

NSTS 37447

# **STS-123 SPACE SHUTTLE MISSION REPORT**

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October 2008



**National Aeronautics and  
Space Administration**

**Lyndon B. Johnson Space Center  
Houston, Texas**

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NSTS-37447

**STS-123**  
**SPACE SHUTTLE MISSION REPORT**

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# STS-123 SPACE SHUTTLE MISSION REPORT

## INTRODUCTION

The Space Transportation System (STS) -123 Space Shuttle Mission Report presents a discussion of the Orbiter activities on the mission, as well as a summary of the External Tank (ET), the Solid Rocket Booster (SRB), the Reusable Solid Rocket Motor (RSRM) and the Space Shuttle Main Engine (SSME) performance during the 122<sup>nd</sup> mission of the Space Shuttle Program. The purposes of this mission, designated as Assembly Flight 1J/A, were to deliver and install the *Japanese Kibo Laboratory* to the International Space Station (ISS), exchange the ISS Flight Engineer 2 crewmembers and deliver critical supplies and cargo to the ISS.

STS-123 was the 9th mission since the return to flight following the STS-107 mission, and the 25<sup>th</sup> mission to the ISS. STS-123 was also the 21<sup>st</sup> flight of the *Endeavour* (Orbiter) vehicle.

The flight vehicle consisted of the OV-105 Orbiter; the ET, a Super Lightweight Tank (SLWT) designated ET-126 three Block II SSMEs that were designated as serial numbers (S/Ns) 2047, 2044, and 2054 in positions 1, 2 and 3, respectively; and two SRBs that were designated BI-133. The two RSRMs were designated flight set RSRM-101. The individual RSRMs were S/N 360W101A (left) and S/N 360W101B (right). Launch Pad 39A and Mobile Launch Platform (MLP) -2 were used as the platform for launch of the STS-123 mission.

The primary objectives of the STS-123 mission were as follows:

1. Install the Japanese Experiment Module-Pressurized Module ([JEM\) Experiment Logistics Module - Pressurized Section \(ELM-PS\) \(also called JLP\)](#) on to the *Harmony* Node 2 module.
2. Perform mandatory activation of the [JLP](#) payload.
3. Install and activate the Special Purpose Dexterous Manipulator (SPDM), which was named *Dextre*.
4. Exchange the ISS Flight Engineer 2 crewmembers and transfer mandatory crew rotation cargo.
5. Perform five Extravehicular Activities (EVA's).
- 5-6. Transfer mandatory quantities of water and nitrogen as well as other critical supplies to ISS.
- 6-7. Transfer experiment data from the ISS to the Orbiter for return.

The STS-123 mission was planned to be a 16-day plus 1 plus 2-contingency-day flight.

All times during the flight are given in Greenwich Mean Time (GMT) and Mission Elapsed Time (MET). Appendix A contains the sequence of events. Appendix B

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provides a table containing all Orbiter, SRB, ET, and Integration in-flight anomalies (IFAs) and their status at the time of the publication of this report. Appendix C provides a list of sources of data, both formal and informal, that were used in the preparation of this report. Appendix D provides a list of acronyms, abbreviations and definitions as used throughout this report.

The eight crewmembers (seven up, seven down) that were on the STS-123 flight were Dominic L. Gorie, Captain, U. S. Navy (Retired), Commander; Gregory H. Johnson Colonel, U. S. Air Force, Pilot; Robert L. Behnken, PhD, Major, Mission Specialist 1; Michael J. Foreman, Captain, U.S. Navy, Mission Specialist 2; Takao Doi, Civilian, Japanese Aerospace Exploration Agency, Mission Specialist 3; Richard M. Linnehan, DVM, Civilian, Mission Specialist 4; Garrett E. Reisman, PhD, Civilian, Mission Specialist 5 (up to ISS), Leopold Eyharts, European Space Agency (down from ISS).

STS-123 was the fourth Shuttle flight for the Commander and Mission Specialist 4. STS-123 was the second Shuttle flight for Mission Specialist 3 and Flight Engineer 2 (Mission Specialist 5) (down from ISS). STS-123 was the first Shuttle flight for the Pilot, Mission Specialist 1, Mission Specialist 2, and Flight Engineer 2 (Mission Specialist 5) (up to ISS).



## **MISSION SUMMARY**

### **Pre-Launch**

During S0007 prelaunch operations, support personnel reported that the Mission Event Timer (MET) on panel O3 had a failed Light Emitting Diode (LED) segment for the Right-Hand (RH) hour reading and the fault light was lit. A self test/lamp test was performed to determine the configuration. The lamp test verified a failure of the top-left vertical segment of the 5th digit had occurred. The aft MET is functional. It was flown in the as-is condition.

During the voice checks, a problem was erroneously attributed to the middeck Multiple Headset Adapter (MHA) for Mission Specialist (MS) 2 Audio Terminal Unit (ATU). The issue was documented and a replacement unit was located for removal and replacement. A retest of the MHA replacement isolated the failure to a misplaced 4-ft cable between the Headset Interface Unit (HIU) and the MS 2 headset. Moving the 4-ft cable to the ATU side of the HIU solved the problem.

During Fuel Cell 1 activation at 070/18:52:00 GMT, the activation of the Fuel Cell (FC) 1 coolant and hydrogen pumps was initiated, and immediately the Electrical Power Distribution and Control (EPD&C) data indicated that both FC 1 pumps were operating on two-phase electrical power instead of three-phase, which is the design for both pumps. FC1 was shut down to avoid any potential operational risks to FC1. Troubleshooting ensued by cycling the AC breaker for phase A five times (as allowed by Operations and Maintenance Requirements and Specification Document (OMRSD)).

Following the on/off cycling of the circuit-breaker, both FC 1 pumps were powered and were operating nominally on all three phases at 070/16:31:46 GMT. FC-1 activation was completed nominally at 070/17:19:36 GMT. The Orbiter Data Reduction Center (ODRC) data as well as the high-speed data were all consistent with the evaluation that the circuit breaker had some contamination or oxide layer that was cleared by the five cycles. This is a known problem with the circuit breakers, and that is the [reason for](#) the five-cycle procedure.

### **Ascent and Flight Day 1**

The STS-123 mission was launched at 071/06:28:13.984 GMT on March 11, 2008, on the twenty-fifth Space Shuttle Program (SSP) mission to the International Space Station (ISS).

The Main Propulsion System (MPS) Engine 3 Liquid Oxygen inlet pressure showed a shift of 30-psi at lift-off (IFA STS-123-V-06). The shift occurred during this flight only when compared to the previous five flights and it lasted until SRB separation. The measurement recovered for the remainder of the ascent phase. The inlet-pressure transducers do not serve a critical function for the remainder of the mission.

At 071/06:28:29 GMT [0/00:00:16 Mission Elapsed Time (MET)], three Left Reaction Control System (LRCS) fault messages occurred coincident with the loss of the fuel leak detector temperatures (off-scale low) for thrusters L2L, L2U and L2D. The cause of this fault was identified as a failure of Dedicated Signal Conditioner (DSC) Orbital Maneuvering System (OMS) Left (OL) 1 Card 1 (IFA STS-123-V-01). Thrusters L2U, L2D, and vernier thruster L5L were automatically deselected by Redundancy Management (RM) as failed leak. The L2L thruster did not deselect because the pod limit of two failed thrusters had already been reached. The affected primary thrusters were placed in last priority and a General Memory Update (GMEM) was developed to allow use of the vernier thruster. This failure did not affect the R-Bar Pitch Maneuver (RPM).

A nominal OMS assist maneuver was performed following SRB separation. Ignition occurred at 071/06:30:28.970 GMT (00/00:02:14.986 MET), and the maneuver was 114.2 sec in duration.

During the Flash Evaporator System (FES) startup on Primary A during ascent, the FES began to cool, but then went into the shutdown mode (IFA STS-123-V-02). The crew switched to the Primary B controller. The primary B controller operated nominally for the remainder of ascent. After the Payload Bay Doors (PLBDs) were opened, the controller was switched back to Primary A in the full-up mode in an attempt to verify the system operation. The FES began responding by temperature controlling, but again the FES went into the shutdown mode. The crew then switched to Primary A in the topping mode, however, with the same results. The controller was switched to the Primary B and it operated nominally and the Primary A controller was declared by the flight rules to be non-operational. There was not an end-of-mission impact for the loss of one FES primary controller.

Approximately 14 sec prior to Main Engine Cutoff (MECO), the Auxiliary Power Unit (APU) 1 gas-generator chamber-pressure indicated a shift upward of 125 psia. After APU shutdown, the pressure reading stabilized at 95 psia, which indicated an instrumentation problem as there was no indication of internal Gas Generator Valve Module (GGVM) leakage (IFA STS-123-V-03). There was no impact to the mission from this instrumentation problem.

MECO occurred at 071/06:36:39 GMT (00/00:08:25 MET). The ET separated from the Orbiter at 071/06:36:59 GMT (00/00:08:45 MET).

Solid Rocket Booster (SRB) and External Tank (ET) separation were clearly visible from the ET camera. During the ET-separation maneuver, the Digital Autopilot (DAP) commanded all available down-firing thrusters to fire. As a result of the L2D thruster not being selected due to the DSC OL1 Card 1 problem plus the resulting thrust imbalance, the Orbiter built-up a 1.2 deg/sec roll-rate during the initial phase of the ET-separation maneuver. This rate was quickly damped once the 6-sec rotation-inhibit period expired.

The APU 1 fuel-tank pressure measurements began to decay shortly after APU shutdown during the post-insertion activities (IFA STS-123-V-05). The decay was greater than what is normally observed due to post-ascent heat soak back, and it is similar to that seen during STS-121. The pressure was observed to decay 8 psi (258 to 250 psia) by FD 4 (2.2 days, as of 073/12:00 GMT). There was no impact to the mission at the observed pressure-decay rate.

A nominal OMS-2 maneuver was performed at 071/07:06:44.170 GMT (00/00:36:15.200 MET). The maneuver was 62.8 sec in duration with a differential velocity ( $\Delta V$ ) of 96.2 ft/sec. The achieved orbit was 85.1 by 124.9 nmi.

The Payload Bay Doors (PLBDs) were opened at 071/08:24:21 GMT (00/01:56:07 MET), and radiator flow was satisfactory. The Ku-Band antenna was deployed at 071/08:58 GMT (00/02:30 MET).

An OMS-3 Nominal Correction (NC1) maneuver was performed as a dual engine, straight-fed firing occurring at 071/09:37:37.6 GMT with the cutoff at 071/09:38:26.3 GMT. The firing time was 49.0 sec with a  $\Delta V$  of 75.5 ft/sec. The resulting orbit was 94.2 by 157.1 nmi. OMS performance was nominal. The firing was 5 ft/sec lower than originally planned by the Flight Dynamics Officer to avoid a conjunction that would have resulted from the original firing time.

The Shuttle Remote Manipulator System (SRMS) power-up and checkout was performed satisfactorily with no problems or issues noted.

## **Flight Day 2**

The ET umbilical-well camera photography was successfully downloaded. New camera flash units located in the left-hand ET/Orbiter umbilical provided illumination of the ET for post-ascent photography. These new flash units were dramatic and effective.

An OMS-4 (NC2) maneuver was a right engine firing that was performed nominally at 071/23:34:44.7 GMT (00/17:06:31 MET) with the cutoff at 071/23:35:00.9 GMT (00/17:06:47 MET). The OMS engine operated satisfactorily. The maneuver was 16.2 sec in duration with a  $\Delta V$  of 12.4 ft/sec. The resulting orbit was 157.2 by 100.9 nmi.

At approximately 072/00:52:28 GMT (00/18:24:14 MET), the APU 3 seal cavity drain-line pressure transducers began a slow decay of approximately 1.1 psi/day (IFA STS-123-V-04). The pressure decay rate was below the threshold for a liquid leakage, and no significant fuel leakage into the drain system was seen during APU operation or after shutdown. There was no impact to the mission at the cited pressure decay rate. The drain system pressures continued to be monitored throughout the mission.

The SRMS unberthed the Orbiter Boom Sensor System (OBSS) at 072/00:22:59 GMT (00/17:54:45 MET) for the Flight Day (FD) 2 vehicle-inspection surveys. The starboard-wing survey began at 072/01:20 GMT (00/18:50 MET) and was completed 73 min later.

The nose-cap survey began at 072/03:20 GMT (00/20:52 MET) and was completed approximately 30 min later. The port-wing survey began at 072/04:00 GMT (00/21:32 MET) and was completed approximately 97 min later. The SRMS/OBSS performance was nominal throughout the surveys. The OBSS was berthed and the SRMS was parked with the brakes on in the pre-cradle position.

During the FD 2 OBSS survey of the leading edge, the crew reported that the pan values on the OBSS Pan-Tilt Unit (PTU) following a reset were approximately 10 deg different than the published crew procedures. For the rest of the FD 2 survey, the crew and ground accounted for the 10 deg pan error and successfully completed the inspection. On Flight Night 5, PTU troubleshooting during crew sleep confirmed the approximate 10 deg offset in the pan value (IFA STS-123-V-09).

Rendezvous Tools checkout was performed with no issues reported.

The General Memory Update (GMEM) to allow use of the vernier thruster L5L was completed and up-linked to the Orbiter at 072/07:48:25 GMT (01/02:20:12 MET). The first pulse of the L5L thruster after the receipt of the GMEM onboard was satisfactory.

The Reaction Control System (RCS) NC3 maneuver was performed at 072/08:58:10 GMT (01/02:29:134 MET). The firing time was 9.6 sec with a  $\Delta V$  of 2.2 ft/sec. The resulting orbit was 101.5 by 157.0 nmi. Thruster performance was nominal.

The Orbiter Docking System (ODS) was activated at 072/09:20:01 GMT (01/02:51:48 MET). Power-on time for the avionics was 5 min and 22 sec. Ring extension to the initial position was nominal, beginning at 072/09:29:01 GMT (01/03:00:48 MET) and ending 9 min and 7 sec (dual motor time) later. The ODS ring extension activity was nominal. The ODS was ready for docking operations.

All Wing Leading Edge Impact Detection System (WLE-IDS) ascent summary data were downloaded and downlinked successfully. Forty half-sec windows of detailed G-time-histories were downlinked to confirm the implication of cases above 1 Grms. In total, there were no probable indications above 1 Grms on either the starboard or port wing.

### **Flight Day 3**

The FD 3 main task was the rendezvous of the Orbiter with the International Space station (ISS).

During G2 Set Expansion, the crew reported that the General Purpose Computer (GPC) 3 OUTPUT talkback on Panel O6 continued to show Barberpole after the GPC was taken to RUN (IFA STS-123-V-12). The crew tapped on the talkback and it went to gray, which was the expected talkback indication.

The OMS-5 Nominal Height (NH) maneuver was a dual-engine firing occurring at 072/22:11:09.6 GMT (01/15:44:55.6 MET) with the maneuver complete at

072/22:12:05.6 GMT (01/15:45:51.6 MET). The firing time was 56.0 sec with a  $\Delta V$  of 87.1 ft/sec. This placed the Orbiter into a 182.0 by 125.0 nmi orbit. Engine performance was nominal.

The OMS-6 (NC4) maneuver was a dual-engine firing occurring at 072/23:10:32.4 GMT (01/16:44:18.5 MET) with the maneuver complete at 072/23:11:31.6 GMT (01/16:45:17.7 MET). The firing time was 59.2 sec with a  $\Delta V$  of 93.4 ft/sec. This placed the Orbiter into a 184.1 by 177.3 nmi orbit. Engine performance was nominal.

The Nominal Correction Combination (NCC) maneuver was a 3.1-second multi-axis RCS firing using 9 thrusters, and the maneuver occurred at 072/23:44:41 GMT (01/17:18:18:24 MET). The maneuver provided a  $\Delta V$  of 0.71 ft/sec. The resulting orbit was 177.3 by 184.0 nmi. Thruster performance was nominal.

The OMS-7 Target Intercept (TI) maneuver was a left engine firing occurring at 073/00:42:22.4 GMT (01/18:16:08.5 MET) with the maneuver complete at 073/00:44:33.6 GMT (01/18:18:19.7 MET). The firing time was 11.2 sec with a  $\Delta V$  of 8.7 ft/sec. This placed the Orbiter into a 181.2 by 185.6 nmi orbit. Engine performance was nominal.

The Mid-course Correction-1 (MC1) was a multi-axis RCS maneuver and it occurred at 073/01:02:24.8 GMT (01/18:50:14 MET) with a firing duration of 1.3 sec, and a  $\Delta V$  of 0.3 ft/sec. The Out-of-Plane Null maneuver was a multi-axis RCS maneuver that began at 073/01:16:28 GMT (01/18:50:14 MET). MC2 was a multi-axis RCS maneuver with an ignition time of 073/01:34:30.8 GMT (01/19:08:16.9 MET). The firing duration was 2.8 sec with a  $\Delta V$  of 0.67 ft/sec. MC3 was a multi-axis 3 sec RCS maneuver with an ignition time of 073/01:51:30 GMT (01/19:25:16 MET). The  $\Delta V$  delivered was 0.7 ft/sec. MC4 was a 9.9-sec multi-axis RCS maneuver. The ignition was at 073/02:01:30 GMT (01/19:35:16 MET). The  $\Delta V$  delivered was 2.3 ft/sec and the Orbiter was in a 180.4 by 185.6 nmi orbit.

The R-bar Pitch Maneuver (RPM) started at 073/02:26:24 GMT (01/20:00:10 MET) and ended 8 min 16 sec later. Peak pitch-rate during the maneuver was 0.715 deg/sec. The maximum roll error reached approximately -2.228 deg and the maximum yaw error reached -1.155 deg. Performance was nominal.

During the manual phase of the rendezvous, the Trajectory Control Sensor (TCS) Continuous Wave (CW) dropped lock on the target and failed to reacquire without intervention. The TCS performance and data were reviewed to determine the cause of the loss of lock, which was determined to not be caused by a hardware or software anomaly.

The ODS was activated at 073/02:59:02 GMT (01/20:30:48 MET) and was deactivated after the avionics had operated for 1 hr, 12 min, 37 sec. The Shuttle's capture of the ISS occurred at 073/03:49:47 GMT (01/21:21:33 MET). The system was allowed to dampen out for approximately 6 min 52 sec after capture. Ring retraction was started at

073/03:56:39 GMT (01/21:28:25 MET). Ring retraction, using dual motors, proceeded nominally for approximately 3 min 23 sec with good ring alignment. The hooks were driven closed nominally and final ring extension was performed, releasing the capture latches with the ring final-position being acquired at approximately 073/04:04:51 GMT (01/21:36:37 MET), at which time docking operations were complete.

The SRMS was maneuvered to the Space Laboratory Pallet (SLP) viewing position at 073/04:38 GMT (01/22:10 MET) to support the unberthing of the SLP from the payload bay with the Space Station Remote Manipulator System (SSRMS).

The Station-to-Shuttle Power Transfer System (SSPTS) was activated at 073/08:24 GMT (02/01:58 MET), and the ISS was transferring 6.4 kW of power to the Orbiter, which is the maximum power level that can be transferred.

No Focused Inspection was required as a result of the review of the Damage Assessment Team (DAT) recommendations by the Orbiter Project Office (OPO) Focused Inspection meeting. All Thermal Protection System (TPS) was cleared for the mission by the OPO, with the exception of a damaged area on the arrowhead Reinforced Carbon-Carbon (RCC). Pending completion of the analysis, the Orbiter TPS was considered degraded in accordance with the Flight Rules.

#### **Flight Day 4**

The Crew's main task for the FD 4 was the first Extravehicular Activity (EVA), which was successfully completed with a total EVA time of 7 hr 1 min. All EVA objectives were accomplished. The EMU hardware performed nominally during the EVA, with no issues reported. During EVA 1, GN<sub>2</sub> tank-to-tank transfer was initiated, and the SRMS successfully unberthed the Japanese Experiment Module (JEM) Experiment Logistics Module-Pressurized Section (ELM-PS) from the payload bay and installed it on the Node 2 module of the ISS.

#### **Flight Day 5**

The crew's main tasks for FD 5 were handoff of the OBSS from the SSRMS to the SRMS, the ingress of the JLP, and preparation for the second EVA.

The Reinforced Carbon-Carbon (RCC) DAT completed their analysis of the imagery obtained of the vehicle during the FD 2 exterior leading-edge surface surveys. The RCC DAT identified no issues and recommended that the Orbiter be cleared for entry. The arrowhead-plate-liberated repair site identified during the RPM was also evaluated and cleared for entry by the DAT.

The TPS Tile and Blanket DAT completed analysis of the imagery obtained from the flight. The imagery review verified that the ET doors were closed, no impacts were found near the forward windows, and all OMS blankets remained in place. A total of 19 items of interest were identified and cleared for entry (IFA STS-123-V-07).

The review of the ascent Modular Auxiliary Data System (MADS) data that was downlinked during post-insertion activities was completed. The OMS-L POD MID Surface Thermocouple gradually and abruptly reached OSH during the MADS/MMU1/SSR1 ascent data phase (IFA STS-123-V-08). The measurement was compared with past flight data and instrumentation near by and it was determined that the measurement is not working correctly. There was no mission impact as a result of this sensor.

### Flight Day 6

The crew's main task for FD 6 was the second EVA, which was successfully completed in 7 hr 8 min. This EVA included removing the SPDM Arm no. 2 and Arm no. 1 from the SLP Flight Support Equipment (FSE) and temporarily stowing them on a SLP bracket.

The nitrogen (N<sub>2</sub>) transfer from the Orbiter to the ISS was completed and approximately 23 lb were transferred.

The APU 3 seal cavity drain system pressure-decay continued at approximately 0.8 psi/day, and the APU 1 fuel tank pressure decay was approximately 3.6 psi/day corrected for temperature. The APU 1 Gas Generator (GG) chamber pressure transducer remained biased, and all other APU on-orbit parameters remained ed nominal.

An outline of the assessment of the APU 1 fuel tank pressure decay was presented at the OPO daily teleconference. The data and the analysis supported ed a GN<sub>2</sub> leak, but not a fuel leak. In parallel, preparations continued d to evaluate the procedures and impacts in the event a full or partial burn-to-depletion of APU 1 fuel iwas required.

### Flight Day 7

The FD 7 crew tasks included waste and supply water dumps, a Public Affairs Office (PAO) event, exercise, transfer operations, and a procedure review for the third EVA.

The Orbit Digital Autopilot (DAP) performance was nominal on FD 7 in support of the waste and supply water dumps. The Orbiter took attitude control from the ISS at 077/02:49:35 GMT (05/20:21:21 MET) and maneuvered approximately 16 deg to the water-dump attitude. After the maneuver to attitude, the Orbiter was in attitude control until all dumps were completed. At 077/05:18:04 GMT (05/22:49:50 MET), the Orbiter began the maneuver back to Torque Equilibrium Attitude (TEA) attitude. The DAP was placed in the FREE mode and the ISS took control of the mated stack at 077/05:34:24 GMT (05/23:06:10 MET).

## Flight Day 8

The FD 8 main task was the third EVA to complete the assembly of the Special Purpose Dexterous Manipulator (SPDM). The EVA crewmembers successfully completed the third EVA with a total EVA time of 6 hr and 53 min.

The APU 1 fuel tank pressure decay assessment was presented to the Mission Management Team (MMT). The assessment concluded that the characteristics of the pressure decay pointed toward the source of the leak as GN<sub>2</sub>, and not fuel, and that deliberate running the APU to deplete the fuel tank *was* not warranted. The MMT concurred with the recommendation to proceed with nominal operations for Flight Control System (FCS) checkout and entry.

The crew reported an unusual noise associated with the cabin temperature controller 1 operation (IFA STS-123-V-14). After switching to controller 2, the crew reported that the unusual noise ceased and the controller operated nominally. Excess noise on cabin temperature controller 1 was reported as a pre-existing condition, but postflight investigation of the controller will be performed.

While investigating the cabin temperature controller, the crew noticed water on the Water Coolant Loop (WCL) 2 tubing between the cabin temperature controller door and the galley, where insulation was found to be missing. The tubing *was* the inlet line into the cabin heat exchanger, and approximately 10-12 in. of insulation was missing. The line was dried and a towel and wash cloth were installed as a temporary solution. The line was checked daily to determine if any condensate continued to form.

## Flight Day 9

The FD 9 main tasks were the stowage of the SPDM on the U. S. Laboratory and the berthing of the SpaceLab Pallet (SLP) in the payload bay for return to Earth.

The crew reported problems potentially associated with high CO<sub>2</sub> concentration (IFA STS-123-N-001). All instrumentation indicated acceptable levels. As a result, both booster fans were powered to attempt to increase air flow.

The crew reported that the Aft Mission Timer was not working with the switch in GMT, MET or TEST positions (IFA STS-123-V-11). The crew cycled the circuit breaker and the Aft Mission Timer was recovered.

## Flight Day 10

The FD 10 main tasks were PAO events and the fourth EVA procedure reviews.

The Orbiter took attitude control at 080/02:24:50 GMT (08/19:56:36 MET) and maneuvered approximately 16 deg to the water-dump attitude. After the maneuver to the water-dump attitude, the Orbiter was in attitude hold until 080/04:33:54 GMT



(08/22:05:40 MET), at which time, the Orbiter then began the maneuver back to Torque Equilibrium Attitude (TEA). ISS took control of the mated stack at 080/05:14:34 GMT (08/22:46:20 MET).

Problems potentially associated with high CO<sub>2</sub> concentration continued to be reported. All instrumentation indicated acceptable levels.

### **Flight Day 11**

The FD 11 main task was the fourth EVA to complete the Tile Repair Ablator Dispenser (T-RAD) Detailed Test Objective (DTO) 848 procedure. The EVA crewmembers successfully completed all DTO objectives by filling all ten tile samples using the T-RAD dispenser. The fourth EVA was completed satisfactorily in 6 hr 24 min.

### **Flight Day 12**

The FD 12 main task was the Late Inspection of the RCC thermal protection system.

All Late Inspection imagery was successfully down-linked to the ground prior to the crew sleep.

Mitigation for the potential problems associated with high CO<sub>2</sub> concentration was performed. The crew installed additional air ducting from Node 2 to the US Laboratory to aid with the air flow in the Orbiter.

### **Flight Day 13**

The FD 13 main task was EVA 5 to hand over and configure the OBSS for stowage on ISS.

During OBSS-stowage operations, the SRMS released the OBSS and EVA crew members connected the keep-alive connector. The keep-alive power was turned on and the OBSS Light Emitting Diode (LED) illuminated indicating a nominal system operation. The thermal bag for OBSS Sensor Package 1 and Laser Camera System (LCS) window cover were installed with no issues reported. The SRMS was cradled and remained there for the remainder of the mission.

The third on-orbit fuel cell purge was initiated at 081/17:38 GMT (10/11:10 MET). During the 118-hour purge interval, the approximate voltage decay was 0.12 Vdc in fuel cell 1, 0.11 Vdc in fuel cell 2, and 0.14 Vdc in fuel cell 3.

All Late-Inspection imagery processing as well as the review were completed. A total of 230 Regions of Interest (ROI's) were identified with 33 sent to the MER for disposition by the Leading Edge Structure System (LESS) Problem Resolution Team (PRT). The LESS PRT reviewed all ROI's and determined that no damage was indicated and cleared the vehicle for entry.

The WLE IDS was powered up and continued monitoring until end of system battery life.

WLE IDS Sensor Unit (S/N 1150) on the Port Wing had excessive triggers (a total of 4452) during the first hour of monitoring. It was determined that the sensor-unit memory was saturated at the time (IFA STS-123-V-10). This problem did not cause an impact to WLE operations as all other sensors within that group were operating nominally.

#### **Flight Day 14**

FD 14 was mostly crew off-duty and also rendezvous tool checkout.

In support of the CO<sub>2</sub> issues seen this mission, the ISS Mission Management Team (IMMT) approved a reconfiguration of a portable air ducts to transport the Orbiter exchange air from the booster fans into the US Laboratory module using a 23-ft hose. The reconfiguration change was made after the crew awoke at approximately 083/18:30 GMT (12/12:02 MET). Measurements indicated an increase in air exchange between the Orbiter and the ISS US Laboratory where Carbon Dioxide Removal Assembly (CDRA) is located.

The crew reported a successful rendezvous tool checkout in preparation for undocking. Ground monitoring software indicated the Trajectory Control Sensor (TCS) also performed nominally.

#### **Flight Day 15**

The fourth on-orbit fuel cell purge was initiated at 084/15:50 GMT (14/09:22 MET). During the 70-hour purge interval, the approximate voltage decay was 0.09 Vdc in fuel cell 1, 0.06 Vdc in fuel cell 2, and 0.08 Vdc in fuel cell 3.

Orbiter undocking and separation from the ISS was nominal after a 30-min delay in ISS latching of the solar arrays prior to undocking. The Orbit DAP was placed in AUTO and the maneuver to the undocking attitude began at 084/22:42:55 GMT (13/16:14:41 MET). The approximate 180-deg roll maneuver was nominal. The ODS mechanism power-on was commanded at 084/23:28 GMT (13/17:00 MET). All hooks and latches were driven with no anomalies observed and undocking was completed satisfactorily. The physical separation maneuver (Separation 1) occurred at 085/00:25:03 GMT (13/17:56:49 MET) at a rate of 1.6 ft/sec.

TCS and Rendezvous Proximity Operations Program (RPOP) performed nominally during the undocking operations. The TCS problems that occurred during rendezvous did not re-appear during undocking, fly-around, or separation.

Post-undocking, the previously observed RCS failure (L3D vernier thruster oxidizer injector temperature to track the fuel-injector temperature trend) resumed as expected. The chamber pressure continues to indicate there is no leakage. Evaluation of the

possible causes as well as monitoring the data signature of the L3D thruster performance continued.

The Ku-Band system operations were nominal for undocking. The Ku-Band was taken to RADAR and locked onto the ISS at an approximate range of 228 ft. The Ku-Band was configured back to COMM at a range of approximately 5500 ft.

At approximately 085/02:35 GMT (013/20:07 MET), the crew reported a small micrometeoroid orbital debris (MM/OD) impact on the thermal pane of Window no. 1. The impact was in the upper left corner and is approximately 1/8 to 3/16 in. in diameter. There ~~was~~ no visible distortion beyond the impact location.

The WLEIDS received one new valid trigger at 085/01:33:03 GMT (13/19:03:49 MET) with a magnitude of 0.66 G on the lower port wing panels 2/3. The adjacent panel sensors were not active at that time.

### **Flight Day 16**

The crew's main tasks for FD 16 were the FCS checkout and the RCS hot-fire.

At 085/19:04:08 GMT (14/12:35:54 MET), the Fuel Cell Common H<sub>2</sub>O line pH-indication was received (IFA STS-123-V-13). It cleared after 39 sec. Additional transient indications were seen. The 3 individual fuel-cell pH sensors did not indicate high and the performance of all three fuel cells was nominal. The crew completed a fuel cell H<sub>2</sub>O pH test and reported a pH of 4.5, which was more acidic than the expected neutral 7.0 reading.

The FCS checkout was performed satisfactorily. APU 1 operation was started at 085/18:36 GMT (14/12:08 MET). A total of 18 lb of fuel was used during the 5 min 44 sec run-time of the APU. All APU parameters were nominal during the FCS checkout.

The RCS hot-fire procedure was initiated at 085/20:05 GMT (14/13:37 MET) and the hot-fire was completed 7 min later. All 38 thrusters were fired for at least 0.240 sec per pulse. All thrusters have now been fired satisfactorily.

The Micrometeoroid/Orbital Debris (MM/OD) impact on the thermal pane of Window no. 1 was reviewed and cleared by the Windows Problem Resolution Team (PRT).

The WLE IDS 0.66 G trigger detected on FD 15 was reviewed and cleared.

### **Flight Day 17**

Both PLBDs were closed nominally by 086/19:23:49 GMT (15/13:49:35 MET) in preparation for landing.

The first landing opportunity at Kennedy Space Center (KSC) was waved off because of weather considerations.

During Deorbit preparations, the Fuel Cell Common pH Sensor received additional transient indications. During OPS 3, these indications are only visible on the ground.

The deorbit maneuver was performed on orbit 249 for the second landing opportunity at KSC, a dual-engine straight-feed firing, was performed at 086/23:33:13.970 GMT (15/17:04:59.986 MET). The duration of the deorbit firing was 165.2 sec and the  $\Delta V$  was 303.8 ft/sec. The orbit following the deorbit firing was 22.5 by 190.0 nmi. The engines performed satisfactorily.

Entry interface occurred at 087/00:07:28.369 GMT (15/17:49:14.375 MET), and entry was completed satisfactorily.

The main landing gear touchdown occurred on KSC concrete runway 15 at 87/00:39:06 GMT (15/18:10:52 MET) on March 26, 2008. The drag chute was deployed at 087/00:39:09 GMT. Nose-gear touchdown occurred at 087/00:39:15 GMT. Drag chute release occurred at 087/00:39:55 GMT. Wheels stop occurred at 087/00:40:38 GMT. The rollout was normal in all respects.

The flight duration was 15 days 18 hr 10 min 52 sec. The last Auxiliary Power Unit (APU) was shutdown at 20 min 45 sec after landing.

### **Post-Flight**

Postflight, it was determined that a radiator retract hose did not properly retract during PLBD closing (IFA STS-123-V-15), but did not affect door closure or cooling system performance.

During the STS-124 PI/OPS (training) pre-event inspection, the Advanced Crew Escape Suit (ACES) glove was found with a large (approximately 1-in. long) tear in left-hand glove bladder in the crotch between the pinky and ring finger (IFA STS-123-V-16). The glove history was reviewed, nothing abnormal was noted, and the glove was not used between post STS-123 landing and the discovery of anomaly. The glove was pressure tested prior to stowage onboard STS-123 for returning ISS crewmember. The glove underwent a general inspection, which did not include a bladder inspection, and was shipped to Houston, where a general inspection was repeated, and then it was placed into bond.

## **PAYLOADS AND EXPERIMENTS**

### **LAUNCH PACKAGE OVERVIEW**

The International Space Station (ISS) 1J/A launch package consisted of the Japanese Experiment Logistics Module-Pressurized Section (ELM-PS), the Canadian Special Purpose Dexterous Manipulator (SPDM) (named Dextre), and seven sidewall-mounted payload components, including two Direct Current Switching Units (DCSU's), one Space Station Remote Manipulator System (SSRMS) Yaw Joint, two Materials on International Space Station Experiment-6 (MISSE-6) Passive Experiment Containers (PECs), one Lightweight Adapter Plate Assembly (LWAPA), and the Rigidizable Inflatable Getaway Special Experiment (RIGEX).

The ISS Program (ISSP) Utilization payloads flown in the Middeck were 12 Microbial Drug Resistance and Virulence (MDRV) Group Activation Packs (GAPs), 4 National Laboratory Pathfinder (NLP) Vaccine GAPs, the European Modular Cultivation System (EMCS)/Cell Wall Resist Wall (CWRW), the Coarsening in Solid-Liquid Mixture (CSLM) Sample Processing Units, and the Synchronized Position Hold, Engage, Reorient, Experimental Satellites (SPHERES) resupply.

The Short Duration Bioastronautics Investigations (SDBIs) performed during the mission included SDBI 1634 (Sleep Short) and ISS Integrated Immune and SDBI 1900 (Integrated Immune). Middeck payloads returned included European Space Agency (ESA) Waiving and Coiling Response of Arabidopsis Roots (WAICO) in the Microgravity Experiment Research Locker Incubator (MERLIN), sample collection kits, and two double Cold-bags were used to return ICEPACS and Samples. The Maui Analysis of Upper-Atmospheric Injections (MAUI) was flown as a payload of opportunity, but was not performed.

### **CREW ACTIVITY SUMMARY**

The Orbiter [Endeavour](#) successfully docked to the ISS at [9:49 p.m. Central Daylight Time \(CDT\)](#) (01/21:21:14 MET) [on March 12, 2008](#), with hard-dock (hooks closed) occurring 14 min later. After the hatches were opened, Garrett Reisman transferred to the ISS and officially became a member of the Expedition 16 crew when he installed his Individual Equipment Liner Kit (IELK) into 16 Soyuz.

After docking, the SSRMS grappled the SpaceLab Pallet (SLP) holding the Special Purpose Dexterous Manipulator (SPDM) and unberthed the SLP/SPDM from the Shuttle cargo bay. The Pallet was handed off to the Shuttle Remote Manipulator System (SRMS), which installed the SLP on the ISS Mobile Base System (MBS) Payload Orbital Replacement Unit (ORU) Accommodation (POA). However, when power was commanded to the MBS and POA, no response was received. On Flight Day (FD) 5, the SSRMS re-grappled the SLP/SPDM to provide keep-alive power to the SPDM components. On FD 7, the SPDM brake run-in tests for ARM 1 and ARM 2 were

completed, however, during step 12, the ARM 2 wrist joint over-rotated by 0.1 degree. Although this was unexpected, the SPDM passed its brake run-in tests.

Five EVAs were successfully performed. These included the installation of the Japanese Aerospace Exploration Agency (JAXA) Experiment Logistics Module – Pressurized Section (ELM-PS), installation of the Canadian Space Agency (CSA) Special Purpose Dexterous Manipulator (Dextre), transfer of two Direct Current Switching Units (DCSUs) and one Space Station Remote Manipulator System (SSRMS) Yaw Joint, demonstration of the Tile Repair Ablator Dispenser (T-RAD) DTO-848, and transfer of the Materials on International Space Station Experiment –6 (MISSE-6). During the initial MISSE-6 transfer, the EV crew was unable to install the initial Passive Experiment Container (PEC) onto the LWAPA and the task was deferred to the final EVA where the crew managed to install the hardware successfully. In addition, the OBSS was transferred to the ISS where it remained until the OBSS is brought home on the next SSP flight (STS-124).

On FD 14, prior the crew sleep period, the crew activated the Rigidizable Inflatable Getaway Special Experiment (RIGEX) experiment in the cargo bay. Following the completion of the sleep period, the crew turned off RIGEX. RIGEX operations were nominal.

The ISS and Shuttle crews bid farewell and closed the ISS hatch on FD 15, at 084/21:58 GMT (13/15:23 MET). Endeavor successfully undocked from the ISS approximately

2.5 hr later, and then completed a flyaround to obtain imagery of ISS with the newly-delivered [Japanese Experiment Module-Pressurized Module \(JEM\) Experiment Logistics Module - Pressurized Section \(ELM-PS\)](#) and Special Purpose Dexterous Manipulator (SPDM). The addition of the JLP added approximately 2,000 cubic feet (ft<sup>3</sup>) of internal volume and 18,490 lbm to the ISS. The SPDM added 3,431 lbm.

#### TRANSFER WEIGHT SUMMARY

The majority of the transfers were successfully accomplished during the mission. The following table and discussion provides an overview of the total transfers

#### TOTAL WEIGHT TRANSFERRED DURING THE MISSION

Parameter	To ISS, lb	From ISS, lb
Middeck	1,423	1565
ELM-PS	18,377	
SPDM	3,431	
ISS ORU	1,546	
MISSE-6	422	
<b>Totals</b>	<b>25,199</b>	<b>1565</b>

1. **Water** – The total quantity of supply water transferred was 608.3 lbm. A total of five Contingency Water Containers (CWC's) were transferred along with eight Portable Water Reservoirs containing 172.8 lbm
2. **Oxygen** – No oxygen was transferred during STS-123.
3. **Nitrogen** – A total of 23 lbm of Nitrogen was transferred to the Airlock tanks.
4. **Lithium Hydroxide** – A total of 10 new Lithium Hydroxide (LiOH) canisters were transferred to the ISS. A total of 16 LiOH canisters were transferred from the ISS to the Shuttle.
5. **Food** – No food was transferred to the ISS.

### **SIGNIFICANT FIRSTS**

The significant firsts for this mission are as follows:

1. Longest planned duration Shuttle mission to the ISS;
2. First Japanese module to be delivered to the ISS (JEM ELM-PS);
3. Delivery of the Canadian SPDM;
4. Docked late inspection;
5. Leaving OBSS on ISS (S1 truss) for retrieval, use, and return on STS-124;
6. First loaded use of the Payload and ORU Accommodation (POA);
7. DTO 848 Tile Repair Ablator Dispenser (TRAD);
8. First flight of the new on-board Shuttle Ethernet Local Area Network (LAN) configuration;
9. First flight of the new Extended Range Ammonia Detection Kit;
10. First flight of the RIGEX experiment;
11. Seven sidewall carriers were carried in payload bay;
12. Three Orbital Replacement Units (ORUs) were carried for transfer;
13. Three-part Payload was carried for transfer and deployment; and
14. One static Payload was carried.
15. First flight of the ET camera flash units located in the left-hand ET/Orbiter umbilical that provided illumination of the ET for post-ascent photography.

### **SIGNIFICANT ISS ANOMALIES**

The SPDM power-up to Keep-Alive in the SpaceLab Pallet was aborted because the Laboratory robotics workstation could not establish communications with either of the Power Switching Unit (PSU) remote terminals on the Mobile Servicing System (MSS) local bus. Power-up attempts on the alternate MSS local bus channel and alternate power string were also unsuccessful. Troubleshooting and software patches were performed, with no success. The SSRMS was used to provide communications and Keep-Alive power to the SPDM until it could be fully assembled and installed on the U. S. Laboratory Power and Data Grapple Fixture (PDGF).

## MAJOR ISS MISSION PRIORITIES AND END-OF-MISSION STATUS

The following table provides the status of the mission priorities at the end of the mission.

### ISS MISSION PRIORITIES COMPLETION STATUS

Item	Task	Flight Day
1	Dock Orbiter to Pressurized Mating Adapter 2 (PMA 2) port and perform mandatory safety briefing for all crewmembers.	FD3
2	Rotate ISS-1E Flight Engineer (FE) with ISS-1J/A FE, transfer mandatory crew rotation cargo per Flight 1J/A Transfer Priority List (TPL), and perform mandatory tasks consisting of Individual Equipment Liner Kit (IELK) installation and Sokol suit checkout.	FD3
3	Transfer items per ballasting plan.	N/A
4	Install JEM ELM-PS to Node 2 zenith port.	FD4
4a	Demate and stow Launch to Activation (LTA) heater cables and remove Passive Common Berthing Mechanism (PCBM) contamination cover.	FD4
4b	Inspect Node 2 zenith Active Common Berthing Mechanism (ACBM).	FD4
4c	Inspect ELM-PS PCBM sealing surface.	FD4
4d	Open Node 2 zenith hatch window flap to allow Centerline Berthing Camera System (CBCS) operations for ELM-PS mate.	FD4
4e	Mate ELM-PS to Node 2 zenith ACBM.	FD4
4f	Perform Node 2 zenith ACBM mate checkout.	FD4
5	Perform JEM ELM-PS critical activation.	FD4
5a	Mate JEM ELM-PS power utility connections and activate JEM ELM-PS heaters.	FD4
5b	Install and configure JEM ELM-PS Minimum Keep Alive Kit (MKAK).	FD4
6	Unberth and install SpaceLab Pallet (SLP-D1) with SPDM on the MBS POA, and apply keep alive power.	FD3 (power not applied until FD4)
7	Perform MBS On-Orbit Checkout Requirements (OCRs) that are mandatory to ensure MBS provides single fault tolerant heater power to SPDM.	FD4
8	Install and route Keep Alive Umbilical (KAU) and stow OBSS on ISS.	FD13
9	Transfer mandatory quantities of water between Orbiter and ISS.	FD4,5,6,11,13
10	Transfer critical items per 1JA TPL.	FD3,4
11	Transfer Waiving and Coiling of Arabidopsis Roots (WAICO) sample run No. 1 from BIOLAB to Shuttle MERLIN.	FD14
11a	Complete WAICO final activities if not completed in Stage 1E.	Not Performed
11b	Perform actual transfer of WAICO sample 1 from BIOLAB to Shuttle MERLIN.	Not Performed



**ISS MISSION PRIORITIES COMPLETION STATUS (Continued)**

<b>Item</b>	<b>Task</b>	<b>Flight Day</b>
12	Transfer double cold bag with Human Research Program (HRP) Nutrition samples to middeck.	FD15
13	Transfer double cold bag with HRP Nutrition and IMMUNO samples to middeck.	FD15
14	Assemble and deploy SPDM/Dextre.	FD4,6,8,9
14a	Install ORU Tool Changeout Mechanism (OTCM) to SPDM arms and attach arms to SPDM body.	FD4,6
14b	Install Tool Holder Assembly and ORU and Tool Platform (OTP).	FD8
14c	Relocate SPDM/Dextre to clear Mobile Transporter (MT) translation path and apply Keep Alive power.	FD9
15	Reberth SLP-D1 in Payload Bay (PLB)	FD9
16	Transfer SSRMS Yaw Joint to External Stowage Platform 2 (ESP-2).	FD8
17	Transfer DCSU No. 1 to ESP-2.	FD8
18	Transfer DCSU No. 2 to ESP-2.	FD8
19	Perform JEM ELM-PS ingress and initial outfitting.	FD5
19a	Remove Control Panel Assemblies (CPAs) (four) and ingress JEM ELM-PS.	FD5
19b	Take Russian and United States On-orbit Segment (USOS) air samples at first ingress of ELM-PS.	FD5
19c	Establish Intermodule Ventilation (IMV); activate Emergency Lighting Power Supply (ELPS), ventilation fan, and General Luminaire Assemblies (GLAs); Install Positive Pressure Relief Valve (PPRV) caps; perform Negative Pressure Relief Valve (NPRV) C/O and configure Portable Fire Extinguisher (PFE) and Portable Breathing Apparatus (PBA).	FD5
19d	Inspect ELM-PS racks for cooling water leakage.	FD5
20	Perform minimum crew handover of 12 hours per rotating crewmember which includes crew safety handover.	FD5,10,11, 12,14,15 (total of 12hr 45min)
21	Deploy MISSE 6 with Lightweight Adapter Plate Assembly (LWAPA) on Columbus External Payload Facility.	FD8 (LWAPA Only)
22	Perform RIGEX experiment.	FD14
23	Release Node 2 Port ACBM petal cover restraints.	FD11
24	Perform DTO-848 – TPS Repair Techniques (T-RAD/STA-54 Tile Repair Demonstration).	FD11
25	S02B-D RPCM R&R and patch panel reconfiguration to restore Control Moment Gyro (CMG) 2 nominal power string.	RPCM R&R on FD11 No patch panel

**ISS MISSION PRIORITIES COMPLETION STATUS (Continued)**

<b>Item</b>	<b>Task</b>	<b>Flight Day</b>
26	Re-inspection of EVA 14 Cover 21 inspection site (alpha 0) – DATUM A.	FD13
26a	Remove Cover.	FD13
26b	Using an EVA wipe, attempt to liberate debris from Datum A.	FD13
26c	If debris cannot be liberated or damage is observed, attain a series of photo-graphs of the site. Care should be taken to take photographs at a variety of incidences to the inspection site. Imagery analyses rely on multiple angles of the same site.	FD13
27	Remove, inspect and replace starboard Solar Alpha Rotary Joint (SARJ) single covers (6, 8, 9, 11, 16).	FD13
27a	Inspect cover for any damage caused by MM/OD and/or Multilayer Insulation (MLI) cover that is torn or damaged.	FD13
27b	Photograph cover only if above inspection results in appearance of damage.	FD13
27c	Inspect and report condition of the SARJ under the cover.	FD13
28	Install spare Trundle Bearing at starboard location no. 5.	Deferred
29	Remove and replace ISS Radiation Area Monitors (RAMS).	FD6 - could not locate one of them
29a	Transfer CWRW from Shuttle to Minus Eighty Laboratory Freezer (MELFI).	FD4
30	Transfer remaining cargo items per flight 1JA TPL ME.	Done
31	Transfer Nitrogen from the Orbiter to the ISS Airlock High Pressure Gas Tanks.	FD5, 6 (23 lb transferred)
32	Transfer Oxygen from the Orbiter to the ISS Airlock High Pressure Gas Tanks, as available.	Not Performed
33	Install Camera/Light/Pan-Tilt Assembly on SPDM.	FD8
34	Remove thermal covers from SPDM Electronics Platform (EP1 and EP2), arms, OTCM's, and Camera Light Assembly (CLA).	FD6,8,11
35	Perform JEM ELM-PS prep for 1J.	FD6,7,8,9,10
35a	Configure racks for on-orbit operations and prepare racks for 1J transfer.	FD6, 7
35b	Unload and stow JEM ELM-PS rack front launched items.	FD6
35c	Assemble hard dummy panels (two).	Done
35d	Retrieve JEM Television Electronics (JTVE) booms.	FD9
35e	Take Japanese Experiment Logistics Module-Pressurized Section (JLP) shell temperatures to correlate thermal model (ref Chit 5966).	FD6, 7
36	Perform SPDM OCRs to complete the nominal deploy sequence.	FD7,8,9
37	Perform ISS daily payload status checks as required.	Daily
38	Perform daily middeck activities to support payloads.	Daily
38a	SDBI 1900, Integrated Immune.	FD5-15

**ISS MISSION PRIORITIES COMPLETION STATUS (Continued)**

<b>Item</b>	<b>Task</b>	<b>Flight Day</b>
38b	SDBI 1634, Sleep Short.	FD5-15
38c	Daily status checks of MERLIN upon power up.	FD13 Powerup
38d	Microbial Drug Resistance and Virulence (MPRV) Group Activation Pack (GAP) Activation / Deactivation (12).	FD2,5,11,12, 14,15
38e	National Lab Pathfinder (NLP) – Vaccine – 1A GAP Activation / Deactivation (4).	Done
39	Perform ISS payload research operations tasks.	Daily
39a	Journals.	Done
39b	Integrated Immune.	Done
39c	Sleep Long.	Done
39d	JAXA Educational Payload Operations for Passive Observatories for Experimental Microbial Systems (POEMS) and SEEDS.	FD11
39e	Transfer and install NLP Critical Safety Item (CSI ) and Commercial Generic Bioprocessing Apparatus (CGBA) Science Insert), and resupply in CGBA 5.	FD5
39f	Remove and stow Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions (InSPACE) -2 hardware from Microgravity Science Glovebox (MSG) work volume.	FD7
39g	Perform relocation of Elaboratore Immagini Televisive 2nd Generation (ELITE) hardware from Express Rack (ER) 5 to ER2.	FD15
39h	Perform ER2 EXPRESS Laptop Computer (ELC) software load.	Deleted (1E Stage)
40	Relocate Express Rack No. 3 from LAB1O3 to COL1A1.	FD12
41	Relocate Microgravity Science Glovebox (MSG) from LAB1S3 to COL1F2.	FD12
41a	Take ITCS samples from Columbus and transfer to Shuttle (ref. Chit 5957).	FD12
42	Perform STDO 13005-U, ISS Structural Life Validation and Extension during ELM-PS installation.	FD14
43	Perform SDTO 13005-U, ISS Structural Life Validation and Extension during ELM-PS installation.	FD4
44	Perform SDTO 13005-U, ISS Structural Life Validation and Extension during Orbiter undocking.	FD15 (IWIS not required)
44a	Install covers in LiOH cans in the ISS stockpile (ref. Chit 5940).	Complete
45	Install Node 2 zenith hatch cover.	FD7
46	Install hatch latch handle guide assemblies (x2) (Node 2 Zenith; JEM ELM-PS Nadir) and Hatch Labels (x2) (JEM ELM-PS Nadir; A/L IV Hatch).	FD7
47	The following tasks are deemed to fit within the existing EVA timelines; however may be deferred if the EVA is behind schedule. The EVA will not be extended to complete these tasks.	N/A

**ISS MISSION PRIORITIES COMPLETION STATUS (Continued)**

<b>Item</b>	<b>Task</b>	<b>Flight Day</b>
48	Reboost ISS with the Orbiter if mission resources allow and are consistent with ISS trajectory analysis and planning.	N/A
49	Perform imagery survey of the ISS exterior during Orbiter flyaround after undock, if propellant available.	FD15
50	Perform MAUI (payload of opportunity) if propellant available.	N/A
51	Perform an additional 4 hours per rotating crewmember of ISS handover (16 hours per crewmember total).	FD15 (went 45min above the 12hr minimum)
52	Gather and package items for 1J.	Done
52a	Perform 1J preparation activities.	Complete
52b	RLT-BU screen saver disable.	Complete
52c	JLP standoff bag retrieval for Bag 11.	Complete
53	Relocate CBCS from Node 2 zenith to port ACBM.	FD3 - removed CBCS from Node 2 zenith
54	Perform program-approved EVA get ahead tasks. The following EVA get ahead tasks do not fit within the existing EVA timelines; however, the EVA team will be trained and ready to perform should the opportunity arise. EVA/Mission Operations Directorate (MOD) has the flexibility to select the tasks to be completed based on efficiencies gained in performing the already scheduled required tasks.	See below
54a	Install JLP trunnion thermal covers.	FD13
54b	Obtain additional data for the SARJ Race Ring under covers 6, 8, 9, 11, and 16. 1. Photograph of Datum A. 2. Photograph outer canted surface. 3. Collect tape samples of portions of the race ring previously not inspected.	FD13
54c	Install Node 1 C2-02 MMOD shield.	Not Performed
54d	Take EUTEF photos.	Not Performed
54e	Relocate APFR to support 1J.	Not Performed
54f	Release Node 2 nadir ACBM petal cover restraints.	FD11
54g	Retrieve Node 2 nadir ACBM pip pin and open window flap.	FD11 - looked for PIP pin but didn't locate; opened window flap

**ISS MISSION PRIORITIES COMPLETION STATUS (Concluded)**

<b>Item</b>	<b>Task</b>	<b>Flight Day</b>
54h	Return 3/8" Drive Ratchets to EVA Tool Stowage Device (ETSD).	Not Performed
54i	Return General Purpose cutters to Airlock Tool Box 2.	FD13
54j	Inspect S0 safety tethers (x2).	FD8
54k	Open Mobile Servicing System (MSS) Common Attach System (MCAS) target protective cover.	FD8
55	Unpack remaining flight 1J/A cargo.	Done
56	Perform ISS periodic maintenance.	Not Performed
57	Assemble JEM TV Camera Electronics (JTVE) boom.	FD8

## VEHICLE PERFORMANCE

### SOLID ROCKET BOOSTERS

All Solid Rocket Booster (SRB) systems performed as expected during the launch-countdown and ascent of the STS-123 mission. The SRB pre-launch countdown was nominal. No SRB Launch Commit Criteria (LCC) or Operations and Maintenance Requirements and Specifications Document (OMRSD) violations occurred, and no waivers or exceptions were written. One in-flight anomaly was identified during the flight when data were lost from the SRB right-hand External Tank (ET) observation camera during ascent (IFA STS-123-B-001).

Both SRBs were successfully separated from the ET and were towed back to Kennedy Space Center (KSC) for inspection and teardown.

### REUSABLE SOLID-ROCKET MOTORS

The STS-123 Reusable Solid Rocket Motor (RSRM) set performed within established and predicted limits (nominal). No RSRM LCC or OMRSD violations were identified. All Ground Environmental Instrumentation (GEI) and Operational Flight Instrumentation (OFI) performed within established requirements. No in-flight anomalies have been identified.

The motor performance parameters for this flight were within Contractor End Item (CEI) specification limits. Reconstructed performance parameters adjusted to a 60 °F Propellant Mean Bulk Temperature (PMBT) standard are listed in the table below.

#### RSRM PERFORMANCE PARAMETERS AT 60° F PMBT

Parameter	CEI specification limit, 60 °F	Left motor delivered	Right motor delivered
Web time, sec	105.4 – 116.7	110.5	110.1
Action time, sec	115.2 – 131.2	122.9	122.8
Head end pressure, psia	847.9 – 965.7	907.7	906.2
Maximum Sea Level Thrust, lbf	2.88 – 3.26	3.08	3.08
Web Time Average Pressure, psia	629.9 – 700.5	666.4	667.5
Web Time Average Thrust, Mlbf	2.46 – 2.74	2.61	2.61
Web time total impulse, Mlbf sec	285.8 – 291.6	288.4	287.6
Action time impulse, Mlbf sec	293.7 – 299.7	296.3	295.8
ISP average delivered, lbf sec/lbm	266.5 – 270.3	268.4	267.9
Loaded propellant weight, lbf	>1103750	1104592	1104817

**Note:** All times referenced to liftoff time (when chamber pressure reaches 563.5 psia),

The ambient temperatures recorded during the 107 hr prior to launch of STS-123 varied from 44 to 79 °F. At the time of launch, the ambient temperature was 67 °F. Propulsion performance is listed in the following table. The calculated PMBT was 64 °F at time of launch. The maximum trace shape variation of pressure vs. time during the 62-80 sec time frame was calculated to be 0.99-percent at 79.5 sec (left motor) and 0.88-percent at 80.0 sec (right motor). These values were within the 3.2-percent allowable limits.

### RSRM PROPULSION PERFORMANCE

Parameter	Left motor, 64 °F		Right motor, 64 °F	
	Predicted	Actual	Predicted	Actual
Impulse gates @ 60 °F				
I-20, 10 <sup>6</sup> lbf-sec	64.2	64.3	64.2	64.0
I-60, 10 <sup>6</sup> lbf-sec	172.5	172.8	172.5	172.1
Vacuum Isp, lbf-sec/lbm	268.5	268.5	268.5	267.9
Burn rate, in./sec @ 60 °F at 625 psia	0.78	0.3691	0.3675	0.3701
Event times, sec <sup>a</sup>				
Ignition interval	0.232	N/A	0.232	N/A
Web time <sup>b</sup>	110.5	110.0	110.7	109.8
50-psia cue time	120.7	120.2	119.2	119.9
Action time <sup>b</sup>	122.9	122.4	123.0	122.4
Separation command	125.2	124.8	125.2	124.8
PMBT, °F	64	64	64	64
Maximum ignition rise rate, psia/10 ms	90.8	N/A	90.8	N/A
Decay time, sec (59.4 psia to 85 K)	3.2	3.1	3.2	3.3
Tailoff impulse imbalance differential <sup>c</sup>	Predicted N/A		Actual 438.1	

<sup>a</sup>All times are referenced to ignition command time except where noted by footnote b.

<sup>b</sup>Referenced to liftoff time (ignition interval).

<sup>c</sup>Impulse imbalance = integral of the absolute value of the left motor thrust minus right motor thrust from web time to action time.

Igniter joint heaters operated for 28 hr 13 min during the launch countdown. Power was applied to the heating elements 68-percent (average) of the time during the LCC time frame of the countdown to keep the igniter joints in their normal operating range. Field joint heaters operated for 14 hr 7 min during the launch countdown. Power was applied to the heating elements 44-percent (average) of the time during the LCC time frame of the countdown. The aft skirt purge operations were for 11 hr 32 min.

During the LCC time frame, both the left and right hand motor nozzle/case joint sensor temperatures ranged from 80 °F to 87 °F. The Flex Bearing Mean Bulk Temperature (FBMT) was calculated to be 84 °F.

## **EXTERNAL TANK**

All STS-123 objectives and requirements associated with the Super Lightweight Tank External Tank (ET) -126 propellant-loading and flight operations were met. No significant oxygen or hydrogen concentrations were detected in the Intertank. All ET electrical equipment and instrumentation operated satisfactorily. Purge and heater operations were monitored and performed properly. Liquid level and Engine Cutoff sensors performed as designed. No ET LCC or OMRSD violations occurred.

ET separation was nominal. Since Main Engine Cut Off (MECO) occurred within expected tolerances, entry and break-up of the ET occurred within the planned footprint.

## **SPACE SHUTTLE MAIN ENGINES**

All Space Shuttle Main Engine (SSME) parameters were nominal throughout the pre-launch countdown and were typical of previous flights. The Block II engines were 2047, 2044, and 2054 and these were in positions 1, 2, and 3, respectively. No LCC or OMRSD violations were noted, nor were any IFAs identified during the data analysis. Engine "Ready" was achieved at the proper time, all LCC's were met, and thrust build-up was nominal.

Flight data indicates nominal SSME performance during startup, mainstage, throttling, and shutdown. High Pressure Oxidizer Turbo Pump (HPOTP) and High Pressure Oxidizer Fuel Turbo Pump (HPFTP) temperatures appeared to be well within specifications throughout engine operation. Commanded Max Q throttle down was a two-step throttle to 99-percent and then 72-percent, which indicates Adaptive Guidance Throttling (AGT) was initiated. Propellant dump operations data were normal and the time of Main Engine Cutoff (MECO) time was Engine Start +510 sec.

The review of STS-123 Advanced Health Monitoring System (AHMS) vibration measurements indicates nominal performance. No Failure Identifiers (FIDs) were reported to the Vehicle Data Table (VDT) from start preparation through propellant dump on all engines. All accelerometer measurements appear healthy.

The average SSME specific impulse tag value was 453.03 sec at 104.5-percent power level.

## **SHUTTLE RANGE SAFETY SYSTEM**

The Shuttle Range Safety System (SRSS) closed-loop testing was completed as scheduled during the launch countdown. There were no OMRSD or LCC violations. All SRSS Safe and Arm (S&A) devices were armed and system inhibits were turned off at the appropriate times. As planned, the SRB S&A devices were safed and SRB system power was turned off prior to SRB separation.



## ORBITER SYSTEMS

### Main Propulsion System

All Main Propulsion System (MPS) systems performed as expected during launch countdown and ascent. No MPS-related LCC and OMRSD violations occurred. The MPS pre-launch countdown was nominal, and one IFA was identified during the post-flight data analysis and it is discussed in a later paragraph in this section.

The maximum hydrogen concentration level in the Orbiter aft compartment, with the normally elevated system back-pressure used for fast-fill, was 146 (uncorrected). System B was used to determine the maximum concentration. This level compares favorably with previous data for this Orbiter.

Data show that the Liquid Oxygen (LO<sub>2</sub>) and Liquid Hydrogen (LH<sub>2</sub>) systems performed as designed. The LH<sub>2</sub> system pre-pressurization cycle count was 9 cycles and the LCC limit is 14 cycles.

The overall Gaseous Hydrogen (GH<sub>2</sub>) system in-flight performance was nominal. All three Flow Control Valves (FCVs) performed nominally with 4 cycles of FCV 1 and 2 and 10 cycles for FCV 3.

The Gaseous Oxygen (GO<sub>2</sub>) fixed orifice pressurization system performed as predicted. Reconstructed data from engine and MPS parameters closely matched the actual ET ullage pressure measurements.

During ascent, the MPS engine 3 LO<sub>2</sub> inlet pressure showed a shift of 30 psi at lift-off (IFA STS-123-V-06). This was the second flight of this transducer and it operated nominally during its first flight. When the data are compared for the last five flights, it is apparent that the shift lasted until SRB separation. Later in the ascent, the measurement recovered until MECO.

### Hazardous Gas Concentrations

The aft hazardous gas concentrations during loading were nominal. The following table summarizes the results.

#### HAZARD GAS CONCENTRATIONS AT LAUNCH

Parameter	Peak, ppm	Steady State, ppm
Helium	11512	8044
Hydrogen	140	32
Oxygen	35.4	9
LD54/55	0	0

## Gas Sample Analysis

The measured sample bottle pressures indicate the redesigned Orbiter aft fuselage gas sampler system successfully collected all six samples. STS-123 was the ninth flight using the new gas chromatograph/mass spectrometer at the Kennedy Space Center (KSC) Materials Science Laboratory.

One oxygen concentration was below the flammability limit. Bottle right hand no. 1 was on the high side of historical values with a concentration of 3.94-percent, which is approximately 0.2-percent below the flammability limit. Only 0.58-percent of the total is attributed to Orbiter system leakage. The measured argon concentrations indicated air as a major source of the oxygen concentrations and not a Main Propulsion System (MPS) leak. Bottles left-hand 1, right-hand 2 and left-hand 2 were more in family. The final two bottles, left-hand 3 and right-hand 3, were on the low side of historical values. The highest helium concentration was 3.59-percent in right hand no. 3 bottle. The helium concentrations were at normal levels consistent with previous data samples taken, and are shown. The following table provides a summary of the Right Hand (RH) and Left Hand (LH) gas sample data analysis.

### SUMMARY OF BOTTLE PRESSURES AND GAS CONCENTRATION

Bottle No.	Position	Pressure, psia	Helium, %	Measured Oxygen, %	Hydrogen, %
1	RH 1	3.42	0.66	3.94	0.07
2	LH 1	1.45	0.31	2.78	0.06
3	RH 2	1.33	0.39	3.60	0.05
4	LH 2	0.83	0.68	3.23	0.08
5	LH 3	0.17	1.59	1.36	0.27
6	RH 3	0.06	3.59	0.54	0.53

The Ascent Hazard Analysis indicates the maximum hydrogen firing leak rate was 3480 scim. The maximum allowable firing leak rate on ascent is 57,000 scim. Hydrogen concentrations were well below the flammability limit in each bottle, and the concentrations are shown in the following table.

### HYDROGEN FIRING LEAK RATES

Bottle no.	Position	Hydrogen Firing Leak Rate, scim
1	RH 1	3480
2	LH 1	1530
3	RH 2	1220
4	LH 2	1380
5	LH 3	1175
6	RH 3	860

The complete results of the gas chemical analysis, provided by Kennedy Space Center, are shown in the following table.

**AFT FUSELAGE SAMPLE BOTTLE GAS ANALYSIS**

S/N	Position	Actual pressure, torr	Ar, %	Air from Ar, %	He, %	CO, %	CH <sub>4</sub> , %	CO <sub>2</sub> , %	O <sub>2</sub> from air, %	O <sub>2</sub> found, %	H <sub>2</sub> , %	H <sub>2</sub> pyro corrected, %
1110 FLT-1	RH1	177.0	0.15	16.06	0.66	<0.01	<0.01	0.01	3.36	3.94	0.07	0.07
1114 FLT-1	LH1	74.9	0.11	11.99	0.31	<0.01	<0.01	0.01	2.52	2.78	0.06	0.06
1111 FLT-1	RH2	68.6	0.15	15.52	0.39	<0.01	<0.01	0.01	3.26	3.60	0.05	0.05
1134 FLT-0	LH2	42.7	0.13	14.24	0.68	0.01	<0.01	0.01	2.99	3.23	0.08	0.08
1142 FLT-0	LH3	8.66	0.05	5.03	1.59	0.03	0.02	0.01	1.06	1.36	0.29	0.27
1112 FLT-1	RH3	3.02	0.04	4.71	3.59	0.01	0.05	0.01	0.99	0.54	0.54	0.53

**Purge, Vent, and Drain System**

The Purge, Vent and Drain (PV&D) system performed well during launch. Purge readings and hazardous gas detection system readings were nominal. Near the end of the Liquid Oxygen (LO<sub>2</sub>) fast fill, an increase in the aft O<sub>2</sub> concentration from 10 ppm to 35 ppm occurred. This Orbiter (OV-105) has a history of increased oxygen concentrations during loading. The limit for aft oxygen is 500 ppm, and there was no impact to the loading operations from this concentration increase.

The PV&D system performed nominally during the entry and landing phases. The post-landing purge was not initiated within 45 min of touchdown (was 56 min). This delay in the purge did not impact the ground operations, but a Data Trend Notice (DTN) was issued for this situation. The purge was initiated within 30 min (was 21 min) of completion of the upper aft safety assessments.

**Reaction Control System**

The Reaction Control System (RCS) performed all functions required for successful completion of the mission. One In-Flight Anomaly (IFA) occurred shortly after lift-off and it is discussed in a later paragraph.

The propellant loading for the mission is shown in the following table.

### RCS PROPELLANT LOADING

Parameter	Forward RCS		Left RCS		Right RCS	
	Oxidizer	Fuel	Oxidizer	Fuel	Oxidizer	Fuel
Target, %	67.70	67.41	100.48	100.76	100.48	100.76
Target, lbs	1141	712	1523	962	1523	962
Calculated, %	72.61	69.41	100.91	100.85	100.32	100.85
Advertised, lbs	1207.3	720.9	1528.8	962.7	1520.8	962.7
PASS WHI <sup>a</sup>	4.2988	4.2551	4.3800	4.2204	4.3868	4.2604
BFS WHI <sup>b</sup>	4.3028	4.2579	4.4035	4.2553	4.4274	4.2759

**Notes:**

<sup>a</sup> PASS WHI – Primary Avionics Software System Initial Weight of Helium Load

<sup>b</sup> BFS WHI – Backup Flight System Initial Weight of Helium Load

All Tyvek covers released nominally. Tyvek cover release speeds and vehicle alpha/beta angles at cover release are shown in the following table.

### TYVEK COVER RELEASE TIMES, VELOCITIES AND ALPHA/BETA ANGLES

Cover	MET (sec)	Velocity (mph)	Alpha (deg)	Beta (deg)
F1D	5.2	59	8	4
F3D	5.2	59	8	4
F2D	6.0	71	7	3
F4D	6.2	74	7	3
F1F	7.9	98	7	2
F3F	8.6	109	6	2
F2U	8.7	111	6	2
F2R	8.7	111	6	2
F3L	8.8	112	6	2
F1U	8.9	114	6	2
F1L	9.0	116	6	2
F4R	9.2	118	6	2
F2F	10.1	133	6	1
F3U	10.5	139	7	1

The RCS window-protect firing of the F1U, F2U and F3U thrusters was initiated at 071/06:30:17 GMT (00/00:02:04 MET)] for total duration of 2.08 sec. The Forward RCS performance was nominal. The Window protect firing is performed to deflect exhaust from the SRB separation motors away from windows during SRB separation.

The RCS firings, times initiated, Differential Velocities ( $\Delta V$ s), and firing times are listed in the following table.

### RCS MANEUVERS AND FIRING DATA

Maneuver/Firing	Engine/ System	Time of Ignition, GMT	$\Delta V$ , ft/sec	Duration, sec
RCS Window Protect	RCS	071/06:28:15	N/A	2.08
ET Separation	RCS	071/06:36:58	N/A	10.0
ET Photo +X	RCS	071/06:37:19.5	N/A	11.6
ET Photo Pitch	RCS	Cancelled	N/A	N/A
NC3	RCS	072/08:58:10	2.2	9.6
NCC	RCS	072/23:44:41	3.1	0.7
MC1	RCS	073/01:02:24	0.3	1.3
Out of Plane Null	RCS	Cancelled	N/A	N/A
MC2	RCS	073/01:34:30	0.7	2.8
MC3	RCS	073/01:51:30	0.7	3.0
MC4	RCS	073/02:01:30	2.3	9.9
Reboost	RCS	Cancelled	N/A	N/A
Separation 1	RCS	085/01:35:14	N/A	6.2
Separation 2	RCS	085/02:03:15	N/A	6.0
Orbit Adjust	RCS	085/17:53:14	4.9	18.9
RCS Hotfire	RCS	086/20:05:25	N/A	N/A
Forward Reaction Control System Dump	RCS	086/23:49:29	N/A	14.4

At 071/06:28:29 GMT (0/00:00:16 MET), three Left Reaction Control System (LRCS) fault messages occurred coincident with the loss of the fuel leak detector temperatures (off-scale low) for thrusters L2L, L2U and L2D. The cause of this fault was identified as a failure of Dedicated Signal Conditioner (DSC) Orbital Maneuvering System (OMS) Left (OL) 1 Card 1 (IFA STS-123-V-01). Thrusters L2U and L2D vernier thrusters were automatically deselected by Redundancy Management (RM) as failed leak. L2L was not deselected because the Pod limit for failed primary thrusters (2) had already been reached. These failures were instrumentation-only and did not affect the thrusters' health. Vernier L5L was automatically deselected by RM when the vernier thrusters were enabled by the flight software transition to OPS 2. The LRCS manifold 2 thrusters were placed in last priority and reselected.

The residual propellants at the end of the mission are shown in the following table.

### RCS RESIDUAL PROPELLANTS

Parameter	Mission Operations Calculation		PASS Model Calculation <sup>a</sup>	
	%	lbs	%	lbs
Forward Oxidizer	4.0	54	3.7	50.0
Forward Fuel	0.0	.0	0.1	0.9
Left Oxidizer	49.8	672	49.7	671.0
Left Fuel	50.2	427	50.1	425.9
Right Oxidizer	46.8	632	46.1	622.4
Right Fuel	47.4	403	47.6	404.6

Note:

<sup>a</sup> The official JSC Engineering RCS propellant residuals are those listed under the PASS model

The Aft RCS propellant usage during interconnect operations with the Orbital Maneuvering System (OMS) is shown in the following table.

### AFT RCS INTERCONNECT USAGE

Parameter	Total, %	Total, lbs
Left OMS	2.330	301.75
Right OMS	1.590	205.92

The RCS propellant consumption, based on the PASS model advertised load in the RCS residual propellant table is shown in the following table.

### RCS PROPELLANT CONSUMPTION

Parameter	Oxidizer, lbs	Fuel, lbs	Mixture ratio, Oxidizer/Fuel
Forward RCS	930.3	581.0	1.60
Left RCS	691.3	431.3	1.60
Right RCS	731.9	452.6	1.62

The attitude control responsibilities between the ISS and the Orbiter are shown in the following table.

## CONTROL RESPONSIBILITIES BETWEEN ISS AND SHUTTLE

Control Responsibility	Control Start, GMT	Orbiter DAP Mode	Comments
Orbiter	073/03:49:47	Free Drift	Docking / ISS Capture
Orbiter	073/04:09:56	LVLH	
ISS	073/04:19:58	Free Drift	
Orbiter	073/04:20:06	Auto	Maneuver to TEA
ISS	073/04:58:21	Free Drift	
Orbiter	073/04:58:56	Auto	
ISS	073/05:07:36	Free Drift	
Orbiter	077/02:49:35	Auto	Simultaneous Dump
Station	077/05:35:24	Free Drift	
Orbiter	080/02:24:47	Auto	Simultaneous Dump
Station	080/05:14:34	Free Drift	
Orbiter	081/22:35:34	Auto	Maneuver to OBSS Survey of Nose Cap
Station	081/23:21:44	Free Drift	Survey performed with ISS controlling
Orbiter	082/01:55:43	Auto	Maneuver to TEA after Survey
Station	082/02:34:06	Free Drift	
Orbiter	084/22:00:03	Auto	Maneuver to undocking attitude
Station	084/23:36:25	Free Drift	
Orbiter	084/23:37:31	Auto	
Station	085/00:22:12	Free Drift	For Primary RCS Jet Driver configuration
Orbiter	085/00:23:02	B/ALT/No Low Z	
Orbiter	085/00:25:05		Undocking

As part of the undocking preparations, thrusters F1U, F2U and F3U were reselected. Undocking was initiated nominally with a +Z pulse at 085/00:25:05 GMT (14/17:56:52 MET). The full flyaround maneuver was initiated with a +X pulse of L1A and R1A at 085/00:49:13 GMT (14/18:21:00 MET), and all thrusters operated properly during the undocking operations.

The primary thrusters were fired 3,655 times for a total firing time of 876.72 sec. The vernier thrusters were fired 9040 times with a firing time of 16047.02 sec.

### Orbital Maneuvering System

The Orbital Maneuvering System (OMS) performed nominally throughout the mission, and no IFAs were identified in the review and analysis of the data.

The OMS configuration is shown in the following table.

### OMS CONFIGURATION

Vehicle/ equipment	Flight	Orbital Maneuvering Engine (OME)	Ancillary data
Left Pod (LP) 03	32 <sup>nd</sup>	L-OME S/N 107	2 <sup>nd</sup> rebuilt flight - 18 <sup>th</sup> flight
Right Pod (RP) 04	28 <sup>th</sup>	R-OME S/N 113	2 <sup>nd</sup> rebuilt flight - 5 <sup>th</sup> flight

The following table shows the maneuvers that were performed during the STS-123 mission.

### OMS MANEUVERS

Maneuver designation	Configuration	Time of ignition, GMT	Firing time, sec	$\Delta V$ , ft/sec/ interconnect usage, %
Assist	Dual Engine	071/06:30:29	114.2	N/A
OMS-2	Dual Engine	071/07:06:44	63.0	96.2
OMS-3 (NC1)	Dual Engine	071/09:37:37	49.0	75.5
OMS-4 (NC2)	Right Engine	071/23:34:44	16.2	12.4
OMS-5 (NH)	Dual Engine	072/22:11:09	56.0	87.1
OMS-6 (NC4)	Dual Engine	072/23:10:32	59.2	93.4
OMS-7 (TI)	Left Engine	073/00:42:22	11.2	8.7
(Deorbit)	Dual Engine	086/23:33:14	165.2	303.8

The interconnect usage from the OMS to the RCS is shown in the following table.

The Official propellant residuals should be taken from the following table using the aft gage results for the left oxidizer and both right tanks. The burn-time Integration should be used for the left fuel tank. The SODB Flow rates are presented for comparison purposes.

### PROPELLANT LOADING AND USAGE DATA

Parameters	Left OMS pod		Right OMS pod	
	Oxidizer	Fuel	Oxidizer	Fuel
Loaded, lbm	7053	4254	7050	4254
Residual, lbm (aft gage)	546	847	570	332
Residual, lbm (burn time integration)	666	343	638	300
Residual, lbm (SODB flow rate)	635	359	610	360



### INTERCONNECT USAGE, PERCENT/POUNDS

Parameter	Interconnect usage, %	Interconnect usage, lbs
Left interconnect	2.330	301.75
Right interconnect	1.590	205.92

### Auxiliary Power Unit System

The Auxiliary Power Unit (APU) system performance was nominal throughout the STS-123 mission. Three In-flight anomalies were identified from the data analysis and review and these are discussed in later paragraphs of this section.

### APU RUN TIMES

APU (S/N)	Ascent, hr:min:sec	FCS Checkout, hr:min:sec	Entry, hr:min:sec	Total time, hr:min:sec
1 (304)	00:19:42	00:05:44	01:03:52	01:29:18
2 (311)	00:19:55	00:00:00	01:31:02	01:50:57
3 (306)	00:20:05	00:00:00	01:04:37	01:24:42

### APU FUEL CONSUMPTION

APU (S/N)	Ascent, lbs	FCS Checkout, lbs	Entry, lbs	Total, lbs
1 (304)	48	18	148	214
2 (311)	50	0	165	215
3 (306)	49	0	131	180

Approximately 14 seconds prior to MECO (071/06:36:23 GMT) the APU 1 Gas Generator (GG) chamber pressure indicated a shift upward of about 98-112 psi at the low end (from 28 to 126-140 psia) (IFA STS-123-V-03). During and after APU shutdown, no indication of internal gas generator valve module (GGVM) leakage was noted and the pressure reading stabilized at 98-105 psia, which indicated this was an instrumentation problem. There were no mission impacts associated with the noted transducer bias shift. A review of other instrumentation with common channelization showed no anomalous signatures. The shift also remained consistent and stable, at approximately +100 psia for the entire pressure range, during the APUs run for Flight Control System (FCS) checkout as well as entry.

At approximately 072/00:52:28 GMT (0/18:00 MET), the APU 3 seal-cavity drain-line pressures began to slowly decay (IFA STS-123-V-04). The decay was seen in both pressure transducers. The initial pressure decay rate was approximately 1.1 psi/day adjusted for temperature, which is below the threshold for liquid leakage. There were no mission impacts associated with the noted pressure decay. The APU 3 fuel pump inlet pressure held steady, and no gross fuel leakage into the APU 3 drain system was

seen during APU operation or after the APU was shutdown. The drain system decay was believed to be an external leak of GN<sub>2</sub> into the aft fuselage. By the end of mission, the drain-line pressure decay rate had slowed and stabilized around 9 psia. APU drain system 3 also had a pressure-decay during the previous OV-105 flight (STS-118). This pressure decay was attributed to the manual drain valve after post-flight leak checks found out-of-specification Helium mass spectrometer readings at this location. As a result, the valve was replaced. Polysulfide sealant was also reapplied at the fuel reference line fitting to improve joint coverage although no leakage was seen at this joint during mass spectrometer leak checks.

At approximately 072/07:38 GMT (01/01:10 MET), the APU 1 fuel tank pressure began to decay (IFA STS-123-05). The APU 1 fuel tank pressure measurements began to decay shortly after APU shutdown after ascent. The decay was greater than what could be attributed to thermal effects and was similar to that seen during STS-121. The GN<sub>2</sub> tank pressure decayed 26 psi (254 to 228 psia) in 11 days (approximately 2.4 psia/day), and virtually stopped prior to a fuel tank heater cycle on FD 14. This condition did not impact the vehicle or the mission. Analysis performed during the flight showed that the signature is most likely a GN<sub>2</sub> pressurant leak and not a liquid fuel leak. This resulted in a decision that APU 1 would be used for normal operations for the mission. APU 1 was run for FCS checkout and for entry (EI-13 start) with no change or worsening of signature noted.

### **Hydraulics/Water Spray Boiler System**

The Hydraulic and Water Spray Boiler (WSB) system performance during all phases of the STS-123 was nominal. All system pressures and temperatures were maintained within nominal limits.

During STS-123, the HYD/WSB subsystem supported the APU system in the APU 1 Fuel Tank pressure-decay investigation. Specifically, the HYD/WSB team was tasked with assessing the ability of the WSB to provide sufficient APU system 1 lubrication oil and hydraulic fluid cooling to operate APU 1 at normal pressure to fuel tank depletion. A simplified WSB Propylene Glycol Monomethyl Ether (PGME)/Water (H<sub>2</sub>O) coolant usage math model was constructed to analyze the cooling requirements for various APU/Flight Controls load inputs. The analysis indicated that the WSB could provide adequate cooling under elevated hydraulic loading for the entire APU run.

Performance on all three WSB systems during entry showed the hydraulic heat exchanger mode operation was first indicated on WSB 1 prior to Terminal Area Energy Management (TAEM). WSB systems 3 and 2 heat exchanger mode operation occurred after landing.

The WSB PGME/H<sub>2</sub>O usage during entry for spray cooling, calculated with the new KSC off-load correlation method, shows that the usage was

1. System 1 - 40.0 lb (PGME/Water)
2. System 2 - 45.3 lb (PGME/Water)
3. System 3 - 40.4 lb (PGME/Water).

### **Power Reactant Storage and Distribution System**

The OV-105 Power Reactant Storage and Distribution (PRSD) system performance was nominal during STS-123. The PRSD system supplied the fuel cells with 2378 lb<sub>m</sub> of oxygen and 299 lb<sub>m</sub> of hydrogen for the production of 3507 kWh of electrical energy. The average power level for the 372.21-hour mission was 9.3 kW. A 117-hour mission extension was possible at the 12.46 kW average power level with the reactants remaining at touchdown.

No in-flight anomalies were identified during the mission and the post-flight analysis of the data.

The following table shows the tank quantities at loading, lift-off and landing.

#### **PRSD TANK QUANTITIES**

<b>Oxygen</b>	<b>Tank 1, %</b>	<b>Tank 2, %</b>	<b>Tank 3, %</b>	<b>Tank 4, %</b>	<b>Tank 5, %</b>	<b>Total Mass, lb<sub>m</sub></b>
Loaded	102.2	100.9	101.8	101.8	101.8	3971
Launch	101.8	100.1	100.9	100.9	100.1	3935
Landing	44.4	37.9	52.8	28.2	6.8	1328
<b>Hydrogen</b>	<b>Tank 1, %</b>	<b>Tank 2, %</b>	<b>Tank 3, %</b>	<b>Tank 4, %</b>	<b>Tank 5, %</b>	<b>Total Mass, lb<sub>m</sub></b>
Loaded	101.9	102.3	101.5	102.3	103.2	469.1
Launch	98.4	99.3	98.8	99.7	98.8	455.4
Landing	58.6	55.0	53.3	1.5	1.1	155.9

The total oxygen supplied to the Shuttle/ISS Environmental Control and Life Support System (ECLSS) was 228 lb<sub>m</sub> of oxygen. No oxygen was transferred to the ISS.

### **Fuel Cell System**

The overall performance of the OV-104 Fuel Cell system was nominal. One in-flight anomaly was identified and it is discussed in a later paragraph.

#### **Fuel Cells**

The prelaunch baseline Cell Performance Monitor (CPM) values for fuel cell 1 were 10, 2, and 56 mV, for fuel cell 2 were 2, 2, and 18 mV, and for fuel cell 3 were 2, 2, and 2 mV. They were established approximately 7 hr prior to launch and approximately 3 hr after the completion of the fuel cell calibration.

The average electrical power level and load was 9.3 kW and 298 Amperes. The fuel cells produced 2677 lb<sub>m</sub> of potable water and 3507 kWh of electrical energy from 2378 lb<sub>m</sub> of oxygen and 299 lb<sub>m</sub> of hydrogen. Five fuel cell purges were performed, occurring at approximately 20, 133, 251, 321, and 369 hr MET.

The actual fuel cell voltages (200-Ampere load) at the end of the mission were 0.15 V above predicted for Fuel Cell 1, 0.10 V above predicted for fuel cell 2 and 0.15 V above predicted for Fuel Cell 3. The voltage margins above the minimum performance curves at 200 amperes at the end of the mission were 0.80 V above minimum for Fuel Cell 1.

Fuel cell operating times, which are the times accumulated on the fuel cells prelaunch, on-orbit, and post-landing, were 411:20:38 (hh:mm:ss) for fuel cell 1, 410:48:36 for fuel cell 2, and 409:45:24 for fuel cell 3. The end-of-mission accumulated operating times for these fuel cells are 2122, 746, 1191 hr, respectively.

The Fuel Cell Common pH Sensor began giving intermittent indications during FCS check-out. The first occurrence at 085/19:04:08 GMT (14/12:35:54 MET), cleared after 39 sec (IFA STS-123-V-13). Later, between 086/04:53:37 and 086/15:54:10 GMT (14/22:25:23 to 15/09:25:56 MET), 14 additional transients were received; lasting varying from 1 to 361 sec in length. The fuel cell 1, 2, and 3 pH indications never read high, and fuel cell performance for all three fuel cells was nominal.

At 086/01:37 GMT (14/19:09 MET), the crew performed an Fuel Cell Monitoring System (FCMS) data take and each fuel cell's individual single-cell voltage was examined and compared with their previous values from the FD 2 FCMS data. All comparisons were reflected nominal performance. Indications recurred again on the day of entry during the preparations for the deorbit maneuver. There were no indications of fuel cell problems, and the sensor indication cleared.

### **Station-to-Shuttle Power Transfer System Operation**

This was the second flight of Station-to-Shuttle Power Transfer System (SSTPS) on OV-103. The system functioned satisfactorily and provided 1631.9 kWh of power to the Orbiter during the docked period. The system transfers and converts power from the 120-Vdc ISS electrical system to supplement fuel cell power to the Orbiter's 28-Vdc buses. The system is activated when the Orbiter is docked to the ISS, and the SSPTS provides up to approximately 6 kW of power to the Orbiter.

When set at maximum output, the SSTPS attempts to regulate orbiter bus voltage at 31.8 Vdc up to its maximum output of about 6 kW. During SSPTS operation at low power levels, 12-13 kW total orbiter power, the fuel cell coolant stack exit temperatures were about 185-187 °F. Fifty-seven Fuel Cell 3 Sustaining Heater cycles were observed due to the stack exit temperature reaching the 183.5 °F turn-on point.

## **Electrical Power Distribution and Control System**

The Electrical Power Distribution and Control (EPDC) system performed nominally during all mission phases of the STS-123 mission. The data review and analysis of all available EPDC parameters have been completed and no abnormal conditions were identified.

As a minimum, the following EPDC parameters are analyzed each mission:

1. Fuel Cell voltages and currents;
2. Power Transfer Unit voltages and currents;
3. Essential bus voltages;
4. Control bus voltages;
5. Forward Power Control Assemblies voltages and currents;
6. Mid Power Control Assemblies voltages and currents;
7. Aft Power Control Assemblies voltages and currents;
8. AC bus voltages and currents;
9. AC bus Monitor/auto switch status and overload/over-voltage alarm
10. Main bus to Control bus RPC status
11. Forward, Mid and Aft Motor Control Assemblies ops status
12. Fuel Cell to Essential bus switch status
13. Main bus to Essential Bus RPC and switch status
14. Drag chute Pyro Controller Functions

In addition, during a SSPTS portion of the flight, the following additional parameters are analyzed:

1. Assembly Power Converter Unit (APCU) voltages and currents;
2. Orbital Power Converter Unit (OPCU) voltages and currents;
3. APCU and OPCU temperatures;
4. Main Distribution Control Assembly (MDCA) motor switch status;
5. APCU status bits and trips and
6. OPCU trips.

## **Orbiter Docking System**

The Orbiter Docking System (ODS) performed satisfactorily, and no IFA's were identified from the review and analysis of the data.

The initial application of power to the ODS and ring extension were performed nominally during FD 2 and the ODS was activated for 9 min 29 sec, and the avionics hardware was powered for 5 min 22 sec. The system was ready for rendezvous and docking with the ISS.

The application of power for the docking activities was initiated at 073/02:59:02 GMT (01/20:30:48 MET), and the ODS was powered for 72 min 37 sec. The initial contact

and capture of the ISS occurred at 073/03:49:47 GMT (01/21:21:33 MET). The initial damping and performance of the "Disable and Release Dampers" procedure was necessary to ensure that any stuck dampers were disengaged. Upon release of the capture latches and completion of the ring retraction, the docking was completed and the ODS power was removed from the system.

In preparation for undocking, the ODS was activated at 084/23:28:52 GMT (13/17:00:38 MET). The undocking and separation from the ISS was completed satisfactorily at 085/00:25:00 GMT (13/17:56:46 MET).

## **Life Support Systems**

### **Atmospheric Revitalization Pressure Control System**

The Atmospheric Revitalization Pressure Control System (ARPCS) performance was nominal for the entire mission. No in-flight anomalies were identified from the review and analysis of the data.

The ARPCS system 1 was configured and used for the entire mission up to the completion of the undocking operations. All of the EVAs were performed from the ISS Airlock, consequently, the PCS was configured to system 2 (post un-docking) to checkout that system. An Orbiter-to-ISS tank-to-tank Nitrogen (N<sub>2</sub>) transfer was performed, and approximately 23 lb were offloaded to the ISS. No Oxygen (O<sub>2</sub>) was transferred to the ISS during this mission. The Vestibule was leak checked for docking and undocking operations. There were five Orbiter/ISS stack repressurizations performed using the Orbiter ARPCS.

### **Supply and Waste Water System**

The Supply Water and Waste Management Systems performed nominally throughout the mission and all of the scheduled in-flight checkout requirements were satisfied. Supply water was managed through the use of the FES, water transfer to the ISS, and the overboard nozzle dump system.

Four supply water nozzle dumps as Simultaneous (SIMO) at a nominal dump rate of 1.5 percent (2.5 lb/min) and one Portable Water Reservoir (PWR) dump through the supply line were performed. The line heater maintained the supply water dump line temperature between 76 °F and 95°F. Four wastewater dumps were made as SIMO nozzle dumps at a nominal average rate of 1.97 percent per min (3.25 lb/min) were performed. In addition, three condensate Contingency Water Containers (CWCs) through the waste line were dumped. The waste water dump line temperature was maintained between 59 °F and 76 °F throughout the mission

Five CWCs were filled with supply water and transferred to the ISS, for a total of 485.8 lbm. In addition, 6 PWRs of iodinated water for a total 122.5 lbm were filled and transferred to ISS.

At 076/07:27:42 GMT (04/20:59:48 MET), the supply water tank B quantity sensor exhibited a quantity dropout at a tank quantity of 77 percent. The tank quantity dropped to 51 percent for 1 sec and recovered. In addition, the tank-quantity sensor dropped multiple times at different quantity levels during the mission. Such dropouts have been experienced in previous flights and the problem was caused by either contamination on the collector bar and/or a surface defect on the collector bar of the potentiometer which causes an intermittent break in continuity. These dropouts are understood problems and are deferred for a quantity sensor replacement during OMDP or during the flow per PRT direction.

Vacuum vent line temperature was maintained between 78 °F and 58 °F.

### **Smoke Detection and Fire Suppression System**

The Smoke Detection and Fire Suppression (SDFS) system operated nominally with no issues. The Smoke Detection Test was performed of FD 1 at 00/04:19:48 MET and all Smoke detection A and B Sensor circuits operated nominally.

Use of the Fire Suppression system was not required.

### **Airlock System**

All of the Extravehicular Activities (EVA's) were performed from the ISS airlock. As a result, the Airlock was not used during this mission.

The external airlock Extravehicular Mobility Unit (EMU) supply water line zone-2B heater temperature failed to cycle during STS-113 and STS-123. However, the temperature did not exceed the 48 °F Fault Detection and Annunciation (FDA) limit and, therefore, it was not detected. The external airlock was removed and re-installed after STS-113, and the external airlock heaters were verified during that reinstallation. Again, the heater did not cycle during the STS-123, and the problem was not detected during the mission or data review. The plot signatures confirmed the failure, which was traced back to the STS-113 mission.

### **Active Thermal Control System**

The Active Thermal Control System (ATCS) performance met all requirements for the entire mission. The radiators were not activated for this flight. However, four IFAs were identified and are discussed in following paragraphs.

During the Flash Evaporator System (FES) startup on Primary A during ascent, the FES began to cool, but then went into the shutdown mode (IFA STS-123-V-02). The crew switched to the Primary B controller which operated nominally for the remainder of ascent. After the Payload Bay Doors (PLBDs) were opened, the controller was switched back to Primary A in the full-up mode in an attempt to verify the system operation. The FES began responding by temperature controlling, but again the FES

went into the shutdown mode. The crew then switched to Primary A in the topping mode, however, with the same results. The controller was switched to the Primary B and the FES operated nominally for the remainder of the mission, and the Primary A controller was declared by the flight rules to be non-operational. There was not an end-of-mission impact for the loss of one FES primary controller.

The crew reported an unusual noise associated with the cabin temperature controller 1 operation (IFA STS-123-V-14). After switching to controller 2, the crew reported that the unusual noise ceased and the controller operated nominally. Excess noise on cabin temperature controller 1 was reported as a pre-existing condition, but postflight investigation of the controller was performed.

While investigating the cabin temperature controller 1 operation, the crew noticed water on the Water Coolant Loop (WCL) 2 tubing between the cabin temperature controller door and the galley, where insulation was found to be missing. The tubing is the inlet line into the cabin heat exchanger, and approximately 10-12 in. of insulation was missing. The line was dried and a towel and wash cloth were installed as a temporary solution. The line was checked daily to determine if any condensate continued to form.

Problems potentially associated with high Carbon Dioxide (CO<sub>2</sub>) concentration were reported. All instrumentation indicated acceptable levels (IFA STS-123-N-001). As a result, both booster fans were powered to attempt to increase air flow. Problems potentially associated with high CO<sub>2</sub> concentration continued to be reported. All instrumentation indicated acceptable levels. The crew installed additional air ducting from Node 2 to the US Laboratory to aid with the air flow in the Orbiter. In support of the CO<sub>2</sub> issues, the ISS Mission Management Team (IMMT) approved a reconfiguration of portable air ducts to transport the Orbiter exchange air from the booster fans into the US Laboratory module using a 23-ft hose. The reconfiguration change was made after the crew awoke at approximately 083/18:30 GMT (12/12:02 MET). Measurements indicated an increase in air exchange between the Orbiter and the ISS US Laboratory where the Carbon Dioxide Removal Assembly (CDRA) is located.

Postflight, it was determined that the starboard forward radiator retract hose did not properly retract during PLBD closing (IFA STS-123-V-15). This did not affect door closure or cooling system performance.

### **Flight Software**

The Primary Avionics Software System (PASS) and Backup Flight System (BFS) Flight Software (FSW) performed satisfactorily throughout the mission.

### **Data Processing System Hardware**

The data review and analysis of Data Processing System (DPS) parameters were completed and no abnormal conditions were identified. The Integrated DPS hardware



performed nominally. One IFA was identified during the mission and post-flight analyses, and this item is discussed in a later paragraph.

### **Multifunction Electronic Display System**

The Multifunction Electronic Display System (MEDS) performed satisfactorily with no problems or issues recorded.

### **Displays and Controls System**

The Display and Controls (D&C) system, including lighting, performed nominally during all phases of STS-123 with the exception of the two IFAs discussed in the following paragraphs.

At approximately 079/01:30 GMT (07/19:30 MET), the crew reported that the Aft Mission Timer (MT) was not working with the switch in GMT, MET or TEST positions (IFA STS-123-V-11). The crew also reported that the Aft Event Timer was properly lit. The crew cycled the circuit breaker (CB) and reported that the Aft MT recovered. This A4 Panel MT failure, combined with the incandescent lamp segment failure in the Forward O3 Panel MT resulted in a degraded display of mission time for the crew. Mission time was, however, available by other means, and as a result, this anomaly did not impact mission success or crew safety. There are two MTs on the vehicle (located on the Aft A4 and Forward O3 Panel). A loss of the Aft MT would not be critical. The Forward MT can be utilized. Post-flight MT functional testing of the MT identified no anomalous operation.

On FD 3 at 072/21:37:21 GMT (01/00:37:53 MET) and again on FD 15 at 084/21:41:25 GMT (13/15:13:11 MET) during the G2 Set Expansion, the crew reported that the GPC 3 output continued to show barberpole after the General Purpose Computer (GPC) was taken to run position (IFA STS-123-V-12). On both occasions, the Crew tapped the talkback and it went gray. All other G2 Set Expansions and Contractions were completed with no further issues. Tapping on the talkbacks is a known and documented procedure for recovery. The talkback response is a visual-only feedback to the crew and does not necessarily indicate a system failure. System success can be relayed to the crew via GPC response to software loading. Post-flight checkout was nominal, and the GPC will continue fly in the as-is configuration.

### **Flight Control System**

The Flight Controls System (FCS) performed nominally during the preflight, countdown, ascent, orbit, FCS checkout, deorbit preparations, entry, landing and post-landing operations.

The FCS hardware/effector systems performed nominally during ascent through APU shutdown. At all times, the SRB thrust vector controller (TVC), MPS TVC, and aerosurface actuators were positioned as commanded with normal driver currents,

secondary differential pressures, and elevon primary differential pressures. The rate outputs of the four Orbiter Rate Gyro Assemblies (ORGAs) and four SRB Rate Gyro Assemblies (SRGAs) tracked one another normally, and there were no Spin Motor Rotation Detector (SMRD) dropouts. The outputs of the four Accelerometer Assemblies (AAs) also tracked one another normally. The Reaction Jet Driver (RJD) operation was also normal with no thruster failures or other anomalies noted. The Device Driver Unit (DDU) and controller operations were nominal as well. Both the Rotational Hand Controller (RHC) and the Translational Hand Controller (THC) were used and exhibited normal channel tracking.

The OMS TVC File IX requirements were met, and OMS TVC actuator rates were normal. Flight control actuator temperatures were also normal. The Rudder/Speed Brake Power Drive Unit (RSB PDU) motor backdrive did not occur during hydraulic system shutdown.

The FCS hardware checkout in the OPS-8 mode performance was nominal. No anomalies were found in aerosurface drive data, individual channel test data, ORGA and AA test data, nose-wheel steering test data, and DDU/controller data.

Entry performance was nominal from the Deorbit Maneuver through vehicle touchdown. The pre-Time of Ignition (TIG) OMS gimbal profile was as expected with the OMS actuator active and standby channels reaching nominal drive rates. All aerosurface actuators performed normally. Secondary differential pressures for all actuators were well within the equalization threshold, and all actuator positions closely tracked General Purpose Computer (GPC) commands. Entry hydraulic system temperatures were comparable to previous flights with aerosurface actuator temperatures being within the normal limits. The MPS TVC actuator performance was normal, with secondary differential pressures within threshold and TVC actuator positions and GPC commands following each other closely.

### **Air Data Transducer Assembly**

The Air Data Transducer Assemblies (ADTAs) performed nominally during preflight, countdown, orbit, FCS checkout, deorbit preparation, entry, landing and post-landing operations.

All four ADTAs functioned nominally from power-on until nominal data loss at the T-minus-20-min transition on launch day. The ADTA self-tests, performed shortly after power-on, were nominal. There is no insight into ADTA performance during the ascent phase until after the elevons are parked during the post-insertion period. All ADTA mode/status words were nominal during the elevon-park activity.

The ADTA was in the OPS-8 mode for FCS checkout performance was nominal. Power-on and self-tests were performed with no anomalies. All 16 transducer outputs showed nominal responses.

Entry performance was nominal from de-orbit through wheels-stop. All 16 transducers tracked during the pre-probe deployment phase of entry. Air data probes were deployed at approximately Mach 4.9, and deployment timing was within specification at less than 15 sec. ADTA data were incorporated into Guidance, Navigation, and Control (GN&C) at about Mach 2.6. No ADTA dilemmas or RM failures occurred during deployment through wheels-stop. Entry data was retrieved and reviewed, and no anomalies were observed.

### **Inertial Measurement Unit and Star Tracker System**

The Inertial Measurement Unit (IMU) system performed satisfactorily throughout the STS-123 mission. No in-flight anomalies or problems were identified during the analysis of the data. The IMU's required one adjustment of the onboard IMU accelerometer compensations during the mission. Also, four adjustments were performed for the IMU drift compensation values.

The Star Tracker (ST) performed nominally in acquiring navigation-stars. The -Y ST acquired navigation-stars 899 times, and also missed a navigation-star 1080 times (54.2 percent) during the mission. Data evaluation showed that 47.5 percent (513) of the missed stars belonged to one star (67). This condition did not impact the mission.

The -Z ST acquired a star 98 times and missed a star 61 times (38.3 percent). Data showed that most of these stars were missed during the docking and undocking activities. This condition also did not impact the mission.

### **Global Positioning System Navigation**

GPS operation during STS-123 was nominal. All three Global Positioning System (GPS) strings were powered prior to launch. During the power-up sequence, the Miniaturized Airborne GPS Receiver (MAGR) receivers were powered prior to the GPS input/output data being activated. This sequence is now standard for day-of-launch power-up and eliminates any potential time-out errors which could have been generated by the GPC's poling unpowered MAGR receivers.

The GPS no.1 and GPS no. 3 were powered OFF as part of the Group B Powerdown about 2.5 hours into the mission. These two receivers were powered up just before the FCS checkout. Upon powerup, both GPS no. 1 and GPS no. 3 experienced the "PPS Anomaly", which is a documented condition and indicates the MAGRS-3S are not authorized although loaded with valid encryption key. This condition cleared itself, as expected, about two hr prior to the next GMT day rollover. GPS no. 2 remained powered the entire mission and did not experience any anomalies.

Beginning with FCS C/O, all three GPS receivers remained ON until 14 min after Landing.

During Entry, the GPS high Figure of Merit (FOM) period usually encountered in the Plasma region cleared well before the GPS was to be incorporated into PASS for navigation use. The GPS state was incorporated as planned into the PASS in MM304 after performance confirmation with high-speed C-band tracking. This occurred at approximately 20 min after Entry Interface (157,000 ft altitude). The effect was that the PASS navigation state residuals were reduced significantly, as expected. The navigation state vector residuals remained consistently low from GPS incorporation through MLS incorporation at approximately 16,300 ft altitude.

The GPS state was intentionally not taken directly to the BFS to keep the two systems independent. The PASS navigation state vector was transferred to the Backup Flight System (BFS) at approximately 67,400 ft altitude.

### **Communications and Tracking System and Navigation Aids**

During the STS-123 mission, the Communications and Tracking systems performed nominally. One in-flight anomaly was identified during the analysis of the data.

Docked audio problems have been experienced on multiple flights and all Orbiters, starting with STS-108. However, the signature for this flight was unique. This is the first flight that a Intercommunications (ICOM) A concern has been reported from the ISS to the Shuttle (IFA STS-123-N-002). ICOM A audio from Shuttle to the ISS worked this flight as it had not worked on previous flights. It is also the first flight of a reported problem with the Page channel.

At 080/02:57:58 GMT (08/19:58:30 MET), the ISS annunciated a Partial Pressure of Oxygen (PPO<sub>2</sub>) out-of-limits" message. This message should have triggered an audible alert signal from ISS-to-Shuttle (IFA STS-123-N-002). The Shuttle crew, when replying to Mission Control Center (MCC) approximately 2.5 hr later, indicated that they never heard the alarm. The ISS Caution and Warning (C&W) tones are transmitted by ISS through the Docked Audio Interface Unit (DAIU) to the Shuttle Audio Central Control Unit (ACCU) on the PAGE loop.

The Navigation Aids (NAV AIDS) Performed nominally throughout the mission. In addition, S-Band system 1 was in operation for 24 hr 59 min, which satisfied the OMRSD requirement to operate the S-Band Backup string continuously for 24 ± 4 hr.

### **Operational Instrumentation/Modular Auxiliary Data System**

The Operational Instrumentation (OI) and Modular Auxiliary Data System (MADS) performed nominally throughout the STS-123 mission. Three in-flight anomalies were identified during the mission and the post-flight review of the mission data.

The Master Timing Unit (MTU) accumulated a timing error with respect to the Global Positioning System at a rate of approximately 0.6 milliseconds per day. This error accumulation rate was steady throughout the mission. The observed error

accumulation rate of 0.6 milliseconds per day corresponds to the oscillator being off its nominal 4.608 MHz by approximately 7 Parts Per Billion (PPB). The oscillator is allowed to drift by as much as 1 part per billion per day. This oscillator frequency deviation was higher than usually observed, but within the established limits of 8 parts per billion imposed by the OMRSD and flight rules. While at the Pad, the oscillator frequency deviation was measured to be -6.022 PPB. Therefore, the drift since launch was small and within specification.

During ascent, the Dedicated Signal Conditioner (DSC) on the OMS Left 1 (OL1) for the following measurements failed Off-Scale Low (OSL) (IFA STS-123-V-01):

1. The RCS-L Aft Fuel L2L Thruster Injector temperature;
2. The RCS-L Aft Fuel L2U Thruster Injector temperature;
3. The RCS-L Aft Fuel L2D Thruster Injector temperature; and
4. The RCS-L Aft Fuel L5L Thruster Injector temperature (available via down-list only)

These measurements were downlinked in the OI data stream. All four measurements were associated with Dedicated Signal Conditioner-Converter Variable Resistance to DC (DSC-CVRD) card 1 of DSC-OL1. The remaining measurements on the DSC-OL1 chassis were not affected by the OSL condition.

The MPS SSME 3 LO<sub>2</sub> inlet pressure data showed a shift of 30 psi at lift-off (IFA STS-123-V-06). This is the 2nd flight of this transducer. The shift occurred during this flight when compared to the previous 5 flights and it lasted until SRB Separation. The measurement recovered for the remainder of the ascent phase until MECO. The problem was isolated to the pressure transducer, which will be replaced on a time-permit basis.

MADS PCM ascent data was recorded on the Solid State Recorder and dumped to the ground. During MADS ascent data review, three MADS PCM thermocouple failures were identified. The Left-Hand (LH) OMS Pod Mid-Surface Temperature gradually but abruptly moved to Off-Scale-High (OSH) throughout the MADS recording phase (IFA STS-123-V-08). Also, two indications on the MADS deferred list (from STS-118), the LH OMS pod Low-Temperature Reusable Surface Insulation (LRSI) forward surface temperature and OMS LH pod Thermocouple, are scheduled to be repaired before the next flight if time allows. There was no mission impact for these sensors.

### **Mechanical and Hatches System**

All mechanical and hatch systems performed nominally. No in-flight anomalies were identified in the review and analysis of the data.

## Landing and Deceleration System

The Landing System performance at KSC was nominal. This assessment includes all events from landing gear deployment, main gear touchdown, nose gear touchdown, through roll out, and including drag chute deployment and brake/deceleration. It was the second flight of this set of nose landing gear tires, which were in good condition and performed nominally. The main landing gear tires appeared nominal. The appearance of tread cord materials on areas of the tire's surface is a known expected condition characteristic of the new tire design. Parachute deployment and jettison occurred nominally. No unexpected affects of performance of the drag chute occurred. An inspection of the flown parachute at the KSC Parachute Refurbishment Facility indicated no anomalies.

### LANDING PARAMETERS

Parameter	From threshold, ft	Time from MLG touchdown, sec	Speed, keas <sup>a</sup>	Speed, kgs	Sink rate, ft/sec	Pitch rate, deg/sec
Main Landing gear touchdown	2228.7	0.0	199.8	201.6	-1.33	N/A
Drag Chute Deployment	3512.2	3.88	187.5	188.5	N/A	N/A
Drag Chute Disreef	5161.1	9.26	162.8	165.9	N/A	N/A
Nose Landing Gear Touchdown	5359.3	10.02	157.2	161.1	N/A	-3.97
Brakes On	9869.5	34.89	76.9	79.1	N/A	N/A
Drag Chute Jettison	11630.2	49.48	OSL	57.8	N/A	N/A
Wheels Stop	13702.9	<u>89.68</u>	0	0	N/A	N/A
Parameter		Data				
Brake Initiation Speed, keas		76.9				
Brake On Time, sec		54.79				
Rollout Distance, ft		11474.2				
Rollout Time, sec		<u>58.7789.68</u>				
Runway Location, Surface and Degrees		KSC/15 Concrete				
Orbiter Weight at Landing, lb		208761.7				
Parameter	Maximum Brake Pressure, psia		Total Brake Energy, Mft/lb			
Left inboard	625.00		6.71			
Left outboard	615.48		7.69			
Right inboard	621.82		6.34			
Right outboard	463.19		4.16			

<sup>a</sup>Knots equivalent air speed

## **Aerothermodynamics, Integrated Heating and Interfaces**

The lower structural temperature data indicate normal entry heating. The recorded structure temperatures were within the flight experience of OV-105. However, the maximum temperatures at the port side forward RCS were 156.1 °F and at the left-hand OMS pod side forward were 88.2 °F, and these experienced the most temperature rise for the OV-105 vehicle. From MADS surface thermocouples and the STS-123 Best Estimate Trajectory (BET), Boundary Layer Transition (BLT) occurred at X/L = 0.6 around Mach 8.3. Also, the aileron deflection and yaw thruster firings indicated a symmetrical BLT.

The following table shows the maximum temperatures and maximum temperature rise during entry.

### **ENTRY MAXIMUM TEMPERATURE AND MAXIMUM TEMPERATURE RISE DATA**

Thermal Sensor Location	Maximum Temperature, °F	Maximum Temperature Rise, °F
Lower fuselage forward center (B1)	132.5	126.5
Lower fuselage forward left-hand (B2)	182.5	173.9
Lower fuselage forward mid left-hand (B3)	158.7	170.5
Lower fuselage mid center (B4)	135.1	141.9
Lower fuselage mid aft center (B5)	171.9	173.6
Lower fuselage aft center (B6)	179.8	156
Left-wing center (LW)	114.2	136.2
Right wing center (RW)	106.4	133.4
Port side FRCS forward (P1)	156.1	122 <sup>b</sup>
Port side fuselage forward center (P2)	116.8	100.6
Port side fuselage forward mid center (P3)	90.8	87.4
Port side fuselage mid aft center (P4)	93.4	56.8 <sup>a</sup>
Port side fuselage aft center (P5)	90.8	59.3
Starboard side FRCS Forward (S1)	140.4	116.5
Starboard side fuselage forward center (S2)	111.6	113.3
Starboard side fuselage forward mid center (S3)	88.2	74.6
Starboard side fuselage mid-aft center (S4)	57.2	64
Starboard side fuselage aft center (S5)	67.5	59
Left-hand OMS pod side forward (LP)	88.2	74.6 <sup>b</sup>
Right-hand OMS pod side forward (RP)	70.1	56.6
Lower body flap center	93.4 <sup>a</sup>	82.3 <sup>a</sup>
Right-hand OMS-pod side forward	70.1	56.6
Left-hand OMS-pod side forward	88.2	74.6
Right-hand PLBD forward	52.1 <sup>a</sup>	94.2 <sup>a</sup>
Left-hand PLBD forward	64.9	76.8
Right-hand PLBD aft	70.1 <sup>a</sup>	107.2 <sup>a</sup>

**ENTRY MAXIMUM TEMPERATURE AND MAXIMUM TEMPERATURE RISE DATA  
(Concluded)**

<b>Thermal Sensor Location</b>	<b>Maximum Temperature, °F</b>	<b>Maximum Temperature Rise, °F</b>
Left-hand PLBD aft	85.6	100
Right wing upper center	72.7 <sup>a</sup>	107.2 <sup>a</sup>
Left wing upper center	75.3 <sup>a</sup>	69.3 <sup>a</sup>
Forward RCS center	88.2	66.9
Forward fuselage upper center	59.8	71.6

**Notes**

- a: Maximum temperature occurred 30 min after wheel stop.
- b: Maximum temperature ever experienced on the OV-105 vehicle.

**Thermal Control System**

All heaters performed nominally, and all temperatures were maintained within limits. The OBSS was transferred successfully to the ISS during the fifth EVA, from where it will be retrieved on STS-124. The thermal clock to violation of a limit (from analysis) was 2 hr and 23 min. The actual no-power time flown was 1 hr and 8 min.

**Thermal Protection System and Post-Landing Assessment**

**Tile and Blanket Flight Assessment**

On FD 3, no Focused Inspection was requested as a result of the review of the Damage Assessment Team (DAT) recommendations by the Orbiter Project Office (OPO) Focused Inspection meeting. All Thermal Protection System (TPS) was cleared for the mission by the OPO, with the exception of a damaged area on the arrowhead Reinforced Carbon-Carbon (RCC). Pending completion of the analysis, the Orbiter TPS was considered degraded in accordance with the Flight Rules.

On FD 5, the TPS Tile and Blanket DAT completed analysis of the imagery obtained from the flight. The imagery review verified that the ET doors were closed, no impacts were found near the forward windows, and all OMS blankets remained in place. A total of 19 items of interest were identified and cleared for entry (IFA STS-123-V-07).

**RCC Flight Assessment**

On FD 2, all Wing Leading Edge Impact Detection System (WLE IDS) ascent summary data were downloaded and downlinked successfully. Forty half-sec windows of detailed G-time-histories were downlinked to confirm the implication of cases above 1 Grms. In total, there were no probable indications above 1 Grms on either the starboard or port wing.



On FD 3, the Reinforced Carbon-Carbon (RCC) DAT completed their analysis of the imagery obtained of the vehicle during the FD 2 exterior leading-edge surface surveys. The RCC DAT identified no issues and recommended that the Orbiter be cleared for entry. The arrowhead-plate-liberated repair site identified during the RPM was also evaluated and cleared for entry by the DAT.

The FD 12 main task was the Late Inspection of the RCC thermal protection system. All Late Inspection imagery was successfully down-linked to the ground prior to the crew sleep.

On FD 13, all Late-Inspection imagery processing as well as the review were completed. A total of 230 Regions of Interest (ROI's) were identified with 33 sent to the MER for disposition by the Leading Edge Structure System (LESS) Problem Resolution Team (PRT). The LESS PRT reviewed all ROI's and determined that no damage was indicated and cleared the vehicle for entry.

**Post-Landing Assessment**

The final debris-related tile damage numbers are shown in the following table.

**SUMMARY OF IMPACT SITES FOR EACH ORBITER SURFACE**

<b>Orbiter Surface</b>	<b>Impacts greater than 1 in.</b>	<b>Total impacts</b>
Lower surface	8	45
Upper Surface/Window	0	9
Right side	-	-
Left side	-	-
Right OMS pod	3	33
Left OMS pod	2	11
<b>Totals</b>	<b>13</b>	<b>98</b>

A post-landing walk-down of the runway was performed. No unexpected flight hardware found on the runway. All components of the drag parachute were recovered. The drag parachute hardware and components appeared to have functioned nominally. Both reefing-line-cutter pyrotechnic devices were expended. One reefing line was found 4300-ft aft of the main parachute, and the other was found 3700-ft aft of the main parachute.

However, drag-chute induced-tile-damage was noted and it was approximately 0.5-in. in diameter on the Left Hand (LH) tile adjacent to the drag parachute door.

Part of a stub tile near Space Shuttle Main Engine (SSME) 3 had approximately 25 percent of the total volume missing. This was seen during the film review, which showed that the damage occurred during SSME startup.

The tire material loss on the Main Landing Gear (MLG) tires and the nose landing gear tires was nominal.

The LH nose landing gear door had a tile corner chip on the aft-inboard edge. The MLG doors did not have any tile chips.

The Orbiter nose cap, LH Reinforce Carbon-Carbon (RCC), and Right Hand (RH) RCC panels all appeared to be in nominal condition.

The SSME Dome-Mounted Heat Shield (DMHS) blankets all appeared to be in excellent condition with a very low amount of fraying.

The LH<sub>2</sub> and LO<sub>2</sub> umbilicals both appeared to be nominal. The External Tank-Orbiter (EO-2) had 3 clips bent around the perimeter.

A gap-filler was protruding on the edge of the RH elevon that was seen in the on-orbit imagery. There was also a gap filler protruding outboard of the LH<sub>2</sub> umbilical adjacent to tile V070-395037-143. Also a AMES gap filler was found laying on the runway beneath the nose landing gear door opening. The consensus was that the tile fell off during inspection and not during the rollout.

Tile V070-192158-562, on the RH wing had a possible stretched Strain Isolator Panel (SIP) because the entire tile appeared to be protruding from the Outer Mold Line (OML) of the adjacent tiles.

### **Windows**

At approximately 085/02:35 GMT (013/20:07 MET), the crew reported a small MicroMeteoroid/Orbital Debris (MM/OD) impact on the thermal pane of Window no. 1. The impact is in the upper left corner and is approximately 1/8 to 3/16 in. in diameter. There is no visible distortion beyond the impact location.

The overall condition of the windows was satisfactory and no in-flight anomalies were identified. Observations showed two conditions as shown below:

1. Window no. 2 had hazing on the upper edge; and
2. Window no. 3 appeared to have a smudge in the upper inboard corner.

### **Waste Collection System**

The Waste Collection System operated properly with no reported problems.

## **EXTRAVEHICULAR ACTIVITY**

Five Extravehicular Activities (EVAs) were successfully performed with all objectives met. No In-Flight Anomalies (IFAs) were identified during the EVA. The four EVA crewmembers were Rick Linnehan (EV1), Bob Behnken (EV2), Mike Foreman (EV3), and Garrett Reisman (EV4).

### **FIRST EXTRAVEHICULAR ACTIVITY**

The first EVA of the mission was performed by the EV1 and EV4 crewmembers and the EVA was successfully completed in 7 hr 1 min. Tasks completed during the EVA include preparing the Japanese Experiment Module (JEM) Logistics Module Pressurized Section (JLP) for berthing to the Node 2 Zenith port and starting assembly of the Special Purpose Dexterous Manipulator (SPDM).

The JEM preparation activities included opening the Node 2 Zenith Centerline Berthing Camera System (CBCS) flap by using Velcro to secure the snaps in place. Eight Passive Common Berthing Mechanism (PCBM) contamination covers were removed from the JLP. The JLP Launch-to-Activation (LTA) connectors were demated and stowed on the EVA Cable Stowage Hardware (ECSH) dummy panel, and connector caps were installed on the LTA receptacles.

The SPDM assembly tasks included releasing two Orbital Replacement Unit (ORU) Tool Changeout Mechanisms (OTCMs) from the launch locations on the Spacelab Pallet (SLP) and installing them on the SPDM. The ORU Temporary Platform (OTP) Expandable Diameter Fastener (EDFs) were released and the SLP Power and Data Grapple Fixture (PDGF) horseshoe connectors were inspected.

Additionally, a tie was installed on the Airlock handrail that was discovered during the previous International Space Station (ISS) EVA.

### **SECOND EXTRAVEHICULAR ACTIVITY**

The second EVA of the mission was performed by the EV1 and EV3 crewmembers, and the EVA was successfully completed in 7 hr 8 min.

The second EVA objectives completed included removing the SPDM Arm no. 2 and Arm no. 1 from the SLP Flight Support Equipment (FSE) and temporarily stowing them on a SLP bracket. The crew encountered difficulty in releasing the Expanded Diameter Fasteners (EDF) on both arms. A bar was required on both arms to release the fasteners. Both SPDM Arm no. 1 and Arm no. 2 were then successfully mated to the "Dextre" main body. Several of the 19 Multi-Layered Insulation (MLI) thermal covers from the SPDM arms were removed.

### **THIRD EXTRAVEHICULAR ACTIVITY**

The third EVA of the mission was performed by the EV1 and EV2 crewmembers, and the EVA was successfully completed in 6 hr 53 min. The final SPDM assembly tasks were completed, along with a variety of ISS objectives.

The ORU Temporary Platform (OTP) and Tool Holder Assembly (THA) were installed. The Multi-Layered Insulation (MLI) thermal blankets were removed except an External Platform (EP) blanket, the OTCM-2 sock and the flaps on joint 2-7. Also, the Camera Light and Pan Tilt Assembly (CLPA) was installed. The Spacelab Pallet (SLP) was configured and prepared for return to the Orbiter payload bay.

Additional ISS objectives completed included transferring the Space Station Remote Manipulator System (SSRMS) Yaw Joint and two Direct Current Switching Unit (DCSU) ORUs and stowing them on the ESP-2. The Light Weight Adapter Plate Assembly (LWAPA) was transferred and installed on the Columbus External Payload Facility (EPF) and prepared for the Materials International Space Station Experiment (MISSE) 6 payload installation. As a get ahead, the Mobile Common Attachment System (MCAS) External Berthing Camera System (EBCS) cover flap was removed and the JEM Experiment Logistics Module Pressurized Section (JLP) trunnion covers were taken outside and stowed on a handrail for future installation.

Tasks not completed were the MISSE-6B installation because the pip pins could not be properly aligned and locked for final installation on the LWAPA. MISSE-6B was returned to the payload bay sidewall carrier. The MISSE-6A was not removed from the payload bay sidewall carrier or installed due to EVA time constraints.

### **FOURTH EXTRAVEHICULAR ACTIVITY**

The fourth EVA of the mission was performed by EV2 and EV3 crewmembers and the EVA was successfully completed in 6 hr 24 min.

Before the Control Moment Gyroscope (CMG) Remote Power Control Module (RPCM) removal and replacement, the Flight Control teams choreographed the required power downs and CMG no. 2 was removed from the Steering Law in preparation for the activities. The crew successfully replaced the RPCM but after two attempts they were not able to complete the patch panel reconfiguration because the difficulty encountered in un-mating the connectors. The purpose of the patch panel reconfiguration was to provide power to CMG no. 2 via the replaced RPCM. There were no impacts to current operations.

One Shuttle EVA task was completed during EVA 4, the crew performed TRAD/STA-54 repair technique demonstration (DTO-848).

The Z1 toolbox was inspected for Micrometeoroid Orbital Debris (MMOD) damage. Several "pits" were noticed by the crew and video imagery was assessed by the

engineering teams. The crew released the Node 2 Port Common Berthing Mechanism (CBM) launch locks. The Port location was completed in preparation for the berthing of the Japanese Experiment Module (JEM) module on Flight 1J in 2008. The EV 2 crewmember removed the remaining SPDM OTCM thermal covers, reconfigured some of the wrist blankets and flaps, and inspected the SPDM Arm no. 2 Shoulder Roll joint for possible MLI interference. The crew reported there was no visible interference. The Wireless Video System (WVS) (helmet cam) also provided video for analysis.

As a get-ahead task, the crew released the Node 2 Nadir CBM launch locks in preparation for the ULF-2 Multi-Purpose Logistics Module (MPLM), which will be delivered on a future flight, and the crew searched for a misplaced Push-in-Place (PIP) pin that was lost during the second EVA on a previous flight. Ground controllers opened and closed the Node 2 Nadir CBM petals and despite searching the entire location the PIP pin, it was not located. Following the search, the crew opened the window flap, since R-bar Pitch Maneuver (RPM) imagery showed it was not secured properly.

## **FIFTH EXTRAVEHICULAR ACTIVITY**

The fifth EVA of the mission was performed by EV2 and EV3 crewmembers and the EVA was completed successfully 6 hr 2 min.

The EVA crew was able to stow the Orbiter Boom Sensor System (OBSS) onto the S0/S1 truss and install the OBSS Keep-Alive Umbilical (KAU). MISSE-6 PEC A and B were installed on the Columbus External Facility and activated. The troublesome pip pins encountered during the first attempt of the installation of MISSE PEC 6B during the third EVA were overcome by the EV1 crewmember using a EVA hammer to persuade the pip pins into the final locked position. This seating of the pip pins secured the PEC 6B to the Light Weight Adapter Plate Assembly (LWAPA) receptacle. The EV2 crewmember completed the planned Starboard Solar Alpha Rotary Joint (SARJ) inspection activities. During the inspection of the datum A surface under cover no. 18, the crew observed a divot (depression) and obtained imagery of that depression. The cover was then reinstalled. Covers 16, 6, 8, 9 and 11 were also removed, inspected and re-installed and the crew did not observe any debris or divots. Get-ahead tasks completed included installation of the five JEM Experiment Logistics Module Pressurized Section (JLP) trunnion thermal covers, and stowage of the General Purpose cutters into the airlock tool box no. 2.

Several tasks were either planned or attempted on 1JA but not completed and will be rescheduled for an EVA on a future mission.. These tasks include removing several SPDM covers, completing the Z1 Patch Panel reconfiguration, installation of Trundle Bearing Assembly (TBA) no. 5, take European Technology Exposure Facility (EuTEF) photos, Node 2 nadir CBCS window flap opening, install Node 1 C2-02 MMOD shield, and return of the 3/8" drive ratchets to the EVA Tool Stowage Device.

## **REMOTE MANIPULATOR SYSTEM AND ORBITER BOOM SENSOR SYSTEM**

The Shuttle Remote Manipulator System (SRMS) performed satisfactorily throughout the STS-123 mission. No in-flight anomalies were identified during the review and analysis of the mission data. STS-123 was the 78th flight of the Shuttle Remote Manipulator System (SRMS), the 19th flight of SRMS S/N 201, the 9th flight of the Orbiter Boom Sensor System (OBSS), and the 2nd flight of Inspection Boom Assembly (IBA) S/N 203.

On-orbit initialization of the arm began at 071/10:03 GMT (00/03:35 MET) on Flight Day (FD) 1. The shoulder brace was released and the port and starboard Manipulator Positioning Mechanisms (MPMs) were deployed. The SRMS Checkout began at 071/10:55 GMT (00/04:27 MET) and was completed 15 minutes later. The SRMS performance during checkout was nominal. The End Effector backup release time was 12 sec.

On FD 2, the SRMS maneuvered to the OBSS Pre-Grapple position at 071/23:53 GMT (00/17:25 MET). The SRMS started the OBSS unberthing to the hover position at 072/0:22 GMT (00/17:54 MET). The Thermal Protection System (TPS) surveys began at 072/01:20 GMT (00/18:52 MET) and were completed at 072/06:32 GMT (01/00:04 MET). The SRMS then re-berthed the OBSS into the starboard MPMs and maneuvered to the pre-cradle position.

On FD 3, Endeavour docked to the International Space Station (ISS) with the SRMS in the pre-cradle position. The SRMS was maneuvered to the Spacelab Pallet (SLP) Viewing Position at 073/4:32 GMT (01/22:04 MET), where it provided viewing support for the installation of the SLP, which carried the Special Purpose Dexterous Manipulator, named DEXTRE, on to the Mobile Base System (MBS).

On FD 4, the SRMS grappled the Japanese Experiment Module Experiment Logistics Module-Pressurized Section (JEM ELM-PS or JLP) at 074/03:20 GMT (02/20:52 MET) and installed it on the zenith Common Berthing Mechanism (CBM) port of the Node 2 module at 074/08:13 GMT (03/01:45 MET). After JLP installation, the SRMS maneuvered to the OBSS Pre-grapple position.

On FD 5, The SRMS grappled the OBSS at 075/00:08 GMT (03/17:30 MET). After handing off the OBSS, the SRMS maneuvered to the viewing position for possible Focused-Inspection support. The SRMS began its maneuver to the -Y Star Tracker Clear position at 075/00:55 GMT (03/18:27 MET). Based on imagery analysis results, no Focused Inspection was required.

There were no SRMS operations on FD 6.

On FD 7 the SRMS maneuvered back to the SLP Viewing Position with the OBSS at 077/00:00 GMT (05/17:32 MET), then back to the -Y Star Tracker Clear Position at 077/06:43 GMT (06/00:15 MET). These maneuvers were completed to place the SRMS out of the way during a Shuttle water dump.

There were no SRMS operations on FD 8.

On FD 9, the SRMS again maneuvered to the SLP Viewing Position with the OBSS at 079/00:28. GMT (07/18:00 MET)

There were no SRMS operations on FD 10 and 11.

On FD 12, the Late Inspection began at 081/19:04 GMT (10/12:36 MET) and the inspection was completed at 082/01:22 GMT (10/18:54 MET). After completing the Late Inspection, the OBSS was maneuvered to the Handoff-to-Stow position.

On FD 13, EVA 5, the SRMS handed the OBSS to the SSRMS at 082/21:01 GMT (11/18:33 GMT) and then the OBSS was installed on the ISS by the Extravehicular Activity (EVA) crewmembers. The Keep-Alive-Umbilical (KAU), which provided heater power to the sensors and IBA avionics, was installed on the ISS truss and the Indicator Cover was installed on the IBA Electrical Flight Grapple Fixture (EFGF). After powering the IBA electronics, the Light Emitting Diodes (LED's) illuminated indicating a successful installation of the KAU, and power was flowing to the OBSS sensors. After hand off of the OBSS to the Space Station Remote Manipulator System (SSRMS), the SRMS maneuvered to the Pre-Cradle position. The SRMS was cradled and latched after the OBSS was installed.

The MPMs were stowed on FD 15.

## **WING LEADING EDGE IMPACT DETECTION SYSTEM**

### **ASCENT MONITORING**

The ascent data requests, downloads, downlinks, and analysis began at 6:24 hr MET. All ascent data files were downlinked nominally and at approximately 13:00 hr MET, the last batch of ascent data was received. The initial findings, which showed no probable indication above the 1.0 Grms reporting threshold, were issued at 14 hr MET. The final ascent report was issued at 14:47 MET.

All units triggered and began data recording on Main Engine Ignition, with units triggering within 0.13 sec of any other unit on the same wing, and within 0.17 sec of any unit from either wing. There were no (zero) probable impacts indications above the 1.0 Grms reporting threshold for this flight, and no additional indications above this threshold were identified in the post-flight data.

Automatic scanning of post-flight data acquired from MET 10-500 sec did reveal a total of 83 probable ascent debris impact indications on the wing leading edge (55 on the port and 28 on the starboard wing) ranging from 0.09 to 0.95 Grms.

### **ORBIT MONITORING**

For this mission, the Wing Leading Edge Impact Detection System (WLE IDS) recorded 4 valid triggers, 3 of which satisfied all impact criteria, and were evaluated and reported in-flight as 3 MM/OD impact indications. None occurred in the period from initial activation until docking at approximately 45 hours MET. The summary of all WLE IDS Micro-Meteoroid/Orbital Debris (MM/OD) probable impacts for this flight is shown in the following table.

### **SUMMARY OF MMOD IMPACTS**

Times <sup>a</sup>	Location			Magni- tude Max. G	Criteria				Impact <sup>b</sup>	
	Wing	RCC	Unit- Channel		Transient	Local	Spectral	Shock	In- Flt	Post- Flt
082/15:34:28	Port	11/12U	1182-J3	0.75	+	+	+	+	P	P
082/21:22:15	Starboard	1U	1161-J1	0.50	+	+	+	+	P	P
085/01:32:45	Port	2/3L	1230-J2	0.66	+	+	+	+	P	P

<sup>a</sup>Adjusted to correct for known differences between the onboard laptop and actual GMT times.

<sup>b</sup>P=Probable

### **SUPPLEMENTAL DATA COLLECTED**

No supplemental data were collected.



## CONCLUSIONS

The WLE IDS performed well for ascent-impact monitoring, allowing an initial ascent report to be published at 14 hr MET. There were no ascent impact indications above the 1.0 Grms reporting threshold.

The MM/OD monitoring detected three impact indications, all of which were reported during the mission.

A recommendation to not perform a focused Wing Leading Edge (WLE) inspection of the Reinforced Carbon-Carbon (RCC) for ascent data was made by the Orbiter Project Office (OPO) based on the ascent findings from all systems including WLE IDS. A recommendation to not perform a focused inspection for the on-orbit impact indications was also made by the OPO because of the relatively low magnitude of the indications, their locations, and comparisons to similar ground test data. The on-orbit assessments and recommendations were coordinated with the Leading Edge Subsystem Problem Resolution Team (LESS-PRT) and provided to the OPO on Flight Days 13 and 15.

A late mission survey inspection was performed on the RCC to visually inspect for damage. that occurred three days before undocking during the transfer of the Orbiter Boom Sensor System (OBSS) from the Orbiter to the ISS in preparation for STS-124. This damage occurred prior to all three WLE IDS on-orbit indications.

## **GOVERNMENT FURNISHED EQUIPMENT/FLIGHT CREW EQUIPMENT**

The Government Furnished Equipment (GFE) and Flight Crew Equipment (FCE) supported the mission in a satisfactory manner. Two in-flight anomalies were identified and two "future-trending" items were identified.

On FD 2 when crew performed the Orbiter Boom Sensor System (OBSS) Pan/Tilt Unit (PTU) reset (pan left to hard stop, tilt up to the hard stop and reset or zero out the pan/tilt values) and pan/tilt to the values called out in the checklist of +103, -260 deg, the view was not the same as shown in the checklist (IFA STS-123-V-09). To match the checklist view of the handrail on the starboard sill for the Laser Dynamic Range Imager (LDRI) calibration, the crew adjusted the pan/tilt to +113.8, -257.4 deg. The LDRI view was therefore off by 10 deg in pan. When crew moved the OBSS to the beginning of the starboard Reinforced Carbon-Carbon (RCC) survey, they adjusted the pan/tilt to +85, -93 deg per the checklist. Again the image in the checklist did not match the LDRI view. The crew was asked to move the PTU by the amount needed to match the image, and this change resulting in a pan/tilt pointing position of +95, -90.6 deg. For the rest of the FD 2 RCC survey, crew and ground took the 10-deg pan error into account and successfully completed the inspection.

This offset was present throughout the mission and the crew was able so reset the view and perform the planned imagery documentation.

While the Group A Wing Leading Edge (WLE) sensors were monitoring for MicroMeteoroid/Orbital Debris (MM/OD) during the late inspection period, sensor unit S/N 1150 on the port wing had excessive triggers (4452) during the first hour of monitoring (IFA STS-123-V-10). The triggers on this sensor forced all other sensors within Group A to trigger on the port wing. It was determined that the sensor unit memory was saturated at the time. Consequently, all port-wing sensor units within Group A were cancelled (taken out of On-Orbit Monitoring mode) to get the trigger file information. The sensor units (S/N 1230) raw-window data were downloaded to determine the trigger validity, and raw-data were found to be "noise-invalid" triggers. A second restart for On-Orbit Monitoring mode was issued for all port-wing sensors within Group A without sensor unit S/N 1150.

Later during the mission, a diagnostic command was sent to sensor unit S/N 1150 and the result file displayed that the unit's flash memory was completely saturated and the sensor was in the idle mode. A File Summary request was sent for S/N 1150 data and the data showed approximately 9600 triggers. The evaluation team was able to download two ½-sec data windows for S/N 1150. After review of the data, the triggers were determined to be an invalid "trigger-noise". The peak G reading for the downloaded data was recorded at 18G.

The Advanced Crew Escape Suit (ACES) glove (S/N 055) was found with a large (approximately 1-inch long) tear in the left-hand glove bladder (IFA STS-123-V-16). The

tear was in the crotch between the little finger and ring finger and was found during the STS-124 pre-event inspection. The history of the glove was reviewed and nothing abnormal was noted, and glove had not been used after the STS-123 landing until discovery of the anomaly. The glove was pressure-tested prior to stowage onboard STS-123 for returning ISS crewmember. The glove underwent general inspection (no bladder inspection), and was shipped to Houston, where a general inspection was repeated, and then it was placed into bond. The selection for STS-124 training initiated a pre-event inspection/test, and the anomaly was discovered. The initial 10x magnification inspection of the tear and adjacent area on the bladder plus outer restraint found neither obvious clues nor any indication of obvious material defect.

A meeting with the crewmember indicated that he did experience greater than "typical" bladder resistance while donning the glove. This resulted in using excessive force during the donning; however, the crewmember did not recall any visual/audible anomalies during donning. Also, the finger nails and jewelry were determined to not be a factor in this occurrence.

During the manual phase of the rendezvous, the Trajectory Control Sensor (TCS) Continuous Wave (CW) dropped lock on the target and failed to reacquire without intervention. The TCS performance and data were reviewed to determine the cause of the loss of lock, which was determined to not be caused by a hardware or software anomaly.

During the FD 12 Late Inspection, a latent image was observed on the Laser Dynamic Range Imager (LDRI). In technical terms, the gain over the LDRI focal plane was not uniform, which can vary particularly when operating in Mode 6 for many hours while focused on deep space or at a fixed scene. This condition is explained as the LDRI was left in MODE 6 (scanning mode) for roughly 54 hr longer than expected, which result in a "burned in" or latent image. This latent image did not affect image the quality, but did increase the processing time. Continued use of the LDRI will cause the latent image to dissipate. Since the OBSS with the LDRI was stowed on the ISS, no further activity is planned.

## **DEVELOPMENT TEST OBJECTIVES**

Three Development Test Objectives (DTOs) were assigned to the STS-123 mission. Two of the three were completed. The results of the two DTOs accomplished may be obtained from the DTO sponsor. No problems were noted in the review of the data and performance of the DTOs, which are as follows.

**DTO 805 Crosswind Landing Performance** – The completion of this DTO of opportunity was not possible during landing, because the crosswind did not meet the minimum requirement of at least 10 knots.

**DTO 848 – Tile Repair Ablative Dispenser (TRAD)** – The TRAD objectives were completed satisfactorily during the fourth EVA. The EVA crewmembers successfully completed all DTO objectives by filling all ten tile samples using the TRAD dispenser.

**DTO 853 - In-Flight Evaluation for Areas of CO<sub>2</sub> Concentration** - The CO<sub>2</sub> Monitor (CDM) activities were executed in accordance with the nominal procedures over the duration of the flight.

## **POST-LAUNCH PAD INSPECTION**

The post-launch inspection of the Main Launch Platform (MLP) -2, Pad A Fixed Service Structure (FSS), and Pad A apron was conducted on March, 11 2008, from Launch +2 hr 20 min to 4 hr 45 min. The inspection proceeded relatively quickly after Safing Teams secured the Pad. The entire Pad, FSS, and MLP were inspected. No flight hardware was found other than minimal Solid Rocket Booster (SRB) nozzle throat plug foam and Room Temperature Vulcanizing (RTV) material from the plug.

The Orbiter lift-off lateral acceleration data indicated a maximum of 0.14g. The hold-down stud hang-ups are typically noted with lateral accelerations above 0.19g.

The inspections of the SRB holddown posts were performed and the results are as follows:

**HDP 1** – The EA934 poured sidewalls were nominal with some acceptable delamination. The Phenolic shim had acceptable minor blistering and the two firing lines remained (approximately 1-ft remaining on each). No galling or chatter marks were noted in the chamfer of the through-hole.

**HDP 2** – The EA934 poured sidewalls were nominal with acceptable delamination from the shoe on the West, East, and South. The Phenolic shim was nominal without visual blistering. Approximately 3-ft of the Range Safety System (RSS) cable was present and both firing lines were present (approx. 3-in. each). No galling or chatter marks were noted in the chamfer of the through hole.

**HDP 3** – This hold down post showed better than nominal indications of erosion on the RTV-coated blast shield and proper closure was noted.

**HDP 4** – This hold down post showed nominal indications of erosion on the RTV-coated blast shield and proper closure was noted.

**HDP 5** – The EA934 poured sidewalls were nominal with acceptable minor delamination from the shoe. The Phenolic shim was nominal with typical erosion and the two firing lines remained (approximately 16-in. and 20-in.). No galling or chatter marks were noted in the chamfer of the through-hole.

**HDP 6** – The EA934 poured sidewalls were nominal and without any delamination from the shoe. The Phenolic shim was nominal without visual blistering and both firing lines were present (approx. 10-in. and 18-in.). No galling or chatter marks were noted in the chamfer of the through-hole.

**HDP 7** – This hold down post showed nominal indications of erosion on the RTV-coated blast shield and proper closure was noted.

**HDP 8** - This hold down post showed typical indications of erosion on the RTV-coated blast shield with proper closure of the blast shield, and the RSS cable was missing.

The inspections of the GN<sub>2</sub> purge lines were performed and the results are as follows:

The Left-Hand (LH) probe was erect and straight with about 85 percent of the protective- tape layering remaining with no exposed braiding. The o-ring was not present.

The Right-Hand (RH) probe was erect and slightly bent to the Southwest with about 85 percent of the protective-tape layering remaining with no exposed braiding. The o-ring was present.

The inspections of the SRB T-0 Ground Carrier Assemblies (GCAs) were performed and are as follows:

The LH SRB T-0 GCAs appeared to be in nominal condition with the proper demate. The 5J1 connector was raised above the plane of the interface (acceptable) to the aft skirt.

The RH SRB T-0 GCAs appeared to be in nominal condition with the proper demate. The 5J1 and 3J1 connectors were raised above the plane of the interface (acceptable) to the aft skirt.

The LO<sub>2</sub> and LH<sub>2</sub> Tail Service Masts (TSMs) appeared to be undamaged and both bonnets appeared to have closed properly. The LH<sub>2</sub> bonnet has a run of hydraulic fluid on the top and center of the closure panel.

The MLP deck was in excellent condition. Typical blast erosion was observed in and around the SRB flame holes with some indication of a Westerly accent. All sound suppression shims appeared to be in place.

The Orbiter Access Arm (OAA) at the 195-ft level was not accessible for a walkdown, but it appeared to be intact with no evidence of plume damage. All slidewire baskets were still secured at the 195-ft level with no evidence of damage. Basket no. 4 had 3 missing pip-pins, while basket no. 3 had 1 pip-pin missing.

The GH<sub>2</sub> vent line on the Ground Umbilical Carrier Panel (GUCP) at the 215-ft level was latched on the eighth tooth (of eight) on the latching mechanism. The vent line was in between the gimbal struts and slightly South of center in the latching mechanism as seen from the FSS. The External Tank (ET) GUCP 7-inch GH<sub>2</sub> Quick-Disconnect (QD) probe was accessible for inspection and appeared to be undamaged. Both the QD-probe sealing surface and the poppet valve assembly were in good condition with minor SRB plume speckles on the poppet probe and minor corrosion on the QD lip. The deceleration cable was in nominal configuration and the GH<sub>2</sub> vent line blanket was mostly torn away by plume impingement. The static lanyard tensioning guide cable was not-centered on the curved guides. The ET GUCP exhibited typical blast damage and the pyrotechnic bolt fired nominally.

At the 255-ft level, the GO<sub>2</sub> vent arm, vent hood, ducts and structure appeared to be in nominal condition and the latch mechanism locked properly. The upper and lower

shock absorbers exhibited corrosion and the GVA air accumulator was leaking fluid with no capture pan or mechanism to capture the leaking fluid.

Although numerous items were found, the Pad facility was found to be in very good condition (above normal). The most notable debris items using the new debris collection criteria are included below.

1. Minor pieces of SRB throat plug material were found on the Pad surface.
2. A fondue fyre and partial bolt were found on the West Pad surface near the elevators.
3. A unistrut attachment and threaded plug were found on the West Pad surface under the RSS.
4. A unistrut bracket, fondue fyre, blue ID tag and metal dog tag were found on the West Pad surface.
5. At the 115-ft level, the northwest speaker was warped, and a cable- tray cover was blown off and captured by the structural frame of the FSS below 115-ft level grating.
6. At the 135-ft level, a frayed ground cable was noted on the cable tray transition, a cable clamp was found on the Orbiter Work Platform (OWP) structural frame, a leaking firex line was noted on the South side of the FSS and a missing J-hook from the pneumatic lines on the Southeast ceiling was noted.
7. At the 155-ft level, a clamp was found on stair landing between the 175-ft and 155-ft level, a ceramic insulator was found on the East side, and a latch on the INCS cabinet was found on the West side of the deck.
8. At the 195-ft level, a welding rod was found on the North side and a cabinet door was blown open on the South side.
9. At the 235-ft level, two clamps were missing and one of which was recovered on the South side, a clamp from the low-voltage enclosure on the North side was loose but didn't liberate.

## **LAUNCH PHOTOGRAPHY AND TELEVISION ANALYSIS**

The ground cameras, both film-type and television, provided very good coverage of the launch and ascent of the STS-123 vehicle. Numerous observations were made and are documented in the NASA Imagery Reporting Database (NIRD). Significant observations and those which were determined to potentially impact the Orbiter included the following.

1. During the prelaunch period between -4.078 and -3.482 sec, a coating loss on the Orbiter Base Heat Shield was noted. This time period was during Space Shuttle Main Engine (SSME) ignition.
2. During the prelaunch period at -3.458 sec, ice/frost debris was observed falling from LH2 T-0 Umbilical and impacting the SSME 2 nozzle bell at the 8th hatband.
3. During the prelaunch period between -3.482 and -3.032 sec, three tile chips on the Orbiter's port stinger pod and one tile chip on the Orbiter's starboard stinger were observed during SSME ignition
4. During the prelaunch period between -2.993 and -2.371 sec, a thin black-and-white (black on one side and white on the other) piece of debris, which was initially identified as a possible tile chip, (based on the location and color) appeared to fall aft from the upper +Z starboard side of the body flap. The damage location is believed to be on the +Z side of the body flap, but may have come from the base heat shield. No imagery of the damage location was obtained from ground imagery. The debris was seen impacting SSME 3 at the no. 6 hat-band location.
5. During the prelaunch period between -2.911 and -2.898 sec, debris impacts were noted on the SSME 3 nozzle bell at the 7th and 8th hatband.
6. Facility debris was observed in the +0.8 to +0.9 sec following lift-off between the Solid Rocket Boosters (SRBs). The debris appeared to be on the +Z side of the Orbiter, but, as observed with relation to view, is coming from starboard SRB.
7. A tile coating loss was observed at 0.968 sec after lift-off outboard of SSME 3 on the dome mounted heat shield.
8. At 14.023 sec MET, a single piece of debris is seen falling aft under the Orbiter's port wing.
9. A missing piece of Thermal Protection System (TPS) tile was noted at approximately -XT 1270 outboard of the LO<sub>2</sub> feedline. The time of this observation was not available.
10. At 6.804 sec, a Tyvek cover from a starboard thruster impacted the leading edge of the vertical stabilizer.
11. Single piece of light colored debris was observed at 9.947 sec after lift-off, and was forward of the launch vehicle and traveling aft. The debris does not appear to originate from the vehicle. Originally, this debris was thought to possibly impact the Orbiter nose near the F3F Reaction Control System (RCS) thruster at the same time as the Tyvek cover F2F released. It is the belief of the Kennedy Space Center's (KSC's) additional analysis that the object passes behind the Port SRB and does not come near the Orbiter. The initial analysis by the Marshall Space Flight Center (MSFC) Imagery Analysis Team (IAT) is that the object also does not impact the Orbiter.



12. During ascent at approximately 14 sec MET, debris was observed falling aft between the Orbiter and ET on the starboard side. There was not an Orbiter impact, and the exact source of the debris is unknown
13. During ascent at 14.023 sec MET, a single piece of debris was noted falling aft under the port wing of the Orbiter.
14. During ascent at approximately 15 sec MET, debris was observed falling aft between Orbiter and ET on starboard side. No Orbiter impact observed. The exact source of the debris is unknown. There is no evidence for this observation being related to the similar debris event at approximately 14 sec that was discussed in a earlier paragraph.
15. During ascent at 19.795 sec MET, debris was observed falling aft of the starboard wing of the vehicle. The light colored debris appeared to ricochet off the starboard wing.
16. Between 22.318 to 22.539 sec, debris was observed passing near the crew hatch and then along the port side of the Orbiter over the wing and finally exiting aft of the vehicle.
17. At approximately 28 sec MET, debris, which was purge barrier material, was observed impacting the vehicle near the base of starboard wing.
18. At approximately 29 sec MET, debris was observed impacting the body flap of the Orbiter.
19. At approximately 36 sec MET, a single piece of debris was noted between the ET and Orbiter on the starboard side. This debris was observed for multiple frames and was first seen near the Liquid oxygen feedline at approximately the Xt 1464 location. No Orbiter impact observed.
20. At 36.904 sec MET, a single piece of debris was observed falling aft between the External Tank (ET) and the Orbiter. The debris was observed for three frames and did not impact the Orbiter.
21. At approximately 37 sec MET, a single piece of debris was observed falling aft between the ET and Orbiter on the starboard side. No Orbiter impact observed.
22. Single light colored piece of debris observed falling aft between vehicle and ET.
23. At 79.313 sec MET, a single piece of debris was observed between the ET and the Orbiter. The piece of debris was falling aft on the starboard side of the vehicle and no impact was observed.
24. During the period from 82.1 to 83 sec MET, a single piece of debris is observed falling aft below the starboard wing. No contact to the vehicle was noted by either MSFC or JSC IATs. The JSC IAT believes the object appears to be aft of the vehicle and possibly is debris from the SRB exhaust plume.
25. At 121.772 sec MET, debris was observed possibly impacting the Starboard Wing Landing Gear Door (LGD) Multiple pieces of debris were seen from camera SRA110 (appears as a single piece from camera SRF210) were observed possibly impacting starboard wing landing gear door and falling aft. The debris appears to emanate from approximately the Xt-1871 area as seen from camera SRA110.
26. At approximately 125 sec MET during the SRB separation, debris that was ET Char was observed impacting the Orbiter. Also at SRB separation, multiple pieces of debris (charred ET TPS) were observed impacting the starboard wing and the port elevon..

**APPENDIX A**  
**STS-123 MISSION EVENTS**

EVENT	DESCRIPTION	ACTUAL GMT
APU Activation	APU-1 Gas Generator Chamber Pressure APU-2 Gas Generator Chamber Pressure APU-3 Gas Generator Chamber Pressure	071/06:23:26.284 071/06:23:28.123 071/06:23:29.863
SRB HPU Activation	LH HPU System A Start Command LH HPU System B Start Command RH HPU System A Start Command RH HPU System B Start Command	071/06:27:46.134 071/06:27:46.294 071/06:27:46.454 071/06:27:46.614
Main Engine Start	SSME-3 Start Command Accepted SSME-2 Start Command Accepted SSME-1 Start Command Accepted	071/06:28:07.429 071/06:28:07.539 071/06:28:07.659
SRB Ignition	SRB Ignition Command	071/06:28:13.984
Throttle Up 104.5 Percent	SSME-3 Command Accepted SSME-1 Command Accepted SSME-2 Command Accepted	071/06:28:17.986 071/06:28:17.995 071/06:28:17.996
Throttle Down to 99 Percent	SSME-3 Command Accepted SSME-1 Command Accepted SSME-2 Command Accepted	071/06:28:32.226 071/06:28:32.235 071/06:28:32.236
Throttle Down to 72 Percent	SSME-3 Command Accepted SSME-2 Command Accepted SSME-1 Command Accepted	071/06:28:49.507 071/06:28:49.516 071/06:28:49.516
Throttle Up to 104.5 Percent	SSME-3 Command Accepted SSME-2 Command Accepted SSME-1 Command Accepted	071/06:29:03.267 071/06:29:03.276 071/06:29:03.276
Maximum Dynamic Pressure (Max Q)	Derived Ascent Dynamic Pressure	071/06:29:13
Both SRMs to less than 50 psi	RH SRM Chamber Pressure LH SRM Chamber Pressure	071/06:30:13.824 071/06:30:14.264
End SRM Action	RH SRM Chamber Pressure LH SRM Chamber Pressure	071/06:30:16.284 071/06:30:16.384
SRB Separation Command	SRB Separation Command Flag	071/06:30:18
SRB Physical Separation	LH APU A Turbine Loss of Signal RH APU B Turbine Loss of Signal LH APU B Turbine Loss of Signal RH APU A Turbine Loss of Signal	071/06:30:18.664 071/06:30:18.664 071/06:30:18.704 071/06:30:18.704
OMS Assist Ignition	R Engine Bipropellant Valve Position L Engine Bipropellant Valve Position	071/06:30:28.9 071/06:30:29.0
OMS Assist Cutoff	R Engine Bipropellant Valve Position L Engine Bipropellant Valve Position	071/06:32:23.4 071/06:32:23.5
Throttle Down for 3g	SSME-3 Command Accepted SSME-2 Command Accepted SSME-1 Command Accepted	071/06:35:35.757 071/06:35:35.762 071/06:35:35.762
3G Acceleration	Total Load Factor (g)	071/06:35:41.4
Throttle down to 67 percent for Cutoff	SSME-3 Command Accepted SSME-2 Command Accepted SSME-1 Command Accepted	071/06:36:30.798 071/06:36:30.803 071/06:36:30.803
SSME Shutdown	SSME-3 Command Accepted SSME-2 Command Accepted SSME-1 Command Accepted	071/06:36:37.239 071/06:36:37.243 071/06:36:37.244
Main Engine Cutoff (MECO)	MECO Command Flag MECO Confirmed Flag	071/06:36:37 071/06:36:39
ET Separation	ET Separation Command Flag	071/06:36:59

**APPENDIX A**  
**STS-123 MISSION EVENTS**

EVENT	DESCRIPTION	
APU Deactivation	APU-1 Gas Generator Chamber Pressure APU-2 Gas Generator Chamber Pressure APU-3 Gas Generator Chamber Pressure	071/06:43:06.396 071/06:43:20.522 071/06:43:31.673
OMS 1 Ignition	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	N/A
OMS 1 Cutoff	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	N/A
OMS 2 Ignition	R Engine Bipropellant Valve Position L Engine Bipropellant Valve Position	071/07:06:44.1 071/07:06:44.2
OMS 2 Cutoff	R Engine Bipropellant Valve Position L Engine Bipropellant Valve Position	071/07:07:47.1 071/07:07:47.2
Payload Bay Doors Open	Right Payload Bay Door Open 1 Left Payload Bay Door Open 1	071/08:23:02 071/08:24:23
OMS 3 Ignition	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	071/09:37:37.3 071/09:37:37.5
OMS 3 Cutoff	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	071/09:38:26.7 071/09:38:26.7
OMS 4 Ignition	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	071/23:34:44.8
OMS 4 Cutoff	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	071/23:35:01.4
OMS 5 Ignition	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	072/22:11:09.5 072/22:11:09.6
OMS 5 Cutoff	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	072/22:12:05.7 072/22:12:05.8
OMS 6 Ignition	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	072/23:10:32.3 072/23:10:32.4
OMS 6 Cutoff	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	072/23:11:31.8 072/23:11:31.9
OMS 7 Ignition	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	073/00:42:22.3
OMS 7 Cutoff	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	073/00:42:33.7
Docking	Capture	073/03:49:48
Undocking	Undocking Complete	085/00:25:01
Flight Control System Checkout – APU 1 Start	APU-3 Gas Generator Chamber Pressure	085/18:30:39.467
APU 1 Stop	APU-3 Gas Generator Chamber Pressure	085/18:36:21.777
Payload Bay Door Close	Left Payload Bay Door Close Right Payload Bay door Close	086/09:17:45 086/09:23:49
APU Activation	APU-2 Gas Generator Chamber Pressure APU-1 Gas Generator Chamber Pressure APU-3 Gas Generator Chamber Pressure	086/23:28:20.541 086/23:55:16.467 086/23:55:23.494
Deorbit Maneuver Ignition	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	086/23:33:14.0 086/23:33:14.0
Deorbit Maneuver Cutoff	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	086/23:35:59.4 086/23:35:59.6
Entry Interface	Orbital Altitude Referenced to Ellipsoid	087/00:07:29
Blackout End	Data Locked (High Sample Rate)	No Blackout

**APPENDIX A**  
**STS-123 MISSION EVENTS**

<b>EVENT</b>	<b>DESCRIPTION</b>	
Terminal Area Energy Management (TAEM)	Major Mode Code (305)	087/00:32:43
Main Landing Gear Contact	Main Landing Gear Left Hand Tire Pressure Main Landing Gear Right Hand Tire Pressure	087/00:39:06 087/00:39:07
Main Landing Gear Weight on Wheels	Main Landing Gear Right-Hand Weight on Wheels Main Landing Gear Left Hand Weight on Wheels	087/00:39:07 087/00:39:08
Drag Chute Deployment	Drag Chute Deploy 1 CP Volts	087/00:39:09.7
Nose Landing Gear Contact	Nose Landing Gear Left Hand Tire Pressure 1	087/00:39:16
Nose Landing Gear Weight on Wheels	Nose Landing Gear Weight on Wheels	087/00:39:17
Drag Chute Jettison	Drag Chute Jettison 2 CP Volts	087/00:39:55.1
Wheels Stop	Velocity with respect to Runway	087/00:40:37
APU Deactivation	APU-1 Gas Generator Chamber Pressure APU-2 Gas Generator Chamber Pressure APU-3 Gas Generator Chamber Pressure	087/00:59:07.367 087/00:59:21.221 087/00:59:59.124

## **APPENDIX B STS-123 IN-FLIGHT ANOMALIES**

### **INTRODUCTION**

This appendix contains listings and discussions of each of the In-Flight Anomalies (IFAs) that were identified for the STS-123 mission.

1. Orbiter
2. Solid Rocket Booster (SRB)
3. Reusable Solid Rocket Motor (RSRM)
4. External Tank (ET)
5. Space Shuttle Main Engine (SSME)
6. Systems Engineering and Integration (SE&I)
7. Flight Operations and Integration (FO&I)
8. Mission Operations Directorate
9. Flight Software

**APPENDIX B  
STS-123 IN-FLIGHT ANOMALIES**

**ORBITER ANOMALIES**

IFA Number	Title	Comments
STS-123-V-01	DSC OL 1 Card 1 Fail Loss of RCS JET Leak Indications	<p>During ascent at 071/06:28:17 GMT, the Dedicated Signal Conditioner Orbital Maneuvering System (OMS) Left 1 (DSC-OL1) chassis measurements the Reaction Control System (RCS)-Left Aft Fuel Thruster injector Temperature L2L, RCS-Left Aft Fuel Thruster Injector Temperature-L2U and RCS-L Aft Fuel Thruster Injector Temperature-L2D) failed Off Scale Low (OSL) and the data were down-linked in the Operational Instrumentation (OI) data stream. The fourth measurement is RCS-Left Aft Fuel Thruster Injector Temperature-L5L, which is only available via the down-list. All four measurements are associated with DSC-CVRD (Dedicated Signal Conditioner-Converter Variable Resistance to DC) card 1 of DSC-OL1. The remaining measurements on the DSC-OL1 chassis were not affected by the OSL condition. In addition, the Multiplexer/Demultiplexer (MDM) are operating nominally.</p> <p>These failures were instrumentation-only and did not affect the thrusters' health. Thrusters L2U and L2D were automatically deselected by Redundancy Management (RM) as Fail Leak; thruster L2L did not deselect because the OMS Pod limit for failed primary thrusters (2 thrusters) had already been reached. The Vernier thruster L5L was automatically deselected by RM when the vernier thrusters were enabled by the flight software transition to Operational Sequence (OPS) 2 mode. The left-pod RCS manifold 2 thrusters were placed in last priority and were reselected (with RM leak flag already set) at 071/20:51:24 GMT. This left these thrusters available should two other thrusters fail in the same pod/direction as one of the failed thrusters.</p> <p>The most probable cause is the DSC-OL1 (Dedicated Signal Conditioner OMS Left 1) card 1 IEEE parts failure (voltage regulator, component location U701).</p> <p><b>Post-flight Plan:</b> Verify the OSL condition and remove and replace card 1 of DSC-OL1. The card changeout will be attempted without removing the pod.</p>

**APPENDIX B  
STS-123 IN-FLIGHT ANOMALIES**

IFA Number	Title	Comments
STS-123-V-02	FES Shutdown on Primary A Controller	<p>At 071/06:31 GMT, the FES shut down while operating with Primary A controller in the full-up mode with high load and topper operating during ascent. Restarts of the Primary A controller were attempted in both the full-up mode and the topper mode. The controller shut itself down in both modes. Prior to this event, the FES had been operating with no anomalous signatures.</p> <p>There were no immediate impacts to mission success or safety. The FES was operational using the redundant Primary B controller and the feedline B systems. The controllers are 1R3.</p> <p>The situation remained stable throughout the remainder of the mission. Nominal ISS docking operations were supported. The plan for the remainder of the mission was to complete the mission on FES Primary B without attempting to restart the Primary A controller.</p> <p><b>Post-flight Status:</b> The FES primary A system checkout was completed and the FES would not start, indicating failure of Primary A controller. The Primary B controller tested satisfactorily. The plan is to replace the Primary A controller.</p>
STS-123-V-03	APU 1 Gas Generator Chamber Pressure Transducer Shift	<p>Approximately 14 sec prior to MECO, at 071/06:36:23 GMT, the Auxiliary Power Unit (APU) 1 Gas Generator (GG) chamber pressure indicated a shift upward of about 97-111 psi at the low end (from 28 to 125-139 psia). During and after APU shutdown, no indication of internal Gas Generator Valve Module (GGVM) leakage was identified. The pressure reading stabilized at 105 psia, which indicates an instrumentation problem. A review of other instrumentation with common channelization showed no anomalous signatures.</p> <p>There were no flight rule or mission impacts for the anomaly seen. The GG chamber pressure is not required for APU start or operation. The GG chamber pressure pulses are still providing insight to the APU function. No crew action was required. There was no effect between this anomaly and the STS-123-V-05 anomaly..</p> <p><b>Post-flight Status:</b> Troubleshooting is in work to isolate source of transducer shift. The decay test was completed and no decay was found. Electrical tests indicate that the vehicle side is satisfactory. An APU GG chamber pressure bias waiver was submitted for approval.</p>

## APPENDIX B STS-123 IN-FLIGHT ANOMALIES

IFA Number	Title	Comments
STS-123-V-04	APU 3 Seal Cavity Drain Line Pressure Decay	<p>At approximately 072/00:52:28 GMT (0/18:00 MET), the APU 3 seal cavity drain line pressures began to slowly decay. The decay was seen in both pressure transducers. The pressure decay was approximately 1.1 psi/day adjusted for temperature.</p> <p>The mission was not impacted at that rate of pressure decay. No significant fuel leakage into the drain system was seen during APU operation or after shutdown. Nominally, small amounts of hydrazine can leak in the drain system during APU operation. The pressure decay rate is below the threshold for a liquid leakage, and the decay was most likely GN<sub>2</sub>. The APU 3 fuel pump inlet pressure held steady for the remainder of the mission. The drain system pressure was closely monitored during the on-orbit phase of the mission. Previous flight IFA for this problem was STS-118-V-04.</p> <p><b>Post-flight Status:</b> The system was re-pressurized with GN<sub>2</sub> and decay was observed similar to flight rate. Helium pressurization will be performed to support sniff checks to isolate the source.</p>
STS-123-V-05	APU 1 Fuel Tank Pressure Decay	<p>The APU 1 fuel tank pressure measurements began to decay shortly after APU ascent shutdown. The decay was greater than that normally seen due to post-ascent heat soakback and was similar to that seen during STS-121 (STS-121-V-08). The pressure decayed 8 psi (258 to 250 psia) in 2.2 days.</p> <p>The pressure decay could be GN<sub>2</sub> pressurant or liquid hydrazine. A fuel tank diaphragm separates the gas and fuel sides, resulting in a common pressure on both sides of the diaphragm. If the leak is liquid, it would likely freeze (no temperature decreases indicate this), and if it is a fuel leak and there is no change to the decay rate (should decrease as pressure drops), a worst case of 25 lb of fuel could leak by the end of the mission. Much of this would sublime, or melt during entry; however a possible fire hazard may be present in the aft fuselage. If the leak rate is determined to be such that it would exceed the hydrazine flammability limit in the aft fuselage at post-landing, the APU may be run on-orbit to deplete some or all of its fuel. The situation remained stable; with no change to the small consistent pressure decay rate. Liquid leak analysis in work.</p> <p><b>Post-flight Status:</b> No evidence was found of a hydrazine leak post-landing inspection. Troubleshooting to isolate GN<sub>2</sub> leak source in work. To support system leak troubleshooting, KSC plans to chill MD12 with GN<sub>2</sub> for an extended period to simulate the flight thermal environment in hopes of locating the leak.</p>
STS-123-V-06	MPS LO <sub>2</sub> Engine 3 Inlet Pressure Drift	<p>The Main Propulsion System (MPS) engine 3 LO<sub>2</sub> inlet pressure showed shift of 30 psi at lift-off. This is the second flight of this transducer. The shift was noted during this flight only when compared to the previous 5 flights and it lasted until SRB Separation. The measurement recovered for the remainder of the ascent phase until MECO. The inlet pressure transducers are idle and don't serve a critical function for the remainder of the mission. No in-flight troubleshooting was required.</p> <p><b>Post-flight Status:</b> The planned troubleshooting of the wiring, connector, MDM, DSC, and transducer was completed with no anomalies found. The transducer has been replaced.</p>



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STS-123 IN-FLIGHT ANOMALIES**

IFA Number	Title	Comments
STS-123-V-07	TPS Anomalies	<p>A complete listing of the TPS Tile, Blanket, and Reinforced Carbon-Carbon (RCC) Regions of Interest (ROI) evaluated by the Tile and RCC Damage Assessment Teams are documented in the Thermal Protection System (TPS) Imagery Inspection Management System (TIIMS) Database. A total of 20 items were identified in TIIMS and reviewed:</p> <ol style="list-style-type: none"> <li>1. 7 lower surface frayed Thermal Barriers/Gap Fillers;</li> <li>2. 5 lower surface Tile damage;</li> <li>3. 2 OMS Pod Gap-Filler protrusions;</li> <li>4. 5 OMS Pod Tile damages (putty repair), and</li> <li>5. 1 Arrowhead Plate has possible exposed carbon.</li> </ol> <p>The Body Flap Stub tile damage was noted in launch imagery though not confirmed with on-orbit imagery. The imagery review verified the ET doors were closed, no impacts were near the forward windows, and all OMS-pod blankets remained in place. Three tile chips (possible tile coating loss, no depth apparent in imagery) on the port OMS pod stinger were observed during the Space Shuttle Main Engine (SSME) ignition. The stinger condition exceeds NSTS 06559 mass allowable or risk baseline (IFA STS-123-I-03). All items were cleared for entry.</p> <p><b>Post-flight Plan:</b> - OV-105 - Standard post-flight repair</p>
STS-123-V-08	MADS PCM Measurement Anomalies	<p>During the Modular Auxiliary Data System (MADS) ascent-data review, three MADS thermocouple failures were identified. One is new and two were pre-existing:</p> <ol style="list-style-type: none"> <li>1. Left-hand OMS Pod Mid Surface Temperature measurement gradually and abruptly moved to OSH (Off Scale High) throughout the MADS recording phase. This is a new failure.</li> <li>2. Left-hand OMS Pod LRSI Forward Surface Temperature sensors and OMS Left Pod Thermocouple Temperature were on the MADS deferred list and are scheduled to be repaired before the next flight if time allows. See IFA STS-118-V-06 for additional details. No mission impact is associated with these sensors.</li> </ol> <p><b>Post-Flight Status:</b> The Orbiter Project Office (OPO) recommendation is to replace all three OMS pod sensors during the current flow at KSC..</p>
STS-123-V-09	OBSS PTU Pan +10 Deg Hard Stop Error	<p>On FD 2 when the crew performed the Orbiter Boom Sensor System (OBSS) Pan-Tilt Unit (PTU) reset (pan left to hard stop, tilt up to the hard stop and reset or zero out the pan/tilt values) and pan/tilt to the values called out in the Payload Data and Retrieval System (PDRS) checklist of +103, -260 deg, the view that was shown was not the same as the checklist. To match that view of the handrail on the Starboard sill for the Laser Dynamic Range Imager (LDRI) calibration, the crew had to readjust the pan/tilt to +113.8, -257.4 deg. The LDRI view was off by 10 deg in pan.</p> <p>When the crew moved the OBSS to the beginning of the Starboard RCC survey, the PTU was adjusted to +85, -93 deg per the checklist. Again the image in the checklist did not match the LDRI view. When the crew asked the Mission Control Center (MCC) if the</p>

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STS-123 IN-FLIGHT ANOMALIES**

IFA Number	Title	Comments
STS-123-V-09 (Continued)	OBSS PTU Pan +10 Deg Hard Stop Error	<p>image was good, the crew was asked to move the PTU by the amount needed to match the image resulting in a pan/tilt of +95, -90.6 deg. For the rest of the FD2 RCC survey, crew and ground took the 10-deg pan error into account and successfully completed the inspection. This 10 deg offset was present throughout the flight and the crew compensated for this offset for the remainder of the mission.</p> <p>Since the OBSS was left on the ISS until the STS-124 mission, the STS-124 late inspection will also be affected by this problem. Any STS-124 procedures that deal with the OBSS pan will take this offset into account.</p> <p><b>Post-flight Status:</b> The ground procedures were reviewed and the Pan Tilt Unit (PTU) Assembly procedures were updated and to the Pre-Installation Acceptance (PIA) procedures to preclude the PTU hard stops from being installed in the incorrect positions. Assembly steps will be modified and the PIA pan-range tolerance was reduced to catch installation errors. The results of these tests will be coordinated and communicated to the JSC Engineering console representatives for any pre-flight procedure modifications. Also, a new test sequence was discussed to confirm the accuracy of the PTU pre-flight by pointing to a target at pre-determined pan and tilt angle.</p>
STS-123-V-10	WLEIDS Sensor Unit S/N 1150 Anomalous Data	<p>While Group A Wing Leading Edge Sensors were monitoring for Micrometeoroid Orbital Debris (MMOD) during the late inspection period (monitoring start time began at 081:22:00 GMT), sensor unit S/N 1150 on the Port Wing had excessive triggers (4452) during the first hour of monitoring. The triggers on S/N 1150 forced all other sensors within Group A to trigger on the Port Wing. It was determined that the Sensor (S/N 1150) memory was saturated at that time.</p> <p>All port sensor units within Group A were cancelled (taken out of On-Orbit Monitoring mode) to get the trigger file information. Raw window data from sensor Unit S/N 1230 was downloaded to check for trigger validity and was found to be "noise – invalid" triggers. A second restart for On-Orbit Monitoring mode was issued for all port sensors within Group A without sensor unit S/N 1150.</p> <p>Later during the mission, a diagnostic command was sent to sensor unit S/N 1150 and the result-file displayed that the unit had its flash memory completely saturated and was operating in the idle mode.</p> <p>The WIS GFE team then sent a File Summary request for S/N 1150 and it displayed approximately 9600 triggers. The sensor manufacturer representative indicated that the trigger count continues to record the quantity of triggers but that the trigger data can no longer be recorded once the memory is full, meaning that the unit would likely have less than 4452 trigger files in the memory bank. The WIS GFE team was able to download two ½ second data windows for S/N 1150. After review of the data, it was determined to be an invalid trigger – "noise". The peak G reading for the downloaded data was recorded at 18G. It is possible that valid trigger indications could be masked if this had occurred during a real</p>

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STS-123 IN-FLIGHT ANOMALIES**

IFA Number	Title	Comments
STS-123-V-10 (Continued)	WLEIDS Sensor Unit S/N 1150 Anomalous Data	<p>accelerometer excitation. This problem did not cause an impact to WLE operations in the that all other sensors within that group are still operating nominally; however, the failure of this sensor does effect the ability of the WLE IDS team to more accurately estimate the G level and location of an indication if it were to occur in the areas of RCC panels 3 and 4 on the port wing.</p> <p>Based upon a similar problem that occurred with sensor unit S/N 1172 during the STS-118 mission and the results of the troubleshooting that occurred with that unit post-flight, the most probable cause is a component failure in the circuitry of the sensor unit. There are sensors within Group A that still monitor on the lower interface of Chine/Panel 1 and on the lower interface of Panel 5/6; however, without Sensor S/N 1150, loss in monitoring capability exists between the upper interface of Panel 3/4.</p> <p><b>Post-flight Status:</b> The sensor will be replaced. The sensor off of OV-105 will be sent to JSC for further troubleshooting</p>
STS-123-V-11	Aft Panel A4 MET& GMT Mission Timer failed	<p>At approximately 079/01:30 GMT, the crew reported that the Aft Mission Timer was not working with the switch in the GMT, MET or TEST positions. The crew also reported that the Aft Event Timer was properly lit. At approximately 079/08:10 GMT, the crew reported that the Aft Mission Timer circuit breaker (CB) was in. The crew cycled the CB and reported that the Aft Mission Timer recovered.</p> <p>Most probable cause of the anomaly is still unknown. It could be an intermittent problem with the CB12 on Panel O15 was not fully engaged on initial closing, or an intermittent open in the wiring between the CB and Mission Timer. CB12 is a 3-A circuit breaker that is dedicated to the Aft Mission Timer.</p> <p><b>Post-Flight Status:</b> The mission timer functional test was completed with no anomalies. The CB was cycled while measuring resistance and open-events were observed on the first two cycles, pointing to a CB12 problem. The circuit breaker had intermittent contact, and the CB will be removed and replaced, which will require Panel O15 to be removed and sent to NASA Shuttle Logistics Depot (NSLD).</p>
STS-123-V-12	Panel O6 GPC 3 OUTPUT Talkback Sticky	<p>On FD 3 (at approximately 72/21:37: 21 GMT), during G2 Set Expansion, the crew reported that General Purpose Computer (GPC) 3 OUTPUT continued to show Barberpole after the GPC was taken to RUN. The crew tapped the Talkback and it went gray. The G2 Set Contraction was completed with no further issues.</p> <p>On FD 15 (at approximately 84/21:41:25 GMT), during G2 Set Expansion, the crew reported that GPC 3 OUTPUT continued to show Barberpole after the GPC was taken to RUN. The crew tapped the Talkback several times and it went gray. The G2 Set Contraction was completed with no further issues.</p> <p><b>Post-flight Status:</b> Troubleshooting showed nominal function (anomaly did not repeat). The Problem Resolution Team (PRT) and crew concurred to fly as is with added user note to "tap the talkback twice" during use.</p>

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STS-123 IN-FLIGHT ANOMALIES**

IFA Number	Title	Comments
STS-123-V-13	Fuel Cell Common H <sub>2</sub> O Line pH Transient Indications	<p>The Fuel Cell Common pH Sensor began giving intermittent indications during the Flight Control System (FCS) checkout with the first occurrence at 85/19:04:08 GMT (14:12:35:54 MET), which cleared after 39 sec. Later, between 86/04:53:37 GMT and 86/15:54:10 (14/22:25:23 and 15/09:25:56 MET), a total of 14 additional transients were received; lasting approximately 50, 6, 281, 5, 1, 30, 7, 14, 34, 64, 13, 37, 205, and 361 sec, respectively. The fuel cell 1, 2, and 3 pH indications never read high. Fuel cell performance for all three fuel cells was nominal. At 86/01:37 GMT (14/19:09 MET), the crew performed a Fuel Cell Measurement System (FCMS) data take and each fuel cell's individual single-cell voltage was examined and compared to the previous values from the FD 2 FCMS data take. All data were nominal. Additional insight into the health of the fuel cell was gained by performing various bus tie configurations and evaluating fuel cell differential Amperes. Again, all data were nominal.</p> <p>At 86/06:11 GMT (14/23:43 MET), the crew completed the fuel cell H<sub>2</sub>O pH Test In-Flight Maintenance (IFM) and reported a pH of 4.5. A pH reading greater than 9 would indicate the presence of KOH, and a nominal pH reading could be up to 8 SU. Preflight chemical analysis testing of the Potable Water tanks performed on 2/22/08 resulted in a measured pH of 4.87 in Tank B and 5.2 in Tank A. Indications recurred again on Entry day during Deorbit Preparation. There were no indications of fuel cell problems, and the sensor indication cleared.</p> <p><b>Post-Flight Status:</b> The sensor performance test was completed with nominal results (no transients). Evaluation of associated circuitry showed the MDM signal to OA3 triggered (on) at 2.4 Vdc and (off) at 2.2 Vdc ,(The indication should be 5 Vdc.). Detailed review indicated that the MDM was within specification. The plan is to remove the transducer and send it to NASA Shuttle Logistics Depot (NSLD) for an extended power-on test in an attempt to duplicate the anomaly. A replacement sensor will be installed after fuel cell 1 removal and replacement.</p>

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IFA Number	Title	Comments
STS-123-V-14	Cabin Temperature Controller 1 Noisy	<p>At 6/14:20 MET (077/20:48 GMT), the crew reported that the Cabin Temperature Controller 1 sounded noisy. The crew stated that the controller's motor would run for about 1 sec, pause for about 3 sec, and then run again. This would occur intermittently as the controller occasionally went several seconds without making a noise. The noisy operation of Cabin Temperature Controller 1 was not heard earlier in the flight. The crew was instructed to reconfigure to Cabin Temperature Controller 2, which was started at 077/22:03 GMT (06/15:35 MET) and was completed by 077/22:15 GMT (6/15:47 MET). Cabin Temperature Controller 2 operated nominally, and the crew reported no unusual noises.</p> <p><b>Post-flight Status:</b> During the STS-123 post-mission crew debriefing, the crew described the no. 1 actuator noise as continuous with the controller in the full-cool position, as though the controller motor continued to drive against the hard stop in full cool. A review of flight data failed to find any off-nominal performance of Cabin Temperature Controller 1; however, a review of data for multiple flights and all vehicles revealed that this controller moves on and off full-heat-exchange less frequently, resulting in wider temperature swings. The cabin temperature controller vendor determined that the crew debriefing description of the problem is an indication of a failed limit position switch. After the crew debriefing, the PRT review of flight data of the actuator no. 1 bus current shows that once the controller is in the full-cool position, the controller 1 no longer draws current. This indicates that the position-limit switch is functioning normally. Also, the vendor evaluation of this type of failure indicates a very low likelihood because of redundancies built into the limit switch. The noisy controller has been reported in previous KSC documentation. Disposition of the KSC documentation was via checkout on the ground that showed controller parameters to be within specification. The checkout of controller function was completed, and the amperage draw for both controllers was from 0.13 to 0.14 A.</p>
STS-123-V-15	Anomalous Bend in Radiator Retract Flex-Hose	<p>During post-flight payload door opening operations at KSC, the starboard forward radiator retract flex-hose was observed to be in an anomalous bend configuration described as a 'C' bend. This bend is caused by the hose not fully stowing into its container during payload bay door closing. The door closure and Freon loop operation were nominal during Entry.</p> <p><b>Post-Flight Status:</b> Action plan in work to assess flex-hose condition. Hardware options being considered are fly as-is, The flex-hose and hose/container will be replaced.</p>

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IFA Number	Title	Comments
STS-123-V-16	ACES Glove Bladder Tear	<p>The Advanced Crew Escape Suit (ACES) glove (S/N 055) was found with a large (approximately 1-inch long) tear in the left-hand glove bladder. The tear was in the crotch between the little and ring finger and was found during the STS-124 pre-event inspection. The history of the glove was reviewed and nothing abnormal was noted, and glove had not been used after the STS-123 landing until discovery of the anomaly. The glove was pressure-tested prior to stowage onboard STS-123 for returning ISS crewmember. The glove underwent general inspection (no bladder inspection), and was shipped to USA-Houston, where a general inspection was repeated, and then it was placed into bond. The selection for STS-124 training initiated a pre-event inspection/test, and the anomaly was discovered. The initial 10x magnification inspection of the tear and adjacent area on the bladder plus outer restraint found no obvious clues nor any indication of obvious material defect.</p> <p>A meeting with the crewmember indicated that he did experience greater than "typical" bladder resistance while donning the glove. This resulted in using excessive force to be used during the donning; however, the crewmember did not recall any visual/audible anomalies during donning. Also, the finger nails and jewelry were determined to not be a factor in this occurrence.</p> <p>Forward work: Complete high-magnification inspection of tear and adjacent area. Possible Scanning Electron Microscopy (SEM) should the high-magnification inspection results offer clues that would be better evaluated by SEM.</p> <p>Expected corrective actions: Ensure crew is made aware of need to be vigilant with respect to proper handling of suit/gloves during donning/doffing process. Remind crew of risk/concern areas (jewelry and nails). The corrective actions will begin with the the STS-124 and migrate into training as quickly as possible.</p>

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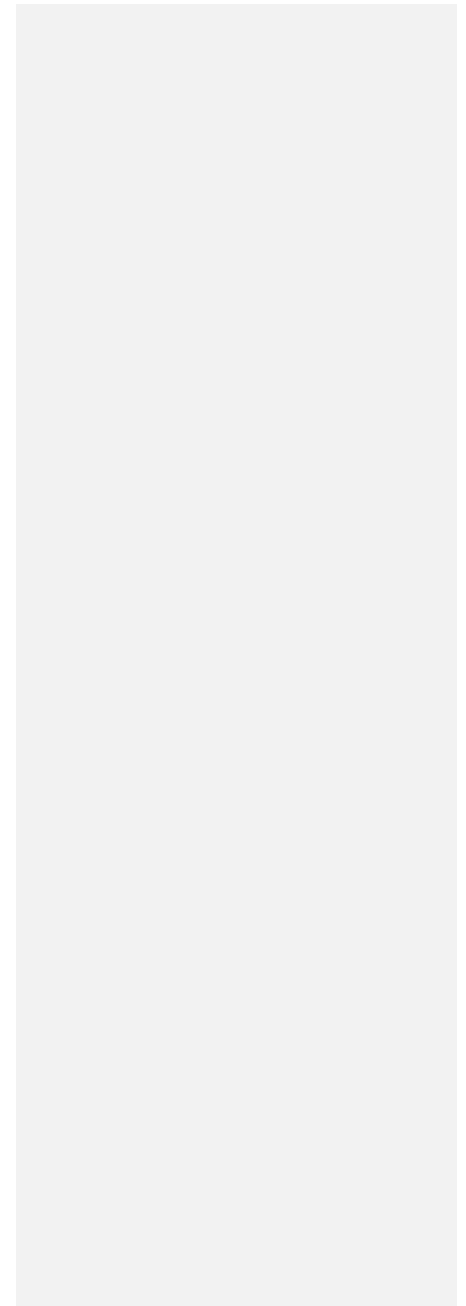
**SOLID ROCKET BOOSTER ANOMALIES**

IFA Number	Title	Comments
STS-123-B-001	Loss of Data from SRB RH ET Observation Camera During Ascent	<p>Post-flight testing has confirmed proper operation of the ET Observation camera and the cables connecting it to the Data Acquisition System (DAS). Visual inspection and continuity testing has confirmed proper operation of the internal DAS on the External Tank (ET) observation camera power and video circuits through the video switch relay. Circuit analysis of the DAS video switch printed wire assembly shows positive isolation of 24-volt traces and video switch relay coil traces.</p> <p>Ongoing laboratory tests have indicated a possibility for premature timer output (excitation voltage on the timer's load terminal immediately upon timer power-up). This condition seems to be dependent on how the power to the timer is applied.</p> <p>Premature switching of the video switching relay which was most likely caused by a premature output from the DAS 350-sec timer. Video analysis confirms that all video recorded by the BI133R/STS-123 DAS came from the DAS parachute camera.</p>

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**REUSABLE SOLID ROCKET MOTOR ANOMALIES**

No Reusable Solid Rocket Motor (RSRM) anomalies were identified from the review and analysis of the data.

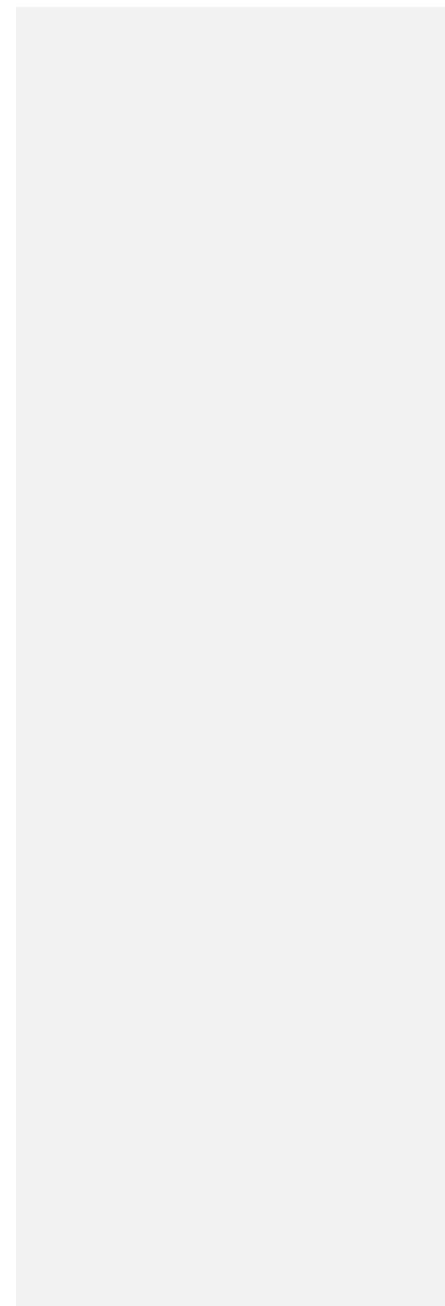




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**EXTERNAL TANK**

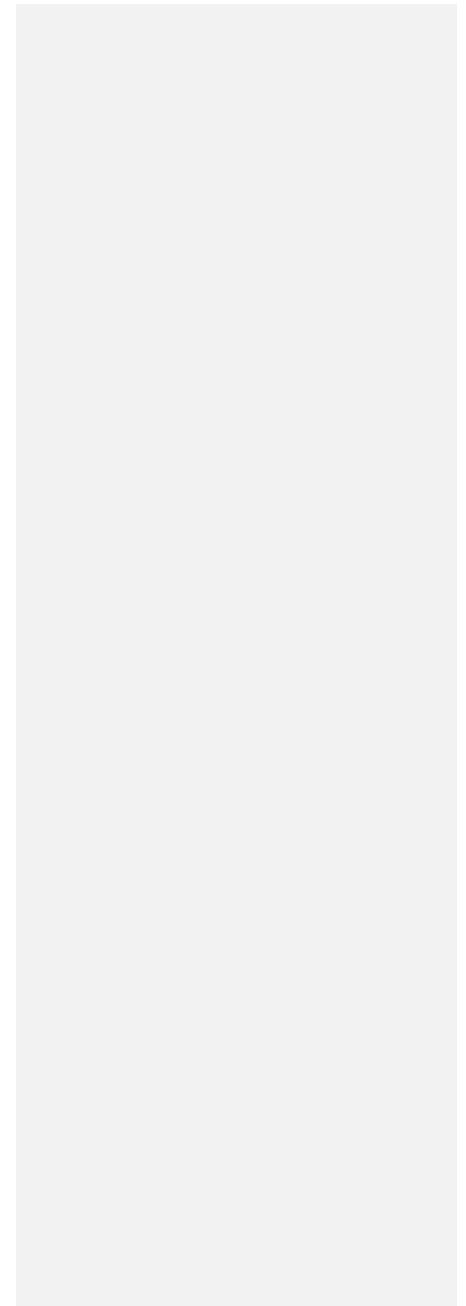
No External Tank (ET) anomalies were identified from the review and analysis of the data.



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**SPACE SHUTTLE MAIN ENGINE ANOMALIES**

No Space Shuttle Main Engine (SSME) anomalies were identified from the review and analysis of the data.



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**SYSTEM ENGINEERING AND INTEGRATION ANOMALIES**

IFA Number	Title	Comments
STS-123-I-001 I00125	Unexpected Debris/Expected Debris Exceeding Mass Allowable Prior to Pad Clearance (Liftoff Debris)	STS-123 experienced unexpected debris/expected debris exceeding mass allowables prior to pad clearance. Approximately 14 KSC-related IFAs are being tracked on this lift-off debris IIFA. The IFA was closed on 05/06/08. Risk Assessment indicates that given the proposed mitigations, the observed debris poses no appreciable increase in risk. Liftoff debris risk is currently characterized as infrequent, catastrophic due to significant uncertainties in controls and significant limitations in analysis. Debris release mitigated for identified potential sources of critical debris: 1) removed items (e.g. speaker tags, ceramic cable clamp insulator) and 2) added inspections of system level components (e.g. conduit clamp, U-bolts on freeze protection line). Ongoing mitigations include FOD awareness, attrition-based removal of MI clamp hardware, double tethering of dog-tags and routine inspections for facility corrosion. No updates to NSTS 60559 are recommended.
STS-123-I-002 I00126	Stub Tile Damage During SSME Ignition	During STS-123/OV-105 Main Engine ignition (MEI) sequence, multiple black and white pieces of debris were seen to liberate from the area above the body flap in the vicinity of SSME no. 3. A single piece is seen impacting SSME no. 3 at the no. 6 hatband location. Post landing inspection activity confirmed a upper aft stub tile was damaged. This stub tile and the adjacent carrier panel were newly installed during STS-123 OPF activity. Similar damage has been seen on previous missions (most recently STS-117) and during flight readiness firings in preparation for launch. In each case, ground processing damage along with Main Engine Ignition (MEI)/ascent loading was determined to cause the damage. Inadequate clearance between the body flap and aft stub tiles could lead to contact due to dynamic loading during MEI. Post-flight analysis of STS-123 SSME Ignition Over Pressure (IOP) and MEI acoustic data was evaluated and determined to be within flight experience and design values and are not believed to be a factor. The Thermal Protection System (TPS) Problem Resolution Team (PRT) review and analysis of this event are ongoing as this report was written.

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**SYSTEM ENGINEERING AND INTEGRATION ANOMALIES**

IFA Number	Title	Comments
STS-123-I-003 I00127	Tile Chips on Orbiter Stingers During SSME Ignition	During STS-123/OV-105 Main Engine ignition sequence, three tile chips on the Orbiter's port stinger pod and one tile chip on the Orbiter's starboard stinger were observed liberating. They did not recontact the vehicle. Post-landing inspection of the Orbiter noted numerous minor tile damages on the Orbiter Stingers and in the area around the base heat shield. Post-flight inspection and a review of previous mission's data were performed and showed the damage was well within what is normally observed and probably even lighter than usual. This type of light tile damage is typical and replacement of the LI-900 9 lb tiles with the more impact-resistant Toughened Unipiece Fibrous Insulation (TUF) coated AETB-8 tiles has already been approved on an attrition basis. Recommend closure of this STS-123 Integrated IFA with reclassification as 'Expected Debris' caused by miscellaneous and unidentified small debris particles typically swirling around at SSME start and/or prelaunch/launch vibro-acoustic environment. A debris transport assessment (DTA) was not performed or considered necessary as the small size of the debris particles causing this damage is bounded by the Ceramic Insert Hazard listed in IDBR-01.

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**FLIGHT OPERATIONS AND INTEGRATION ANOMALIES**

IFA Number	Title	Comments
AR-3176	Battery Powered Speaker Microphone Unit (BPSMU) Cables Not Onboard ISS As Expected	<p>The 22-ft and 4-ft cables that support the drag-through ISS airlock BPSMU operations on the Shuttle-side were not onboard the ISS. These cables were inadvertently returned on STS-122, instead of being left on International Space Station (ISS). With loss of docked Intercommunications (ICOM), the crew only had one ICOM loop available rather than two ICOM loops.</p> <p>The cables were labeled to stay on ISS, but were inadvertently returned. The cables that were inadvertently brought home on STS-122 are planned to be manifested and pre-routed on the next shuttle flight (STS-124).</p>
<p>AR3175</p> <p>Note: These two anomalies are being reported as one problem because the issues appear to be related</p>	ISS to Orbiter Intercom (ICOM) A Failed	<p>After docking, the ICOM A audio from ISS-to-Orbiter failed, while ICOM A audio from Orbiter-to-ISS was satisfactory. On previous missions, ICOM A has failed from Orbiter-to-ISS. This is a different signature in that the failure is reversed, which is a variation of the ICOM problems that occurred on STS-115, 116, 117, 118, 120, and 122.</p> <p>No in-flight troubleshooting was performed due to the pre-planned contingency of using the BPSMU's for ICOM audio links between the Orbiter and ISS. Based on STS-118 (ISS-13A.1) troubleshooting, the root cause of the problems with the Docked Audio Interface Unit (DAIU) audio channels is determined to be at the Pressurized Mating Adapter (PMA) 2 X3 connector.</p> <p>Operationally, this issue had a low mission impact (loss of redundant ICOM loop from the ISS-to-Orbiter). The crew used a BPSMU for ICOM discussions.</p>
AR-3232	ISS C&W Not Heard on Shuttle	<p>The ISS Caution and Warning (C&amp;W) could not be heard in the Orbiter on the "Page" loop. The C&amp;W alerts will be transmitted from ISS-to-Shuttle via hardline and/or through Portable Computer System (PCS) workstations. Post-flight troubleshooting will be performed on OV-105.</p> <p>These two anomalies are not a constraint to STS-124 as other onboard radios are available onboard to provide the necessary communications.</p>

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**FLIGHT OPERATIONS AND INTEGRATION ANOMALIES**

IFA Number	Title	Comments
STS-123-N-001	Orbiter CO <sub>2</sub> and Air Flow Issues	<p>The local Partial Pressure (pp) Carbon Dioxide (CO<sub>2</sub>) readings in Node 2 and Columbus were about 1 mm Hg (Mercury) higher than in the US Laboratory. The ppCO<sub>2</sub> difference may be due to increased crew activity in the area and/or insufficient airflow between the Node 2 area and the US Laboratory. The higher-than-normal CO<sub>2</sub> levels in the vicinity of the Shuttle may also increase the Orbiter Lithium Hydroxide (LiOH) consumption.</p> <p>"Carbon dioxide is the most potent cerebral vasodilator known."</p> <p>On Flight Day (FD) 14, the ISS crew added a 23-ft duct to transport Orbiter air from the PMA 2 to the US Laboratory. Subsequently, the ppCO<sub>2</sub> difference between Node 2 and the U. S. Laboratory decreased. Additional details are documented in AR-3237, MER-12, and IFI 02782.</p> <p>The Mission Operations Directorate (MOD) personnel will lead the integrated effort on this investigation to identify mitigation steps for the crew to implement on-orbit.</p> <p>MOD is initiating a Change Request to the Flight Rules that will lower the ppCO<sub>2</sub> upper limit from 7.6 mmHg to 5.0 mmHg on the Orbiter. Flight Control will optimize the LiOH change-out schedule to reduce the rise rates and lower the peaks</p> <p>The STS-124 LiOH change-out plan will maintain ppCO<sub>2</sub> levels below 5 mm Hg.</p>

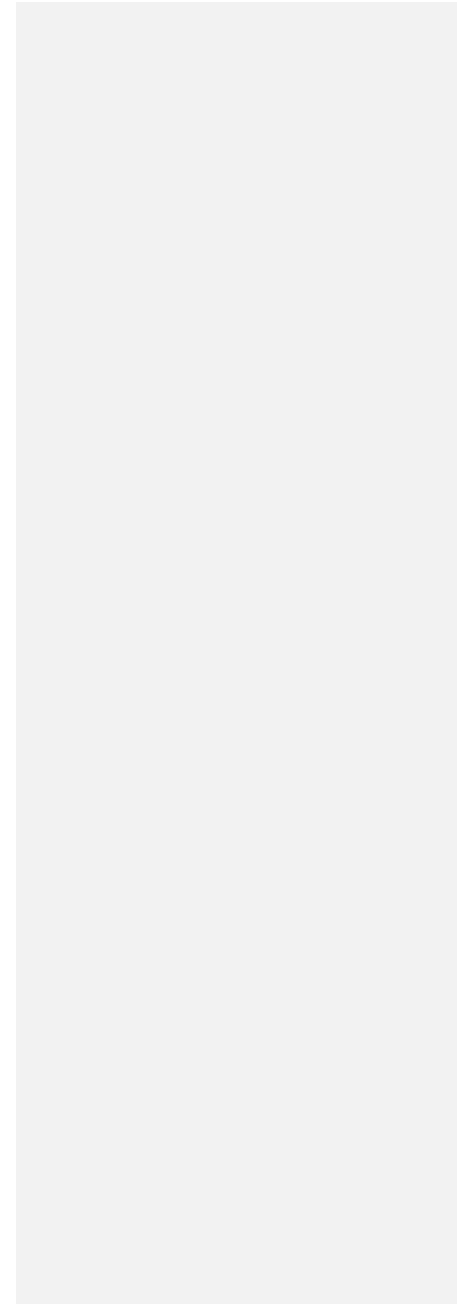
**APPENDIX B  
STS-123 IN-FLIGHT ANOMALIES**

**MISSION OPERATIONS ANOMALIES**

IFA Number	Title	Comments
STS-123-D-001 (Closed)	Wall Clocks Hung in Both Flight Control Rooms	<p>The Video Timing Services (VTS) server hangs when a user attempts to delete a global clock. The problem originally occurred during the STS-120 Mission. With the Operations Note in place no hangs occurred during STS-122. During STS-123, two occurrences of the anomaly occurred, one on March 11 and the second on March 18.</p> <p>As a workaround for STS-120, the users were instructed to discontinue use of the automated global clock generation function and use the manual method. For STS-122, the OPS Notes was updated to provide the necessary steps to change a global timerso that it would automatically terminate at either a user-provided clock time or after a user-provided duration as a workaround for deleting global clocks.</p> <p>As a corrective actions after STS-123, a new process was created where all Operations Notes are reviewed and the significant Operations Notes were bumped up to a Flight Note to raise visibility. The Flight Disciplines are being asked to ensure all significant Operations Notes and Flight Notes for their area of expertise will be reviewed prior to flight. Additionally, the Flight Control Team (FCT) will be briefed at the start of Mission Support on the importance of not deleting Global Clocks. Also, a Flight Note will be added at the start of Mission Support to remind the FCT not to delete Global Clocks.</p>

**APPENDIX B**  
**STS-123 IN-FLIGHT ANOMALIES**  
**FLIGHT SOFTWARE ANOMALIES**

There were no Flight Software anomalies during the STS-123 mission.





## **APPENDIX C**

### **STS-123 DOCUMENT SOURCES**

#### **MER DAILY REPORTS**

The following STS-123 MER Daily Reports by Malise Fletcher, Lead MER Manager:

- First Daily Report (Ascent Plus 2-Hour Report), dated March 11, 2008
- Second Daily Report, dated March 12, 2008
- Third Daily Report, dated March 13, 2008
- Fourth Daily Report, dated March 14, 2008
- Fifth Daily Report, dated March 15, 2008
- Sixth Daily Report, dated March 16, 2008
- Seventh Daily Report, dated March 17, 2008
- Eighth Daily Report, dated March 18, 2008
- Ninth Daily Report, dated March 19, 2008
- Tenth Daily Report, dated March 20, 2008
- Eleventh Daily Report, dated March 21, 2008
- Twelfth Daily Report, dated March 22, 2008
- Thirteenth Daily Report, dated March 23, 2008
- Fourteenth Daily Report, dated March 24, 2008
- Fifteenth Daily Report, dated March 25, 2008
- Sixteenth Daily Report, dated March 26, 2008
- Landing Plus 2 Hour Report, dated March 27, 2008
- Mission Summary Report, dated March 30, 2008

#### **ET/SRB/RSRM/SSME REPORTS**

- STS-123 Anomalies, David W. Morr, USA-Huntsville, June 25, 2008
- STS-123 Console Flash Report, David W. Morr, USA-Huntsville, March 11, 2008
- STS-123 Initial Event Times, David W. Morr, USA-Huntsville, March 11, 2008
- STS-123 Final Event Times, David W. Morr, USA-Huntsville, August 16, 2007/March 19, 2008
- STS-123 RSRM Flash Report, Daniel McGough, ATK--Huntsville, March 13, 2008
- STS-123 SRB Debris Open Assessment, Thomas F. Ford, NASA-KSC, March 14, 2008

#### **ORBITER REPORTS**

- STS-123 Launch + 2 Day Report Ascent Performance Report, Diana Coronado, Boeing-Houston, March 13, 2008
- STS-123 Consolidated Landing Report, Lonnie W. Jenkins, March 26, 2008
- STS-123 Landing and Deceleration Report, C. C. Heinol, Boeing-Houston, April 17, 2008
- STS-123 Landing Summary Report, Caston L. Hunt, Boeing-Houston, April 10, 2008
- STS-123 Flight Controls and ADTA Report, Donald E. Marquith, Boeing-Houston, April 7, 2008.
- STS-123 Communications and Tracking Report, C. J. Stafford, Boeing-Houston, April 1, 2008
- STS-123 Ascent Hazard Analysis Report, Lillian P. Gibson, Boeing-Houston, April 8, 2008
- STS-123 Descent Postflight Summary, Rosalyn R. Mark, USA-Houston, April 29, 2008
- STS-123 Displays and Controls and Lighting Report, Q. P. Ngo, Boeing-Houston, April 10, 2008
- STS-123 Shuttle Remote Manipulator System, Nik Doshewnek, MDA-Houston, April 12, 2008

STS-123 HYD/WSB Subsystem Douglas T. Morsches, Boeing-Houston, April 11, 2008  
 STS-123 PRSD System Mission Report, Johnny D. Wong, Boeing-Houston, April 11, 2008  
 STS-123 Main Propulsion System Report, Mohammed M. Jebril, Boeing-Houston, April 14, 2008  
 STS-123 Mechanical Systems Report, Jeff Goodmark, Boeing-Houston, March 28, 2008  
 STS-123 Auxiliary Power Unit System, Christopher N. Adi, Boeing-Houston, April 9, 2008  
 STS-123 OI/MADS Mission Reports, Dwight A. Favors, Boeing-Houston, April 10, 2008  
 STS-123 OI/MADS Sensors, Signal Conditioners and Fuel Cell Monitoring System, Dwight A. Favors, Boeing-Houston, March 31, 2008  
 STS-123 OI/MADS MUX and Timing Report, Bruce S. Woods, Boeing-Houston, April 14, 2008  
 STS-123 Data Processing System Integrated Report, Kevin Moormann, Boeing-Houston, April 10, 2008  
 STS-123 EPDC Mission Report, William D. Peterson, Boeing-Houston, April 1, 2008  
 STS-123 ATCS Post-Flight Mission Report, Carmelo Asuncion, Boeing-Houston, April 10, 2008  
 STS-123 Life Support Systems Report (ARPCS and Airlock Systems; Supply Water and Waste and Water Management, Isaac Andu, Boeing-Houston, April 1, 2008  
 STS-123 Orbiter Docking System Summary, Robert E. Davis, Boeing-Houston, April 22, 2008  
 STS-123 OMS Report, Donald E. Varanauski, Boeing-Houston, April 14, 2008  
 STS-123 RCS Mission Report, Donald E. Varanauski, Boeing-Houston, April 14, 2008  
 STS-123 Final Aeroheating Report, Dennis C. Chao, Boeing-Houston, April 4, 2008  
 STS-123 Fuel Cells Mission Report, Johnny D. Wong, Boeing-Houston, April 11, 2008.  
 STS-123 Global Positioning System Report, Ray Nuss, NASA-JSC April 1, 2008  
 STS-123 Thermal Control System Summary, David Norman, Boeing-Houston, April 14, 2008  
 STS-123 Purge, Vent and Drain Report, C. C. Heinol, Boeing-Houston, April 3, 2008  
 STS-123 Flight Controls Mission Report, Donald E. Marquith, Boeing-Houston, April 7, 2008  
 STS-123 Final Mission Events List, Vernon C. Hill, ESCG-Houston, May 1, 2008  
 STS-123 WLE IDS Post Flight Report, Jon N. Maynard, Boeing-Houston, **Not received yet**  
 STS-123 SE&I In-Flight Anomalies, James J. Hill, NASA-JSC, June 27, 2008  
 STS-123 Flight Operations and Integration Anomalies, Todd W. Heliner, NASA-MS, April 17, 2008  
 STS-123 MOD Anomalies, Gregory Lange, NASA-JSC, July 2, 2008

## OTHER REPORTS

STS-123 CSR Report, Ann Patterson, NASA-JSC, May 29, 2008  
 STS-123 Final Debris Hits, Thomas F. Ford, NASA-KSC, March 28, 2008  
 STS-123 Beginning of EVA 1, Jeff Outlaw, Hamilton Standard, March 13, 2008  
 STS-123 End of EVA1, Chun H. Yau, Hamilton Standard, March 14, 2008  
 STS-123 Extravehicular Activity Report for EVA 2, Shannon L. Cagle, Hamilton Standard, March 15, 2008  
 STS-123 End of EVA 2, Chun H. Yau, Hamilton Standard, March 16, 2008  
 STS-123 Extravehicular Activity Report for EVA 3, Dennis Dawson, NASA-JSC, March 18, 2008  
 STS-123 Extravehicular Activity Report for EVA 4, Dennis Dawson, NASA-JSC, March 21, 2008  
 STS-123 End of EVA 4, Jeff Outlaw, Hamilton Standard, March 22, 2008  
 STS-123 Extravehicular Activity No. 5 Report, Shannon L. Cagle-Strimple, Hamilton Standard, March 22, 2008  
 STS-123 End of EVA 5, Jeff Outlaw, Hamilton Standard, March 23, 2008  
 STS-123 Extravehicular Activity No. 5 Report, Jeff Outlaw, Hamilton Standard, March 23, 2008  
 STS-123 Significant Firsts, Todd W. Heliner, NASA-JSC, May 30, 2008  
 STS-123 Final Extravehicular Activity Report, Tara E. Jochim, NASA-JSC, June 23, 2008  
 STS-123 MLP Post-Launch Walkdown, Kevin D. Vega, NASA-KSC, March 11, 2008

## APPENDIX D

### ACRONYMS, ABBREVIATIONS, AND UNITS OF MEASURE

<b>Acronym/ Abbreviation</b>	<b>Explanation</b>
A	Ampere
AA	Accelerometer Assembly
ac	alternating current
ACCU	Audio Central Control Unit
ACBM	Active Common Berthing Mechanism
ADTA	Air Data Transducer Assembly
ACES	Advanced Crew Escape Suit
AGT	Adaptive Guidance Throttling
AHMS	Advanced Health Monitoring System
APCU	Auxiliary Power Converter Unit
APU	Auxiliary Power Unit
ARPCS	Atmospheric Revitalization Pressure Control System
ATCS	Active Thermal Control System
ATU	Audio Terminal Unit
AVIU	Audio Visual Interface Unit
BET	Best Estimate Trajectory
BFS	Backup Flight System
BLT	Boundary Layer Transition
C & W	Caution and Warning
CB	Circuit Breaker
CBCS	Centerline Berthing Camera System
CBM	Common Berthing System
CDM	Carbon Dioxide Monitor
CDR	Commander
CDRA	Carbon Dioxide Removal Assembly
CDT	Central Daylight Time
CEI	Contract End Item
CGBA	Commercial Bioprocessing Generic Apparatus
CLA	Camera Light Assembly
CLPA	Camera Light and Pan Tilt Assembly
CMG	Control Moment Gyroscope
C/O	Checkout
CO <sub>2</sub>	Carbon Dioxide
CPA	Control Panel Assembly
CPM	Cell Performance Monitor
CSA	Canadian Space Agency
CSI	Critical Safety Item
CSLM	Coarsening in Solid Liquid Mixture

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### ACRONYMS, ABBREVIATIONS, AND UNITS OF MEASURE

<b>Acronym/ Abbreviation</b>	<b>Explanation</b>
CVRD	Converter Variable Resistance to Direct Current
CW	Continuous Wave
CWC	Contingency Water Container
CWRW	Cell Wall Resist Wall
DAIU	Docked Audio Interface Unit
DAP	Digital Autopilot
DAT	Debris Assessment Team
D & C	Display and Control
DCSU	Direct Current Switching Unit
DDU	Data Display Unit
DMHS	Dome Mounted Heat Shield
DPS	Data Processing System
DSC	Dedicated Signal Conditioner
DTN	Data Trend Notice
DTO	Development Test Objective
$\Delta V$	Differential Velocity
ECLSS	Environmental Control and Life Support System
ECSH	EVA Cable Stowage Hardware
EDF	Expandable Diameter Fastener
EI	Entry Interface
ELC	EXPRESS Laptop Computer
ELITE	Elaboratore Immagini Televisive 2 <sup>nd</sup> Generation
ELM-PS	Experiment Logistics Module-Pressurized Section
ELPS	Emergency Lighting Power Supply
EMCS	European Modular Cultivation System
EMU	Extravehicular Mobility Unit
EO	External Tank/Orbiter
EOM	End-of-Mission
EPDC	Electrical Power Distribution and Control
EPF	External Payload Facility
ER	Express Race
ESA	European Space Agency
ESP	External Stowage Platform
ET	External Tank
ETVCG	External Television Camera Group
EuTEF	European Technology Exposure Facility
EV	Extravehicular
EVA	Extravehicular Activity
FBMBT	Flexible Bearing Mean Bulk Temperature

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### ACRONYMS, ABBREVIATIONS, AND UNITS OF MEASURE

<b>Acronym/ Abbreviation</b>	<b>Explanation</b>
FC	Fuel Cell
FCE	Flight Crew Equipment
FCMS	Fuel Cell Monitoring System
FCS	Flight Control System
FCV	Flow Control Valve
FD	Flight Day
FDA	Fault Detection and Annunciation
FE	Flight Engineer
FES	Flash Evaporator System
FID	Failure Identifier
FOM	Figure of Merit
FSE	Flight Service Equipment
FSS	Fixed Service Structure
FSW	Flight Software
g/G	gravity
GAP	Group Activation Pack
GCA	Ground Carrier Assembly
GEI	Ground Environmental Instrumentation
GFE	Government Furnished Equipment
GG	Gas Generator
GGVM	Gas Generator Valve Module
GH <sub>2</sub>	Gaseous Hydrogen
GLA	General Luminaire Assembly
GMEM	General Memory Update
GMT	Greenwich mean time
GN&C	Guidance, Navigation and Control
GN <sub>2</sub>	Gaseous Nitrogen
GO <sub>2</sub>	Gaseous Oxygen
GPC	General Purpose Computer
GPS	Global Positioning System
Grms	Gravity root mean square
GSE	Ground Support Equipment
GUCP	Ground Umbilical Carrier Plate
H <sub>2</sub> O	Water
H <sub>2</sub> O <sub>2</sub>	Hydrogen-Oxygen
HDP	Holddown Post
HIU	Headset Interface Unit
HPFTP	High Pressure Fuel Turbopump
HPOTP	High Pressure Oxidizer Turbopump

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### ACRONYMS, ABBREVIATIONS, AND UNITS OF MEASURE

<b>Acronym/ Abbreviation</b>	<b>Explanation</b>
HR	High Resolution/Hand Rail
HRP	Human Research Program
HYD	Hydraulic
IBA	Inspection Boom Assembly
ICOM	Intercommunications
ID	Identification
IELK	Individual Equipment Liner Kit
IFA	In-Flight Anomaly
IMMT	ISS Mission Management Team
IMU	Inertial Measurement Unit
IMV	
InSPACE	Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions
IR	Infrared
ISS	International Space Station
ISSP	International Space Station Program
IV	Intravehicular
JAXA	Japanese Aerospace Exploration Agency
JEM	Japanese Experiment Module
JPM/JEM-PM	Japanese Experiment Module Pressurized Module
JSC	Johnson Space Center
KAD	KAU Attachment Device
KAU	Keep Alive Umbilical
KSC	Kennedy Space Center
LAN	Local Area Network
LCC	Launch Commit Criteria
LCD	Liquid Crystal Display
LCS	Laser Camera System
LDRI	Laser Dynamic Range Imager
LED	Light Emitting Diode
LESS	Leading Edge Structure System
LH	Left Hand
LH <sub>2</sub>	Liquid Hydrogen
LiOH	Lithium Hydroxide
LO <sub>2</sub>	Liquid Oxygen
LPOTP	Low Pressure Oxidizer Turbopump
LRCS	Left Reaction Control System
LTA	Launch to Activation
LWAPA	Lightweight Adapter Plate Assembly
MADS	Modular Auxiliary Data System

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### ACRONYMS, ABBREVIATIONS, AND UNITS OF MEASURE

<b>Acronym/ Abbreviation</b>	<b>Explanation</b>
MAGR	Miniature Airborne-to-Ground Receiver
MAUI	Maui Analysis of Upper Atmosphere Injections
MBS	Mobile Base System
MC	Midcourse Correction
MCC	Mission Control Center
MDCA	Main Distribution Control Assembly
MDRV	Microbial Drug Resistance and Virulence
MECO	Main Engine Cutoff
MEDS	Multifunction Electronics Display System
MELFI	Minus Eighty Laboratory Freezer
MER	Mission Evaluation Room
MERLIN	Microgravity Experiment Research Locker Incubator
MET	Mission Elapsed Time
MHA	Multiple Headset Adapter
MISSE	Materials on International Space Station Experiment
MLG	Main Landing Gear
MLI	Multilayer Insulation
MLP	Main Launch Platform
MLS	Microwave Landing System
MKAK	Minimum Keep-Alive Kit
MM	Momentum Manager
MM/OD	MicroMeteoroid/Orbital Debris
MMT	Mission Management Team
MMU	Master Measurement Unit
MPC	Main Power Converter
MPCA	Mid Power Control Assembly
MPLM	Multi-Purpose Logistics Module
MPM	Manipulator Positioning Mechanism
MPS	Main Propulsion System
MRL	Manipulator Retention Latch
MPRV	Microbial Drug Resistance and Virulence
MS	Mission Specialist
MSG	Microgravity Science Glovebox
MSS	Mobile Servicing System
MT	Mobile Transporter/Mission Timer
MTU	Master Timing Unit
N <sub>2</sub>	Nitrogen
NASA	National Aeronautics and Space Administration

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### ACRONYMS, ABBREVIATIONS, AND UNITS OF MEASURE

<b>Acronym/ Abbreviation</b>	<b>Explanation</b>
NAVAIDS	Navigation Aids
NC	Nominal Correction
NCC	Nominal Correction Combination
NH	Nominal Height (Maneuver)
NLP	National Laboratory Pathfinder
NPRV	Negative Pressure Relief Valve
O <sub>2</sub>	Oxygen
OAA	Orbiter Access Arm
OBSS	Orbiter Boom Sensor System
OCR	Orbit Checkout Requirements
ODRC	Orbiter Data Reduction Center
ODS	Orbiter Docking System
OFI	Operational Flight Instrumentation
OI	Operational Instrumentation
OML	Outer Mold Line
OMRSD	Operational Maintenance and Requirements Specification Document
OMS	Orbital Maneuvering System
OPCU	Orbiter Power Converter Unit
OPO	Orbiter Project Office
ORGA	Orbiter Rate Gyro Assembly
ORU	Orbital Replacement Unit
OSH	Off-Scale High
OSL	Off-Scale Low
OTCM	ORU Tool Checkout Mechanisms
OTP	ORU Temporary Platform
OV	Orbiter Vehicle
OWP	Orbiter Work Platform
PAO	Public Affairs Office
PASS	Primary Avionics Software System
PBA	Portable Breathing Apparatus
PCBM	Passive Common Berthing System
PDGF	Power and Data Grapple Fixture
PDU	Power Drive Unit
PEC	Passive Experiment Container
PFE	Portable Fire Extinguisher
PGME	Propylene Glycol Monomethyl Ether
PIP	Push In Place
PLB	Payload Bay



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### ACRONYMS, ABBREVIATIONS, AND UNITS OF MEASURE

<b>Acronym/ Abbreviation</b>	<b>Explanation</b>
PLBD	Payload Bay Door
PMA	Pressurized Mating Adapter
PMBT	Propellant Mean Bulk Temperature
POA	Payload Orbital Replacement Unit Accommodations
POEMS	Passive Observatories for Experimental Microbial Systems
PPB	Parts Per Billion
PPO <sub>2</sub>	Partial Pressure Oxygen
PPRV	Positive Pressure Relief Valve
PRSD	Power Reactant Storage and Distribution System
PRT	Problem Resolution Team
PSU	Power Switching Unit
PTU	Pan and Tilt Unit/Power Transfer Unit
PV&D	Purge Vent and Drain
PWR	Payload Water Reservoir
QD	Quick Disconnect
R & R	Remove and Replace
RCC	Reinforced Carbon-Carbon
RCS	Reaction Control System
RH	Right Hand
RHC	Rotational Hand Controller
RIGEX	Rigidizable Inflatable Getaway Special Experiment
RIP	Requirements Integration Panel
RJD	Reaction Jet Driver
RM	Redundancy Management
ROI	Regions of Interest
RPCM	Remote Power Controller Modules
RPM	R-Bar Pitch Maneuver
RPOP	Rendezvous Proximity Operations Program
RSB	Rudder Speed Brake
RSRM	Reusable Solid Rocket Motor
RSS	Range Safety System
RTV	Room Temperature Vulcanizing (material)
S&A	Safe and Arm
SARJ	Solar Alpha Rotary Joint
SDBI	Short Duration Bioastronautics Investigation
SDFS	Smoke Detection and Fire Suppression
SIMO	Simultaneous
SIP	Strain Isolation Pad
SLP	SpaceLab Pallet

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### ACRONYMS, ABBREVIATIONS, AND UNITS OF MEASURE

<b>Acronym/ Abbreviation</b>	<b>Explanation</b>
SLWT	Super Lightweight Tank
SMRD	Spin Motor Rotation Detector
S/N	Serial Number
SODB	Shuttle Operational Data Book
SPDM	Special Purpose Dextrous Manipulator
SRB	Solid Rocket Booster
SRGA	Station Rate Gyro Assembly
SRMS	Shuttle Remote Manipulator System
SRSS	Shuttle Range Safety System
SSME	Space Shuttle Main Engine
SSP	Space Shuttle Program
SSPTS	Station-to-Shuttle Power Transfer System
SSRMS	Space Station Remote Manipulator System
ST	Star Tracker
STS	Space Transportation System
TBA	Trundle Bearing Assembly
TCS	Thermal Control System/Trajectory Control Sensor
TEA	Torque Equilibrium Attitude
THA	Tool Holder Assembly
THC	Translation Hand Controller
TI	Terminal Phase Initiation/Transfer Initiation
TIG	Time of Ignition (SRB)
TPL	Transfer Priority List
TPS	Thermal Protection System
TRAD	Tile Repair Ablator Dispenser
TSM	Tail Service Mast
TVC	Thrust Vector Controller
USOS	United States On-Orbit Segment
VCU	Video Control Unit
VDT	Vehicle Data Table
WAICO	Waiving and Cooling Response to Arabidopsis Roots
WCL	Water Coolant Loop
WLE	Wing Leading Edge
WLEIDS	Wing Leading Edge Impact Detection System
WLES	Wing Leading Edge Subsystem
WS	Work Site
WSB	Water Spray Boiler
WVS	Wireless Video System

## APPENDIX D

### ACRONYMS, ABBREVIATIONS, AND UNITS OF MEASURE

<u>Unit of Measure</u>	<u>Explanation</u>
°F	Degree Fahrenheit
deg	degree
deg/sec	degree per second
ft	feet
ft/sec	feet per second
g/G	gravity
Grms	gravity root mean square
hr	hour
in.	inch
kW	Kilowatt
kWh	Kilowatt hour
lb	pound
lb <sub>m</sub> /lbm	pound mass
lb/min	pound per minute
min	minute
mmHg	millimeters Mercury
mph	miles per hour
mv	millivolt
nmi	nautical mile
ppm	parts per million
psi	pound per square inch
psia	pound per square inch absolute
sec	second
V	Volt
Vdc	Volt direct current