confirmed that the aft starboard floodlight was failed. The floodlight was replaced.

Communications and Tracking Subsystems

Significant events involving the communications and tracking subsystems are detailed in the following paragraphs.

At approximately 062:16:45 G.m.t. (08:20:27 MET), the crew reported a problem with a cable between the video interface unit (VIU) and a camcorder. The crew reported at 064:14:46 G.m.t. (10:18:28 MET) that the VIU-to-camcorder cable had failed completely (Flight Problem STS-75-F-03). The crew repaired the cable and it performing nominally for the remainder of the mission.

At 065:21:44 G.m.t. (012:01:26 MET), ground controllers were unable to power-off closed circuit television (CCTV) camera A. An hour later, the crew reported that CCTV cameras C and D could not be powered up. Ground commanding also failed to power cameras C and D. All other camera commands (pan, tilt, etc.) functioned nominally, both from the ground and from Orbiter panel A7. To recover control of the cameras, the ground cycled power on the video control unit (VCU) at 065:23:26 G.m.t. (012:03:08 MET). Power cycling the VCU cleared the logic in the video switching unit (VSU) and commanded all cameras to a powered-off state. Subsequently, the power for all cameras was then successfully cycled using both ground and panel A7 commands. A data review indicated that a ground command at 065:19:49 G.m.t. (011:23:31 MET) rapidly switched VCU power from main bus A to main bus B. This rapid power switching is believed to have caused the hang-up in the VSU logic. Ground checkout was not required.

Forward link communications to the vehicle were lost at Tracking and Data Relay Satellite-West (TDRS-W) when the S-band system was placed in the TDRS mode at 068:07:59 G.m.t. (014:11:41 MET) (Flight Problem STS-75-V-08). Communications were re-established at 068:08:49 G.m.t. (014:12:31 MET) via UHF radio. The S-band system was reconfigured from string 2 to string 1 and S-band communications were also re-established. During subsequent troubleshooting of the forward link problem, string 2 performed nominally. Troubleshooting on the ground isolated the problem to transponder 2, which was replaced.

At 068:12:49 G.m.t. (014:16:31 MET), CB 59 on panel MA73C tripped. The short circuit was caused by an overload at the output of connector J31 on panel ML85E. The thermal impulse printer system (TIPS), which is powered through this circuit breaker, was being deactivated for entry at the time that the CB tripped. The TIPS unit and its power cable are suspected as causes of the short circuit (Flight Problem STS-75-F-04). As a precaution, this TIPS unit and power cable were not used again during the flight. The TIPS unit will undergo postflight testing.

During the final approach to the runway, the microwave scanning-beam landing system (MSBLS) 2 failed to lock on in range (Flight Problem STS-75-V-09). Azimuth and elevation data for this unit were nominal, as was performance of all parameters on MSBLS units 1 and 3. KSC troubleshooting could not repeat the anomaly. The MSBLS 2 RF assembly was replaced and the failed unit was sent to the laboratory for testing.

Operational Instrumentation/Modular Auxiliary Data System

The operational instrumentation (OI) and the Modular Auxiliary Data System (MADS) performed nominally during the mission.

During the prelaunch activities at 053:20:09.885 G.m.t., which was approximately nine minutes prior to launch, a command was sent to the operations (OPS) 1 recorder to begin recording. The recorder did not respond to the command for 21 seconds. The delay is believed to have been caused by the tape sticking to the head. This is the original tape and head that were installed in this recorder in April 1984. The recorder operated satisfactorily throughout the mission. The OPS recorder performed nominally during postflight testing, and it will be flown as-is on the next flight of this vehicle.

At 060:12:35 G.m.t. (06:16:17 MET), the primary left-inboard tire-pressure measurement began a 38-minute period of erratic readings. At 060:13:13 G.m.t.

(06:16:55 MET), the measurement went to a zero-count reading (231.5 psia) where it remained for over seven days with only two spikes to the 350-psi range noted for one data sample each. At 067:20:25 G.m.t. (014:00:07 MET), following a 23-minute period of erratic behavior, the measurement recovered and provided nominal tire pressure data. During the last flight of this vehicle (STS-73), this same tire pressure measurement went to the full-scale low reading for a period of 55 hours before returning to nominal operation. Postflight troubleshooting following STS-73 did not isolate the source of the problem. The backup tire pressure measurement performed nominally throughout the mission. Postflight troubleshooting identified a bad connector that was intermittent because of wear and tear. The connector was replaced.

Structures and Mechanical Subsystems

With one exception, the structures and mechanical subsystems performed satisfactorily throughout the mission. One of the six blades in the left-hand aft structural attach blade valve did not fully close (Flight Problem STS-76-V-10). The blade was one of three in the lower (outer) blade set. No ordnance fragments were found on the runway beneath the umbilical cavity. STS-75 was the eighth flight of this mechanism since the Program implemented the requirement for the mechanism, and the first in-flight failure of the valve. The failure analysis showed that the blade had seized on its hinge pin. The clearance between the blade and pin was too tight. Minor modifications of the pin and blade bore diameters were implemented to make the valves less critical to the manufacturing process. The NSLD modified the blade mechanism, and the blade valve will be reinstalled on the vehicle. The right-hand blade valve was also removed from the vehicle and sent to NSLD for modification. All other debris retention shutters performed nominally.

The Orbiter window hazing and streaking was typical of that seen on previous missions.

The drag chute subsystem performed properly, and all drag chute hardware was recovered and appeared to have functioned properly. The drag chute door had skidded along the runway and impacted a runway perimeter light. The major pieces of the light stanchion and lens were recovered.

The tires and brakes were in good condition for a landing on the KSC concrete runway. The landing and braking parameters are shown in the table on the following page.

Integrated Aerodynamics, Heating and Thermal Interfaces

The prelaunch thermal interface purges were completed nominally. Also, the ascent aerodynamics and plume heating were nominal, as was the entry aerodynamic heating on the SSME nozzles.

LANDING AND BRAKING PARAMETERS

Parameter	From threshold, ft	Speed, keas	Sink rate, ft/sec	Pitch rate, deg/sec
Main gear touchdown	2294	189.3	~ 0.4	N/A
Nose gear touchdown	6472	148.4	N/A	~4.4

Brake initiation speed	99.5 knots
Brake-on time	42.5 seconds
Rollout distance	8429 feet
Rollout time	64.3 seconds
Runway	33 (Concrete) KSC SLF
Orbiter weight at landing	226,312 lb

Brake sensor location	Peak pressure, psia	Brake assembly	Energy, million ft-lb
Left-hand inboard 1	756	Left-hand outboard	10.24
Left-hand inboard 3	648	Left-hand inboard	12.45
Left-hand outboard 2	564	Right-hand inboard	9.73
Left-hand outboard 4	636	Right-hand outboard	13.30
Right-hand inboard 1	552		
Right-hand inboard 3	540		
Right-hand outboard 2	588		
Right-hand outboard 4	612		

Thermal Control Subsystem

The performance of the thermal control subsystem (TCS) was nominal during all phases of the mission, and all subsystem temperatures were maintained within acceptable limits. No TCS instrumentation or heater systems failures were identified during the mission. A total of 21 revisions to the attitude timeline were successfully analyzed during the course of the mission.

Aerothermodynamics

The acreage heating and local heating during entry were nominal. Likewise, the boundary layer transition was nominal.

Thermal Protection Subsystem and Windows

The thermal protection subsystem (TPS) performed satisfactorily. Based on structural temperature response data, the entry heading was slightly below average. Boundary layer transition from laminar to turbulent flow occurred at 1260 seconds after entry interface on the forward centerline of the vehicle as well as the aft port side of the vehicle. Surface thermocouple data are not available on OV-102 to determine if transition occurred symmetrically from right to left on the vehicle.

The postflight inspection by the debris team also indicates that the overall debris damage was below average. The TPS sustained a total of 96 hits of which 17 had a major dimension of one-inch or larger. A comparison of these numbers to statistics from 58 previous missions of similar configuration indicates that both the total number of hits and the number of hits one-inch or larger was less than average. The distribution of the hits in both categories is shown in the following table.

TPS DAMAGE SITES

Orbiter Surfaces	Hits > 1 Inch	Total Hits
Lower Surface	11	55
Upper Surface	4	28
Right Side	0	0
Left Side	0	4
Right OMS Pod	1	3
Left OMS Pod	1	6
Total	17	96

The largest lower surface tile damage site occurred on the right inboard elevon and measured 5.0 inches long by 1.0 inch wide by 0.75 inch maximum depth. This damage site plus one other nearby showed signs of thermal degradation. The tile damage sites aft of the LH_2 and LO_2 ET/Orbiter umbilical, usually caused by impacts from umbilical ice or shredded pieces of umbilical purge barrier material flapping in the air-stream, were typical in number and size.

The X-33 advanced TPS demonstration tiles flown on the lower body flap and base heat shield showed no signs of damage or degradation as a result of the flight. Tile damage sites on the upper surface of the body flap outboard of SSME 3 (six places in the RTV coated area and three places along the edge) were caused by plume impingement from the downward firing RCS R5D thruster. This thruster firing time was above average but within the experience data base. Visual inspection of the damage site revealed the approximate size to be 5.5 inches by 3.5 inches by 0.25 inch at two of the locations.

No tile damage from micrometeorites or on-orbit debris were noted on the vehicle.

The SSME 1 and 2 dome-mounted heat shield (DMHS) closeout blankets were unstitched or torn at the 6:00 to 7:00 o'clock and 3:00 to 5:00 o'clock locations, respectively. The SSME 3 DMHS was in excellent condition with no observed damage.

Tiles on the vertical stabilizer stinger and around the drag chute door were intact and undamaged

A reddish-brown discoloration similar to that observed previously on OV-105 was present on the leading edge of the right payload bay door. A discoloration around RCS thruster F1L was similar in appearance. No unusual tile damage was noted on the leading edge of the vertical stabilizer. The left-hand OMS pod leading-edge tiles sustained one large hit measuring 5 inches long by 1.25 inches wide by 0.5 inch deep along with several smaller hits.

Orbiter window hazing and streaking was typical. The numerous damage sites on the window perimeter tiles were attributed to a combination of new hits from the forward RCS thruster paper cover/adhesive and old tile repair material flaking off.

FLIGHT CREW EQUIPMENT/GOVERNMENT FURNISHED EQUIPMENT

The flight crew equipment (FCE)/Government furnished equipment (GFE) performed nominally. Four in-flight anomalies were identified, none of which impacted the mission significantly.

The crew reported problems interfacing the Tethered Satellite System (TSS) payload general support computer (PGSC) with the TSS (Flight Problem STS-75-F-01). The crew changed computers and data ports and the interface problems continued. After the RS422 data cable was changed, the problem cleared, and the crew reported nominal data transfers. The cable was tagged and stowed. The cable was returned to JSC for postflight troubleshooting.

The crew reported that the focus capability of CCTV camera C (monochrome) was poor at far distances in low-light situations (Flight Problem STS-75-F-02). The crew stated that camera C was noticeably worse than camera D. The camera was still usable, but images at far distances were blurred. On-orbit troubleshooting determined that the iris would not open with the manual command, but all auto commands worked nominally. The camera was shipped to JSC for postflight troubleshooting.

At approximately 062:16:45 G.m.t. (08:20:27 MET), the crew reported a problem with a cable between the video interface unit (VIU) and a camcorder. Initially, when the cable was moved, the video became intermittent. The crew reported two days later at 064:14:46 G.m.t. (10:18:28 MET) that the VIU-to-camcorder cable had failed completely (Flight Problem STS-75-F-03). The crew repaired the cable and it performed nominally for the remainder of the mission. The cable was returned to JSC for repair.

At 065:21:44 G.m.t. (012:01:26 MET), ground controllers were unable to power-off CCTV camera A. An hour later, the crew reported that CCTV cameras C and D could not be powered up. Ground commanding also failed to power the cameras. All other camera commands functioned nominally, both from the ground and from Orbiter panel A7. To recover control of the cameras, the ground cycled power on the video control unit (VCU) at 065:23:26 G.m.t. (012:03:08 MET). Power cycling the VCU cleared the logic in the video switching unit (VSU) and commanded all cameras to a powered-off state. The power for all cameras was successfully cycled using both ground and panel A7 commands.

At 068:12:42 G.m.t. (014:16:24 MET), circuit breaker (CB) 59 on panel MA73C tripped while the crew was deactivating the TIPS. Data showed that there was a current spike and low ac phase B voltage for 0.4 second. The crew also received a master alarm (Flight Problem STS-75-F-04). The TIPS unit and its power cable are suspected as causes of the short circuit. As a precaution, this TIPS unit and power cable were not used again during the flight.

CARGO INTEGRATION

The cargo integration hardware performed satisfactorily throughout the mission with no issues or in-flight anomalies identified.

DEVELOPMENT TEST OBJECTIVES/DETAILED SUPPLEMENTARY OBJECTIVES

DEVELOPMENT TEST OBJECTIVES

DTO 301D - Ascent Structural Capability Evaluation - Data were recorded on the Modular Auxiliary Data System (MADS) for this data-only Development Test Objective (DTO). The data were recovered postflight and have been given to the sponsor for evaluation. The results of this DTO will be reported in separate documentation.

DTO 307D - Entry Structural Capability - Data were recorded on the MADS for this data-only DTO. The data were recovered postflight and have been given to the sponsor for evaluation. The results of this DTO will be reported in separate documentation.

DTO 312 - External Tank Thermal Protection System Performance - Photography of the ET was acquired using the Nikon F4 camera with a 400 mm lens and a 2X extender. A total of seven views of the ET were received for review. The -Z (far) side of the ET was imaged. The ET was back-lit and this decreased the usability of the photographs. The ET roll rate was approximately 0.01 deg/sec, and the ET tumble rate was approximately 0.03 deg/sec.

The exposure was good on all seven frames, and the focus was good on five of the seven frames. Timing data were also present on the film. The STS-75 mission was the first time that the 400 mm lens was used for the photography, and excellent results were achieved. Additionally, no specific pitch maneuver was performed for this DTO; however, the maneuver to the OMS-2 attitude was performed early and this enhanced the viewing capability by providing a much larger image than previously seen. As a result, this early attitude change may be performed on future missions.

DTO 319D - Orbiter/Payload Acceleration and Acoustics Environment Data - Data were recorded on the MADS for this data-only DTO. The data were recovered postflight and have been given to the sponsor for evaluation. The results of this DTO will be reported in separate documentation.

DTO 667 - Portable In-Flight Landing Operations Trainer - The planned operations of the Portable In-Flight Landing Operations Trainer (PILOT) were performed by the Commander and the Pilot.

DTO 805 - Crosswind Landing Performance - This DTO of opportunity was not accomplished since the required winds were not present at landing.

DETAILED SUPPLEMENTARY OBJECTIVES

DSO 331 - Interaction of the Space Shuttle Launch and Entry Suit and Sustained Weightlessness on Egress Locomotion - All activities in support of the Detailed Supplementary Objective (DSO) were completed, and the data have been given to the sponsor. The results of the sponsor's evaluation will be reported in a separate document.

DSO 487 - Immunological Assessment of Crewmembers - The activities in support of this DSO were performed as planned during the preflight and postflight crew activities. The data have been given to the sponsor for evaluation, and the results will be reported in separate documentation.

DSO 491 - Microbial Transfer Among Crewmembers during Spaceflight - The activities in support of this DSO were performed as planned during the preflight and postflight crew activities. The data have been given to the sponsor for evaluation, and the results will be reported in a separate document.

DSO 492 - In-Flight Evaluation of a Portable Clinical Blood Analyzer (Configuration B) - During flight day 2 activities, the Red Team members noted a high glucose reading on both control samples. The ground operators re-evaluated the control range and believed that the instrument was operating properly. All other crew activities were completed in accordance with the timeline. The data from this DSO have been given to the sponsor for evaluation, and the results will be published in separate documentation.

DSO 493 - Monitoring Latent Virus Reactivation and Shedding in Astronauts - All planned activities in support of this DSO were completed in accordance with the flight plan. The data have been given to the sponsor for evaluation, and the results will be reported in separate documentation.

DSO 802 - Educational Activities - The TSS- and USMP-related subjects were completed and recorded on video in accordance with the preflight plan. These educational videos are now available for use as teaching aids.

DSO 901 - Documentary Television - The video in support of this DSO was recorded and returned to the sponsor for evaluation.

DSO 902 - Documentary Motion Picture Photography - The motion picture photography in support of this DSO was recorded, and the film was returned for processing and evaluation by the sponsor.

DSO 903 - Documentary Still Photography - The still photography in support of this DSO was taken, and the film was returned for processing and evaluation by the sponsor.

PHOTOGRAPHY AND TELEVISION ANALYSIS

LAUNCH PHOTOGRAPHY AND VIDEO DATA ANALYSIS

A total of 24 videos of the launch of STS-75 were reviewed for anomalous conditions and no such conditions were found. In addition, thirty-three 16 mm films and twenty 35 mm films were also reviewed. No items of significance were noted during the reviews of the films.

ON-ORBIT PHOTOGRAPHY AND VIDEO DATA ANALYSIS

The only on-orbit photography reviewed was that taken of the ET following separation from the Orbiter. A discussion of the findings during the review of this film are presented under DTO 312 in the Development Test Objectives section of the report.

LANDING PHOTOGRAPHY AND VIDEO DATA ANALYSIS

A total of 12 videos of the landing were received and reviewed following the mission. No items of significance were noted in the video data of landing.

TABLE I.- STS-75 MISSION EVENTS

Event	Description	Actual time, G.m.t.
APU Activation	APU-1 GG chamber pressure APU-2 GG chamber pressure APU-3 GG chamber pressure	053:20:13:10.837 053:20:13:12.307 053:20:13:14.158
SRB HPU Activation[a]	LH HPU System A start command LH HPU System B start command RH HPU System A start command RH HPU System B start command	053:20:17:32.134 053:20:17:32.294 053:20:17.32.454 053:20:17:32.614
Main Propulsion System Start[a]	ME-3 Start command accepted ME-2 Start command accepted ME-1 Start command accepted	053:20:17:53.458 053:20:17:53.577 053:20:17:53.698
SRB Ignition Command (Liftoff)	Calculated SRB ignition command	053:20:18:00.004
Throttle up to 104 Percent Thrust[a]	ME-3 Command accepted ME-2 Command accepted ME-1 Command accepted	053:20:18:04.032 053:20:18:04.045 053:20:18:04.058
Throttle down to 67 Percent Thrust[a]	ME-3 Command accepted ME-2 Command accepted ME-1 Command accepted	053:20:18:36.193 053:20:18:36.206 053:20:18:36.219
Throttle up to 104 Percent[a]	ME-3 Command accepted ME-2 Command accepted ME-1 Command accepted	053:20:18:56.034 053:20:18:56.046 053:20:18:56.060
Maximum Dynamic Pressure (q)	Derived ascent dynamic pressure	053:20:18:51
Both SRM's Chamber Pressure at 50 psi[a]	RH SRM chamber pressure mid-range select LH SRM chamber pressure mid-range select	053:20:20:00.844 053:20:20:01:444
End SRM [a] Action[a]	LH SRM chamber pressure mid-range select RH SRM chamber pressure mid-range select	053:20:20:03.214 053:20:20:03.884
SRB Physical Separation[a]	LH rate APU turbine speed - LOS RH rate APU turbine speed - LOS	053:20:20:06.324 053:20:20:06.324
SRB Separation Command	SRB separation command flag	053:20:20:07
3g Acceleration	Total load factor	053:20:25:31
Throttle Down for 3g Acceleration[a]	ME-3 command accepted ME-2 command accepted ME-1 command accepted	053:20:25:31.082 053:20:25:31.096 053:20:25:31.105
Throttle Down to 67 Percent Thrust[a]	ME-3 command accepted ME-2command accepted ME-1 command accepted	053:20:26:21.643 053:20:26:21.657 053:20:26:21.670
SSME Shutdown[a]	ME-3 command accepted ME-2 command accepted ME-1 command accepted	053:20:26:28.043 053:20:26:28.057 053:20:26:28.070
MECO	MECO command flag MECO confirm flag	053:20:26:28 053:20:26:29
ET Separation	ET separation command flag	053:20:26:48

[a]MSFC supplied data

TABLE I.- STS-75 MISSION EVENTS (Continued)

Event	Description	Actual time, G.m.t.
APU Deactivation	APU-2 GG chamber pressure APU 1 GG chamber pressure APU 3 GG chamber pressure	053:20:32:26.254 053:20:32:45.278 053:20:33:05.099
OMS-1 Ignition	Left engine bi-prop valve position Right engine bi-prop valve position	Not performed - direct insertion trajectory flown
OMS-1 Cutoff	Left engine bi-prop valve position Right engine bi-prop valve position	
OMS-2 Ignition	Left engine bi-prop valve position Right engine bi-prop valve position	053:20:57:52.5 053:20:57:52.6
OMS-2 Cutoff	Left engine bi-prop valve position Right engine bi-prop valve position	053:21:00:17.1 053:21:00:17.2
Payload Bay Doors (PLBDs) Open	PLBD right open 1 PLBD left open 1	053:21:42:43 053:21:44:04
Tethered Satellite System Deployment	Voice call	056:20:46:00
Tethered Satellite System Tether Break	Voice call	057:01:29:35
OMS-3 Ignition	Left engine bi-prop valve position Right engine bi-prop valve position	067:10:21:00.3 067:10:21:00.3
OMS-3 Cutoff	Left engine bi-prop valve position Right engine bi-prop valve position	067:10:21:31.1 067:10:21:31.1
Flight Control System Checkout APU Start APU Stop	 APU-1 GG chamber pressure APU-1 GG chamber pressure	 067:11:20:44.703 067:11:46:08.824
Payload Bay Doors Close	PLBD left close 1 PLBD right close 1	068:12:01:13 068:12:03:04
Payload Bay Doors Reopen	PLBD right open 1 PLBD left open 1	068:15:05:28 068:15:06:47
Payload Bay Doors Close	PLBD left close 1 PLBD right close 1	069:08:42:42 069:08:44:16
APU Activation for Entry	APU-2 GG chamber pressure APU-1 GG chamber pressure APU-3 GG chamber pressure	069:12:50:47.230 069:13:13:24.328 069:13:13:36.081
Deorbit Burn Ignition	Left engine bi-prop valve position Right engine bi-prop valve position	069:12:55:43.1 069:12:55:43.3
Deorbit Burn Cutoff	Left engine bi-prop valve position Right engine bi-prop valve position	069:12:59:17.9 069:12:59:17.9
Entry Interface (400K feet)	Current orbital altitude above	069:13:26:45
Blackout end	Data locked (high sample rate)	No blackout
Terminal Area Energy Mgmt.	Major mode change (305)	069:13:52:01

TABLE I.- STS-75 MISSION EVENTS (Concluded)

Event	Description	Actual time, G.m.t.
Main Landing Gear Contact	LH main landing gear tire pressure 1 RH main landing gear tire pressure 2	069:13:58:20 069:13:58:21
Main Landing Gear Weight on Wheels	RH main landing gear weight on wheels LH main landing gear weight on wheels	069:13:58:21 069:13:58:21
Drag Chute Deployment	Drag chute deploy 1 CP Volts	069:13:58:28.2
Nose Landing Gear Contact	NLG LH tire pressure 1	069:13:58:36
Nose Landing Gear Weight On Wheels	NLG weight on wheels 1	069:13:58:36
Drag Chute Jettison	Drag chute jettison 1 CP Volts	069:13:58:51.8
Wheel Stop	Velocity with respect to runway	069:13:59:25
APU Deactivation	APU-1 GG chamber pressure APU-2 GG chamber pressure APU-3 GG chamber pressure	069:14:15:31.135 069:14:15:54.720 069:14:16:08.271

TABLE II.- ORBITER IN-FLIGHT ANOMALY LIST

No.	Title	Reference	Comments
STS-75-V-01	Left Main Engine Pc Tape Meter Instrumentation Biased Low	53:20:19 06 G.m.t. 00:00:00:06 MET CAR 75RF01 IPR 78V-0002	The crew reported that the left main engine Pc tape meter indicated 40 percent until throttle down, at which time the Pc dropped to zero percent; it returned to 40 percent at throttle up. Crew concluded that the Pc tape meter was biased low 60 percent because it had appeared to track the other engines throughout ascent. An analysis of the Pc meter circuit identified a possible failure mode. A fault-to-ground in the scaling circuit of the output servo for the meter can cause the observed bias. These failures can affect single and multiple channels. KSC: Initial testing consisted of running calibration commands on the Pc meter. During this testing, no bias was observed. The Pc meter was removed, and NSLD troubleshooting failed to reveal a problem with the Pc meter. As a result, MDM FF2 was removed and replaced.
STS-75-V-02	APU 1 Fuel Pump Inlet Pressure Low	054:00:03 G.m.t. 00:04:12 MET CAR 75RF03 IPR 78V-0005	At approximately 054:03:00 G.m.t. (00:04:12 MET), APU 1 fuel pump inlet pressure decreased below an expected minimum pressure of approximately 100 psia. The pressure continued to decrease to approximately 38 psia (22 psia based on known instrumentation bias), with slight transient pressure increases corresponding to heater cycles. An analysis of the condition was performed, and no concerns were identified regarding APU 1. Data suggest that the low inlet pressure was caused by leakage past the fuel pump seal and into the seal cavity drain system. The Engineering recommendation was to proceed with nominal operations for the remainder of the mission. In accordance with the normal plan, APU 1 was used during FCS checkout and its performance was nominal. A decrease in the fuel pump inlet pressure was seen during both the FCS checkout and entry runs of APU 1. KSC: On March 14, 98 cc of liquid was drained from the catch bottle. The decision was made to fly as-is.
STS-75-V-03	SSME 2 LH2 Recirculation Valve Closure Unconfirmed	053:20:17:51 G.m.t. -00:00:00:09 MET CAR 75RF04	A closed indication was not received for the SSME 2 LH_2 recirculation valve (PV15) after it was commanded closed at T-9.5 seconds. Loss of the valve-open indication was nominal. Note that the recirculation-valve position indications are monitored by a ground bus and are lost at T-0. All three SSME recirculation valves are closed by removal of open pneumatic pressure from a common solenoid valve. The SSME 1 and 3 valves operated nominally. The LH_2 recirculation valve is only critical in the event of an engine-out situation to contain trapped LH_2 in the feed system. A review of post-MECO engine-inlet and

TABLE II.- ORBITER IN-FLIGHT ANOMALY LIST

No.	Title	Reference	Comments
STS-75-V-03 (Continued)			LH_2-manifold pressure data indicate that PV15 was closed at that time. This indicates that the problem may be with the valve position indication; however, a sluggish valve is also a possibility. KSC: Troubleshooting indicates that the valve did close and it is not leaking. Also, the valve's closed indication functioned properly. The valve was removed and replaced.
STS-75-V-04	H_2 Tanks 4 and 5 Quantity Divergence	055:21:00 G.m.t. 02:00:42 MET CAR 75RF08 IPR 78V-0010	At approximately 055:21:00 G.m.t. (02:00:42 MET), while the fuel cells were using oxygen and hydrogen tanks 4 and 5, the two tanks' quantities began diverging, with the tank 4 quantity decreasing at a slower rate than tank 5. Analysis of the fuel cell 3 current data indicate that the A heater in tank 4 had failed-off and caused the divergence. The heaters to both tanks are controlled by a common controller and are, therefore, commanded on simultaneously. At 058:12:29 G.m.t (04:16:11 MET), the crew switched to hydrogen tanks 6 and 7. Being unable to use the hydrogen in tanks 4 and 5 had no impact on the planned mission duration plus contingency days. A request was made to switch back to hydrogen tanks 4 and 5 and use only the B heaters so that data could be obtained on the behavior of paired tanks with a quantity imbalance. This switch was made at 060:21:14 G.m.t. (07:00:56 MET). During operations of hydrogen tanks 4 and 5, the quantities within the tanks converged. The tanks were depleted at approximately 062:18:35 G.m.t. (08:22:17 MET). KSC: Prior to detanking, the heater failure was confirmed on the ground. Testing following detanking again repeated the failure. Further troubleshooting started with a checkout of the fuse in the heater controller. Visual inspection did not reveal a problem; however, an X-ray examination revealed that the fuse was cracked. The failure was caused by thermal cycles, not excessive current. The fuse was removed and replaced.
STS-75-V-05	FES Shutdowns	062:08:04 G.m.t. 08:11:46 MET CAR 75RF11 IPR 78V-0019	Upon initiation of a FES water dump at 062:08:04 G.m.t. (08:11:46 MET), the FES shut down on the primary A controller without ever reaching the control band. Several minutes later, the FES was successfully restarted on the primary A controller. However, approximately one and a half hours into that run, at 062:09:40 G.m.t. (08:13:22 MET), the FES shut down again. At 062:09:52 G.m.t. (08:13:34 MET) the FES was configured to the primary B controller and a FES startup was initiated with no response. A second attempt on the primary B controller was attempted five minutes later and the FES responded initially, but shut down before stabilized cooling was established. Core icing

TABLE II.- ORBITER IN-FLIGHT ANOMALY LIST

No.	Title	Reference	Comments
STS-75-V-05 (Continued)			was suspected, and the FES core flush procedure was performed. It was believed that the first shutdown on the primary A controller and the subsequent FES core icing were procedurally induced. To verify this theory for the shutdowns, a supply water dump through the FES using the primary A controller was initiated at 065:07:20 G.m.t. (011:11:02 MET). The dump was terminated at 065:09:13 G.m.t. (011:12:55 MET) when icing again led to a shutdown. A FES core flush was performed to clear the ice. Subsequently, starting at 065:18:44 G.m.t. (011:22:26 MET), a 3-hour supply water dump using the primary B controller was performed in an effort to exonerate the B system and FES core. The data indicate that the performance of the B system was nominal. The FES primary A system was selected for topping evaporator supplemental cooling at 066:17:48 G.m.t. (012:21:30 MET) to obtain additional data in this mode. The FES primary A system was enabled for approximately 23 hours and during this time its performance was nominal. The FES was configured back to the primary B controller at 067:16:42 G.m.t. (013:20:24 MET). The FES shut down at 068:11:30 G.m.t. (014:15:12 MET) while on the primary B controller. At the time, the radiator coldsoak (radiators at high set point) was being extended for the orbit 236 deorbit opportunity. The FES core flush procedure was completed successfully at 068:11:57 G.m.t. (014:15:39 MET) to rid the FES of ice. The shutdown occurred after the FES outlet temperatures became unstable and increased above the temperature control band indicating that ice had formed in the core. This shutdown was similar to the two shutdowns that occurred during primary A system FES water dumps. Procedures to back out of deorbit preparation were completed at approximately following the wave-off due to forecasted cloud coverage at KSC. No further FES problems were encountered during the mission. KSC: The postflight troubleshooting that was performed included an analysis of water samples from the vehicle and GSE to determine particulate, dissolved gas, and non-volatile residue (NVR) content. Also, a boroscope inspection was made of the FES core to inspect for contaminants and corrosion. No anomalies were found with the water or with the FES core. The FES topping A and B valves were replaced and the removed valves were sent to the vendor for testing.

TABLE II.- ORBITER IN-FLIGHT ANOMALY LIST

No.	Title	Reference	Comments
STS-75-V-06	IMU 3 X- and Y-Axis Excessive Drift	061:06:26 G.m.t. 07:10:08 MET CAR 75RF10 PR GNC-2-20-0119	The inertial measurement unit (IMU) 3 (s/n 210) Y-axis drift increased steadily over the course of the flight. A one-sigma compensation for a high accuracy inertial navigation system (HAINS) IMU is 0.006 deg/hr. A Y-axis compensation of 1.5-sigma was performed at 057:14:31 G.m.t. (03:18:13 MET) and a 3-sigma compensation was uplinked at 061:06:26 G.m.t. (07:10:08 MET). Up to that time, the drift-rate trend had been increasing linearly in the Y-axis and very little drift-rate trend had been seen in the X-axis. After approximately eight days of flight, a significant increase was seen in the Y-axis drift- rate trend, and a drift-rate trend was also seen in the X-axis. At 062:19:33 G.m.t. (08:23:15 MET), an 8-sigma compensation was uplinked for the Y-axis and a 3-sigma compensation was uplinked for the X-axis in an attempt to arrest the observed drift. A fourth compensation (3-sigma to the Y-axis and 2-sigma to the X-axis) was performed at 063:14:26 G.m.t. (09:17:08 MET). This magnitude of drift is out-of-family for a HAINS IMU. An analysis of the drift signature indicates that the IMU X-Y (vertical) axis gyro was failing. Past failure history suggests a lubrication problem within the bearings of that gyro. As a result and to preserve the remaining usable life of the IMU, a recommendation was made to power it down until shortly before entry. The IMU was powered down at 064:00:12 G.m.t. (010:03:54 MET). It was subsequently powered back up at approximately 068:00:48 G.m.t. (014:04:30 MET), and commanded from standby to operate at 068:01:50 G.m.t. (014:05:32 MET) in support of landing. As expected, the IMU exhibited drift rate trending similar to what was seen prior to shut down. When the nominal end-of-mission landing opportunities were waved-off because of cloud coverage, the IMU was powered off to preserve operating time. IMU 3 was powered up prior to the subsequent landing and again its performance was as expected. No additional drift-rate uplink compensations were required, and the unit performed within the redundancy management threshholds. KSC: The IMU was briefly operated in the vehicle to determine its postflight condition prior to shipment. It was removed and shipped to the manufacturer for additional failure analysis and repair.
STS-75-V-07	MDM FA1 AOD Card O Failure	067:11:24 G.m.t. 013:15:06 MET	During flight control system (FCS) checkout, a problem was noted during the FCS channel 1 aerosurface tests.

TABLE II.- ORBITER IN-FLIGHT ANOMALY LIST

No.	Title	Reference	Comments
STS-75-V-07 (Continued)		CAR 75RF12 IPR 78V-0013	Multiplexer/demultiplexer (MDM) flight aft (FA) 1 was identified as the likely cause of the problem, and the input/output (I/O) error FA 1 procedure was performed by the crew. A port mode and power cycle of the MDM were performed, as well as a power cycle of the aerosurface amplifier (ASA). The MDM was port moded again to return to primary ports. None of the recovery procedures were successful. The data could be explained by a failure of the analog output differential (AOD) card 0 in FA1. A BITE status register (BSR) read was performed on the primary port, with 8080 being the response. A response of 8000 is nominal; 8080 indicates that bit 9 is set, which indicates an internal error. This bit would be set if a sequence control unit (SCU) had a problem handing off data to a card. BITE-4 tests on card 0 were performed in-flight and resulted in initial timeout errors. AOD card 0, among other things, commands aerosurfaces via ASA 1. Possible failure modes include an IOM/SCU reply line failure that would prevent processing the general purpose computer (GPC) command or a failure of the card's power supply. KSC: Postflight troubleshooting of the MDM has been performed on the vehicle. The power supply BITE was good; however, the SCU BITE test was failed, which indicates a possible failure of the IOM/SCU reply line. The MDM was removed from the vehicle and sent to NASA Shuttle Logistics Depot (NSLD) for troubleshooting and repair. The troubleshooting isolated the failure to the power supply for the card.
STS-75-V-08	Loss of S-band Forward Link	068:07:59 G.m.t. 014:11:41 MET CAR 75RF13 IPR 78V-0024	At 068:07:51 G.m.t. (014:11:33 MET) on orbit 231 TDRS-E loss of signal (LOS), the S-band PM system was handed down to Diego Garcia for comm in the zone of exclusion (ZOE). At 068:07:59 G.m.t. (014:11:41 MET) at TDRS-W acquisition of signal (AOS), the S-band PM system was handed back to TDRS mode. At that time, forward- link communications to the vehicle were lost. The return link was not affected. Communications were re-established with the crew at 068:08:49 G.m.t. (014:12:31 MET) via UHF radio. The S-band PM system was configured from string 2 to string 1 and the forward link was re-established. On-orbit troubleshooting was performed in an attempt to isolate the cause of the forward-link problem. At 068:09:05 G.m.t. (014:12:47 MET), transponder 2 continued to sweep without locking onto TDRS-W during a 20-second test. At 068:09:27 G.m.t. (14:13:09 MET), transponder 2 acquired Indian Ocean in the SGLS mode and at 068:10:25 G.m.t.

TABLE II.- ORBITER IN-FLIGHT ANOMALY LIST

No.	Title	Reference	Comments
STS-75-V-08 (Continued)			(014:14:07 MET), transponder 2 was able to acquire TDRS-W after 30 seconds. Additional tests were performed the following day and string 2 performed nominally. Transponder 1 was used for the remainder of the mission. It is believed that there is an intermittent failure in transponder 2. KSC: Troubleshooting isolated the cause of the anomaly to transponder 2 and it was replaced.
STS-75-V-09	MSBLS 2 Failed to Lock in Range	069:13:58 G.m.t. 015:17:40 MET CAR 75RF15 IPR 78V-0014	The microwave scanning-beam landing system (MSBLS) unit 2 range failed to lock on. Azimuth and elevation for this unit were nominal, as was the performance of all parameters on MSBLS units 1 and 3. The unit passed its self-test during FCS checkout. KSC: Troubleshooting could not repeat the anomaly. The RF assembly was replaced and the RF assembly was sent to the communications and tracking laboratory for testing.
STS-75-V-10	LH Aft Structural Attach Blade Valve Not Fully Closed	053:20:26:48 G.m.t. 00:00:08:48 MET CAR 75RF16 PR PYR-2-20-0150	Video taken during the postlanding walkaround inspection showed that one of the six blades on the blade valve mechanism at the left-hand aft structural-attach point did not fully close. The blade was one of three in the outer blade set. No ordnance fragments were found on the runway beneath the umbilical cavity. The blade valve assembly was removed for failure analysis. STS-75 was the eighth flight of the Program since implementation of the blade valve mechanism modification (3 flights each on OV-104 and OV-105 and 2 flights on OV-102). This is the first in-flight problem with the blade valve mechanism. KSC: The failure analysis showed that the blade had seized on its hinge pin. The clearance between the blade and pin was found to be too tight. Minor modifications of the pin and blade bore diameters are being implemented to make the valves less critical to the manufacturing process. The NSLD modified the OV-102 left-hand blade mechanism and it will be installed on the vehicle. The OV-102 right-hand blade mechanism was also removed and sent to the NSLD for modification.

TABLE III.- GOVERNMENT FURNISHED EQUIPMENT PROBLEM TRACKING LIST

No.	Title	Time	Comments
STS-75-F-01	Tethered Satellite System (TSS) Payload General Support Computer (PGSC) Data Cable Bad	054:23:44 G.m.t. 01:03:26 MET	The crew reported problems interfacing the TSS PGSC with the TSS. The crew rebooted the PGSC and swapped computers and data ports without success. After the RS422 data cable was replaced with the spare RS422 data cable, the problem cleared and nominal data transfer capability was restored. The cable was tagged and stowed and will be returned to JSC for postflight troubleshooting.
STS-75-F-02	Closed Circuit Television (CCTV) Camera C Has Poor Focus Capability	062:04:06 G.m.t. 08:07:48 MET	The focus capability of CCTV camera C, a monochrome camera, was poor at far distances. The crew reported that camera C was noticeably worse than camera D, also a monochrome camera. The camera C serial number is 022. The camera was still usable, but images at far distances were blurred. On-orbit troubleshooting performed at 065:17:50 G.m.t. (011:21:32 MET) determined that the iris would not open with the manual command, but all auto commands worked nominally. KSC: Remove camera and ship it to FEPC for testing.
STS-75-F-03	Camcorder/Video Interface Unit (VIU) Power Cable Failure	064:14:46 G.m.t. 010:18:28 MET	At 062:16:43 G.m.t. (08:20:25 MET), the crew reported that the cable between the VIU and the camcorder was degraded. When the cable was wiggled, video became intermittent. The crew was advised to limit cable movement. Two days later, at 064:14:46 G.m.t. (010:18:28 MET), the crew reported that the cable had failed completely and that they had performed an In-Flight Maintenance to recover the cable. They cut off the connector, crimped pins to the conductors and attached the pins to the VIU. They reported that the VIU cable was now working nominally. The cable will be returned to FEPC for repair.

TABLE III.- GOVERNMENT FURNISHED EQUIPMENT PROBLEM TRACKING LIST

No.	Title	Time	Comments
STS-75-F-04	AC1 Phase B Undervoltage at Thermal Impulse Printer System (TIPS) Deactivation	068:12:42 G.m.t. 014:16:24 MET	At 068:12:42 G.m.t. (04:16:24 MET), while the crew was deactivating TIPS 1, a current spike and low ac phase B voltage were observed in the data for approximately 0.4 second. The crew received a master alarm and reported that the circuit breaker (CB) for AC 1 on panel MA73C row F (CB 59) popped. The crew stated that they had followed the procedures during the deactivation of TIPS 1. The TIPS 1 and power cables in use at the time of the undervoltage were considered suspect and were not be used for the remainder of the mission. An ac power cable could have been adapted for use with TIPS 2. The TIPS power cables and the TIPS unit will be shipped to FEPC and JSC, respectively, for testing.

DOCUMENT SOURCES

In an attempt to define the official as well as the unofficial sources of data for this mission report, the following list is provided.

1. Flight Requirements Document
2. Public Affairs Press Kit
3. Customer Support Room Daily Science Reports
4. MER Daily Reports
5. MER Mission Summary Report
6. MER Quick Look Report
7. MER Problem Tracking List
8. MER Event Times
9. Subsystem Manager Reports/Inputs
10. MOD Systems Anomaly List
11. MSFC Flash Report
12. MSFC Event Times
13. MSFC Interim Report
14. Crew Debriefing comments
15. Shuttle Operational Data Book

ACRONYMS AND ABBREVIATIONS

The following is a list of the acronyms and abbreviations and their definitions as these items are used in this document.

AADSF	Advanced Automated Directional Solidification Furnace
AOD	analog output differential
APU	auxiliary power unit
ARPCS	atmospheric revitalization pressure control system
ASA	aerosurface amplifier
BITE	built in test equipment
CB	circuit breaker
CCTV	closed circuit television
CEI	contract end item
CO_2	carbon dioxide
CPCG	Commercial Protein Crystal Growth
CPM	cell performance monitor
CSR	Comparative Soot Diagnostics
DACA	data acquisition and control assembly
DCORE	Deployer Core Experiment
DDCS	data display control system
DH	data handling
DMHS	dome-mounted heat shield
DR	Discrepancy Report
DSO	Detailed Supplementary Objective
DTO	Developmental Test Objective
ΔV	differential velocity
ECLSS	Environmental Control and Life Support System
EGA	electron generator assembly
EGT	exhaust gas temperature
EIU	engine interface unit
emf	electromotive force
EPDC	electrical power distribution and control subsystem
ESTL	Electronic Systems Test Laboratory
ET	External Tank
EVA	extravehicular activity
FA	flight aft
FCE	flight crew equipment
FCP	fuel cell powerplant
FCS	flight control system
FCV	flow control valve
FES	flash evaporator system
FF	Forced Flow Flame Spreading Test
FF2	flight forward 2 (MDM)
ft/sec	feet per second
GFE	Government furnished equipment
G.m.t.	Greenwich mean time
GN_2	gaseous nitrogen

GPC	general purpose computer
GSE	ground support equipment
H_2	hydrogen
HPFTP	high pressure fuel turbopump
HPOTP	high pressure oxidizer turbopump
ICD	Interface Control Document
IDGE	Isothermal Dendritic Growth Experiment
IFA	in-flight anomaly
IMU	inertial measurement unit
Isp	specific impulse
ISSA	International Space Station Alpha
JSC	Johnson Space Center
keV	kiloelectron volts
kV	kilovolts
KSC	Kennedy Space Center
kW	kilowatt
kWh	kilowatt/hour
lbm	pound mass
LCC	Launch Commit Criteria
LH_2	liquid hydrogen
LMES	Lockheed Martin Engineering and Science
LO_2	liquid oxygen
mA	milliamperes
MADS	modular auxiliary data system
MDM	multiplexer/demultiplexer
MECO	main engine cutoff
MEPHISTO	Material pour L'Etude des Phenomenes Interessant la Solidification sur Terre et en Orbite Experiment
MET	mission elapsed time
MGBX	middeck glovebox
MPS	main propulsion system
MSBLS	Microwave Scanning Beam Landing System
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
nmi.	nautical mile
NPSP	net positive suction pressure
NSLD	NASA Shuttle Logistics Depot
NSTS	National Space Transportation System (i.e., Space Shuttle Program)
OARE	Orbital Acceleration Research Experiment
OI	operational instrumentation
OMRSD	Operations and Maintenance Requirements and Specifications Document
OMS	orbital maneuvering subsystem
OPS	operations
PAL	protuberance air load
PASS	primary avionics software system
Pc	chamber pressure
PGSC	payload general support computer
PI	Principal Investigator/payload interleaver
PILOT	Portable In-Flight Landing Operations Trainer

PMBT	propellant mean bulk temperature
ppm	parts per million
PRSD	power reactant storage and distribution
psia	pound per square inch absolute
psid	pound per square inch differential
RCRS	Regenerative CO_2 Removal System
RCS	reaction control subsystem
RETE	Research on Electrodynamic Tether Effects
RITES	Radiate Ignition and Transition to Spread Investigation
RM	Redundancy Management
r/min	revolutions per minute
ROPE	Research on Orbital Plasma Electrodynamics
RPC	remote power controller
RSRM	Reusable Solid Rocket Motor
RTV	room temperature vulcanizing (material)
SA	Satellite Ammeter
SAMS	Shuttle Acceleration Measurement System
S&A	safe and arm
SETS	Shuttle Electrodynamic Tether System
SFMDM	smart flex multiplexer/demultiplexer
SLA	Shuttle Laser Altimeter/Satellite Linear Acceleration
SLF	Shuttle Landing Facility
SPREE	Shuttle Potential and Return Electron Experiment
SRB	Solid Rocket Booster
SRSS	Shuttle range safety system
SSME	Space Shuttle main engine
Tc	critical temperature
TCS	thermal control subsystem
TDRS	Tracking and Data Relay Satellite
TEMAG	Tether Magnetometer
TIPS	thermal impulse printer system
TOP	Tether Optical Phenomenon
TPS	thermal protection system/subsystem
TSS-1R	Tethered Satellite System-1R
TT&C	telemetry, tracking and command
UHF	ultrahigh frequency
USMP-3	United States Microgravity Payload-3
V	Volts
VCU	video control unit
Vdc	Volts direct current
VIU	video interface unit
VSU	video switching unit
W	Watts/West
WCS	waste collection system
WSB	water spray boiler
ZENO	Critical Fluid Light Scattering Experiment