

STS-118 SPACE SHUTTLE MISSION REPORT

March 2008



**National Aeronautics and
Space Administration**

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

NOTE

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STS-118

SPACE SHUTTLE MISSION REPORT

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March 2008

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STS-118 SPACE SHUTTLE MISSION REPORT

INTRODUCTION

The Space Transportation System (STS) -118 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 119th mission of the Space Shuttle Program. The purpose of this mission, designated as Flight 13A.1, was to deliver and install International Space Station (ISS) assembly hardware, and deliver critical supplies and cargo to the ISS.

STS-118 was the 6th mission since the return to flight following the STS-107 mission, and the 22nd to the ISS. STS-118 was also the 20th flight of the OV-105 (Endeavour) vehicle.

The flight vehicle consisted of the OV-105 Orbiter; the ET, a super lightweight tank (SLWT) designated ET-117; three Block II SSMEs that were designated as serial numbers (S/Ns) 2047, 2051, and 2045 in positions 1,2, and 3, respectively; and two SRBs that were designated BI-130. The two RSRMs were designated flight set RSRM-97. The individual RSRMs were S/N 360W097A (left) and S/N 360W097B (right). Launch pad 39A and Mobile Launch Platform (MLP) -1 were used as the platform for launch of the STS-118 mission.

The primary objectives of the STS-118 mission were as follows:

1. Install the Integrated Truss Segment Starboard-5 (ITS S5).
2. Install the 3rd External Stowage Platform (ESP) 3.
3. Transfer mandatory quantity of water.
4. Transfer of critical cargo items per the transfer priority list.

The secondary objectives were:

1. Transfer mission success items per the transfer priority list.
2. Perform port S-band communications system upgrade.
3. Relocate both Crew and Equipment Translation Aid (CETA) carts.
4. Cinch the P6 forward radiator.
5. Transfer new Control Moment Gyroscope (CMG) from ESP 3 to ESP 2.
6. Engage Z1 S-Band Antenna Structural Assembly (SASA) gimbal locks.
7. Retrieve the P6 transponder.
8. Remove and replace the CMG 3.
9. Remove and Replace Russian Service Module БOK-3 (Command Processing Unit).

Two secondary payloads of opportunity were flown – Ram Burn Observation (RAMBO) and Maui Analysis of Upper-Atmospheric Injections (MAUI). The STS-118 flight was planned to be an 11-day plus 3-day plus 2 contingency-day (11+3+2) flight of which 7 days were planned for docked operations. The +3 days were based on

the Station-to-Shuttle Power Transfer System (SSPTS) providing power to increase the docked period to 10 days. Consumables, crew provisions, and operations planning assumed a Flight Day (FD) 3 rendezvous and a 14+0+2 day mission. The additional docked days would enable a 4th Extravehicular Activity (EVA).

An additional docked day, above the +3 SSPTS days, was approved during the flight by the Mission Management Team (MMT) to allow for an additional EVA for tile repair if needed, however due to the threat of Hurricane Dean affecting operations at JSC, undocking was moved up a day earlier.

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 provides a table containing all Orbiter, SRB, RSRM, 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 seven crewmembers that were on the STS-118 mission were Scott J. Kelly, CDR, U. S. Navy, Commander; Charles O. Hobaugh, Colonel, USMC, Pilot; Tracy E. Caldwell, PhD., Civilian, Mission Specialist 1; Rick Mastracchio, Civilian, Mission Specialist 2; Dafydd (Dave) Rhys Williams, M.D., Canadian Space Agency, Mission Specialist 3; Barbara Radding Morgan, Civilian, Mission Specialist 4; Benjamin A. Drew, Jr., Colonel, USAF, Mission Specialist 5.

STS-118 was the second flight for the Commander, Pilot, Mission Specialist 2, and Mission Specialist 3, and the first flight for Mission Specialist 1, Mission Specialist 4, and Mission Specialist 5.

MISSION SUMMARY

Pre-Launch

During the prelaunch ingress/egress hatch closing operations, one of the two latch mechanism over-center limit switches failed the continuity check (IFA STS-118-V-13). The closeout crew performed preplanned troubleshooting, and the mechanism was cycled with no acceptable reading. A closeout crew member was placed inside the crew module to visually inspect the operation and the latches were verified to be operating nominally. The decision was made to continue the launch with one of the two limit switch indications.

Also during the prelaunch count a Payload Class 3 fault message was anticipated for the Spacehab parameter "Emergency Bus Voltage, but was not seen upon the Backup Flight System (BFS) being moded from Standby to Run. The BFS used stale values, from the Technical Countdown Demonstration Test (TCDDT), for fault processing, thus precluding annunciation of the '206 PL CL 3' SM Alert as previously anticipated.

During the evaluation of the Quality Assurance (QA rules) for the Day of Launch I-loads Update (DOLILU) it was determined that all were GO with the exception of an exceedence of DOLILU Experience Rule 16, Wind I-Load Experience Envelope. The East Wind I-load value at 48,000 ft. exceeded the cert experience envelope. An exception was processed based on the following rationale:

- The rule is based on the wind envelope used to certify Day-of-Launch Ascent Design System (DADS), and does not represent the certification envelope of the vehicle.
- The pitch and yaw I-loads were within experience envelopes.
- The dispersed alpha and beta profiles were within q-plane limits.
- The top 10 dispersed load indicators peaked at 80 percent.
- Wind change was minimal from balloon to balloon.
- The as-measured wind was well within the worst-month wind envelope used for systems certification.

The Mission Management Team approved the exception.

Ascent and Flight Day 1

The STS-118 mission was launched at 220/22:36:41.989 GMT on August 8, 2007. All Orbiter subsystems performed nominally during ascent and post-insertion.

Solid Rocket Booster (SRB) and External Tank (ET) separation were clearly visible from the ET camera. A nominal Orbital Maneuvering System (OMS) assist maneuver was performed following SRB separation. Ignition occurred at 220/22:38:58.454 GMT [00/00:02:16.465 Mission Elapsed Time (MET)], and the maneuver was 91.2 sec in duration.

Main engine cutoff (MECO) occurred at 220/22:45:07 GMT (00/00:08:25 MET). The ET separated from the Orbiter at 220/22:45:28.014 GMT (00/00:08:46.025 MET) and

the ET Separation maneuver followed at 220/22:45:29 GMT (00/00:08:47 MET) and was a 6.0-sec, 10-thruster translation.

A nominal OMS-2 maneuver was performed at 220/23:13:42.853 GMT (00/00:37:00.864 MET). The maneuver was 165 sec in duration with a Differential Velocity (ΔV) of 253.0 ft/sec. The achieved orbit was 124.0 by 172.2 nmi.

A late notification for a conjunction with a rocket body was received approximately 16 min prior to the Time of Closest Approach, 221/00:11 GMT (0/01:34 MET) with the Orbiter. This conjunction was reported with a small radial miss distance, which is typically the most influential parameter that drives an avoidance maneuver. With so much uncertainty in the Orbiter state vector at that time, a decision was made to not perform any attitude adjustment or a translational maneuver.

The payload bay doors were opened at 221/00:13:05.714 GMT (00/01:36:23.725 MET), and radiator flow was satisfactory. The Ku-Band antenna was deployed, using the dual-motor mode, at 221/00:34 GMT (00/01:57:18 MET). The system was powered 2 min later.

Ground imagery showed that when Reaction Control System (RCS) thruster F3D's Tyvek rain cover released at 4.39 sec MET (approximately 56 mph), a small piece remained attached to the thruster lip (image observed at 220/22:36:52 GMT, approx 10 sec MET). This piece separated at approximately 16 sec MET (approximately 240 mph). Imagery showed that the piece did not impact the Orbiter.

During ascent, the Wing Leading Edge Impact Detection System (WLEIDS) identified three indications that exceeded 1.0 g.

During ET door closure, all four door "closed" indications failed to transfer on. All "ready-to-latch" indications were obtained, and the uplock latches for both doors were driven to the fully-latched positions. It was determined that the crew had manually terminated door closure prematurely, after receiving the door "closed" talkback. This talkback is driven by the "ready-to-latch" indications rather than the "door closed" indications. The "ready-to-latch" indicates that the door uplock rollers are within capture range of the uplock latches, and typically transfer on before the door "closed" indications.

After approximately 4.5 minutes, at the request of ground controllers, the crew resumed operation of the door drive actuators in the closed direction. The "closed" indications were successfully obtained within 0.5 seconds for the left hand side and 1.2 seconds for the right hand side.

The door drive mechanism is designed to be in the fully-closed and over-center configuration when the uplock latches are driven. Without the "closed" indications, the door drive mechanism was in an unknown and uncertified configuration during latching. It was possible that the door drive and/or uplock mechanism were exposed to loading sufficient to cause yielding, and in the worst-case scenario could have resulted in incomplete door closure. Because the door "closed" and uplock "latched" limit switches are located inside the actuators, they are not direct indicators of door

position. As a result, some concern remained over whether the door properly closed.

Approximately 20 min after lift-off, the Integrated Display Processor (IDP) 2 reported a single Built-In Test Equipment (BITE) Mass Storage Unit (MSU) fault message. The IDP continued to perform nominally and was not a concern for the completion of the mission. The MSU issue was not a constraint to the flight, even if it had failed.

The port-side Manipulator Positioning Mechanisms (MPMs) were deployed at 221/01:23 GMT (00/02:46 MET) and the starboard MPMs followed 2 min later.

A nominal OMS-3 (NC-1) maneuver was performed at 221/01:36:14 GMT (00/02:59:33 MET). The maneuver was 52 sec in duration with a ΔV of 79.8 ft/sec. The achieved orbit was 159.3 by 180.7 nmi. OMS performance was nominal.

The crew reported that while performing a lamp test, the lights on the left side of the F7 panel would not illuminate when taking the panel 08 Annunciator Lamp Test switch to the left position, but would illuminate the lights on the right side of the F7 panel when the switch was taken to the right position (IFA STS-118-V-02). Troubleshooting confirmed that the F7 panel functioned properly and the failure was in the panel 08 Annunciator Lamp Test switch. The Panel 06 Annunciator Lamp Test switch was used to test the panel 07 panel lamps.

The Shuttle Remote Manipulator System (SRMS) was parked with the brakes-on in the pre-cradle position. During the SRMS Checkout Direct Drive Test, a payload deployment retrieval system (PDRS) Arm Based Electronics (ABE) message was received when the shoulder yaw joint was driven. The shoulder yaw joint was driven a second time with no ABE message being annunciated. The remainder of the SRMS checkout was nominal and the message did not repeat through out the remainder of the mission.

The Auxiliary Power Unit (APU) 3 fuel-seal-cavity drain system pressure began a slow pressure-decay following post-ascent APU shutdown (IFA STS-118-V-04). The pressure decay was confirmed to have violated the in-flight decay limit of 0.3 psia/day maximum decrease adjusted to a nominal temperature of 70 °F. The decay was below the liquid-leak threshold, which indicated that this was a gas leak, not a hydrazine leak. There was no mission impact.

During the crew sleep, the cryogenic Oxygen Tank 2 control pressure went off-scale low (IFA STS-118-V-01). The tank was not in use at the time. Troubleshooting confirmed the loss of the automatic heater control. The plan for the rest of the mission was to use manual heater operation as required for Oxygen Tank 2. The crew used Oxygen Tank 1 during crew sleep periods to minimize manual heater operations and associated crew interaction.

Flight Day 2

The OMS-4 (NC-2) maneuver was a dual OMS engine firing with an ignition time of 221/14:36:18 GMT (00/15:59:36 MET), a firing time of 15.4 sec, a ΔV of 23.9 ft/sec, and resulting orbit of 169.0 by 185.8 nmi. Engine performance was nominal.

The SRMS unberthed the Orbiter Boom Sensor System (OBSS) at 221/16:08 GMT (00/17:31 MET) for the FD 2 vehicle inspection surveys. The starboard-wing survey started at 221/17:11 GMT (00/18:34 MET) and was completed 83 min later. The nose-cap survey was started at 221/19:17 GMT (00/20:40 MET) and was completed 35 min later. The port-wing survey was started at 221/19:57 GMT (00/21:20 MET) and was completed 91 min later. All imagery from the surveys was downlinked for analysis. 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.

The Orbiter Docking System (ODS) was activated at 221/23:26:06 GMT (01/00:49:25 MET). Power-on time for the avionics was 9 min, 17 sec. Ring extension to the initial position was nominal, beginning at 221/23:29:55 GMT (01/00:53:14 MET) and ending 3 min, 40 sec (dual motor time) later. The ODS ring extension activity was nominal. The ODS was declared ready for docking operations.

One of the Payload and General Support Computer (PGSC) dropped off of the onboard network (IFA STS-118-S-001). The crew performed troubleshooting, but the PGSC could not be seen on the network from the ground. The crew then replaced the Communications (COMM) card 3 and restarted the PGSC, and the ground verified that the PGSC was on the network and operating properly.

The NC-3 maneuver was a multi-axis RCS firing that occurred at 222/01:51:37 GMT (01/03:14:56 MET). The firing time was 11.3 sec with a ΔV of 2.6 ft/sec, and a resulting orbit of 186.3 by 170.0 nmi. Thruster performance was nominal.

Flight Day 3

A nominal OMS-5 (NC-4) right OMS engine maneuver was performed at 222/13:45:44.1 GMT (01/15:09:02 MET). The maneuver was 15.0 sec in duration with a ΔV of 11.4 ft/sec. The achieved orbit was 177.1 by 186.0 nmi. OMS engine performance was nominal.

The NCC maneuver was a multi-axis RCS firing with an ignition time of 222/14:17:37 GMT (01/15:40:56 MET). The firing duration was 8.5 sec with a ΔV of 1.89 ft/sec. The resulting orbit was 177.0 by 186.1 nmi.

The TI (Terminal Phase Initiation) maneuver was a straight-feed, left OMS-engine firing with an ignition time of 222/15:15:19.2 GMT (01/16:38:37 MET). The firing duration was 8.8 sec with a ΔV of 6.9 ft/sec. The resulting orbit was 186.1 by 181.0 nmi. Engine performance was nominal.

Mid-course Correction-1 (MC-1) was a multi-axis RCS maneuver with an ignition time of 222/15:35:20 GMT (01/16:58:39 MET), a firing duration 5.8 sec, and a ΔV 1.37 ft/sec. The Out-of-Plane Null maneuver was a single RCS pulse at 222/15:48:38 GMT (01/17:11:57 MET). MC-2 was a multi-axis RCS maneuver with an ignition time of 222/16:11:18 GMT (01/17:34:37 MET). The firing duration was 6.0 sec with a ΔV of 1.39 ft/sec. MC-3 was a +X RCS maneuver. The ignition was at 222/16:28:16 GMT (01/17:51:35 MET). The ΔV delivered was 1.53 ft/sec and the maneuver duration was 6.6 sec. MC-4 was a 3.2-sec -Z RCS maneuver. The ignition was at 222/16:38:17 GMT (01/18:01:36 MET). The ΔV delivered was 0.73 ft/sec and the Orbiter was in a 185.6 by 180.9 nmi orbit.

The R-Bar Pitch Maneuver (RPM) was started at 222/16:56:19 GMT (01/18:19:38 MET) and ended 8 min later. The peak pitch rate during the maneuver was 0.71 deg/sec. The maximum roll error reached approximately 8 deg. Performance was nominal.

The ODS was activated at 222/17:26:02 GMT (01/18:49:21 MET) and was deactivated after the avionics had operated for 57 min, 18 sec. The Orbiter captured the ISS at 222/18:01:55 GMT (01/19:25:14 MET). The system was allowed to dampen out for approximately 14 min, 27 sec. Ring retraction was started at 222/18:16:22 GMT (01/19:39:41 MET). Ring retraction, using dual motors, proceeded nominally for approximately 3 min, 16 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 222/18:23:54 GMT (01/19:47:13 MET), at which time docking operations were complete.

The SRMS unberthed the S5 Truss Segment at 222/21:00 GMT (01/22:23 MET) and handed it off to the Space Station Remote Manipulator System (SSRMS). The SRMS was then maneuvered to the S5 Install Viewing Position where it was parked with brakes-on.

The Station-to-Shuttle Power Transfer System (SSPTS) was installed and electrical power transfer began at 222/21:13:27 GMT (01/22:36:46 MET), and the system operated satisfactorily. Approximately 6.233 kW was being transferred and all current and voltage measurements continued to remain nominal. This was the first usage of SSPTS by the Programs.

Based on the FD2 imagery, the Leading Edge Structure System (LESS) Problem Resolution Team (PRT) cleared the Reinforced Carbon-Carbon (RCC) for the mission. The Orbiter Project Office held its Focused Inspection meeting and determined that a requirement did exist for a FD5 focused inspection of four tile locations and a frayed thermal barrier around the Main Landing Gear Door (MLGD) (IFA STS-118-V-03).

Flight Day 4

During the 6 hr 17 min first Extravehicular Activity (EVA), all primary objectives were accomplished as well as several get-ahead tasks. All of the EVA hardware

performed nominally with the exception of the EV1 crewmember biomedical signal, which was lost about 5 hr into the EVA. The signal returned occasionally during the remainder of the EVA.

The SSPTS continued to operate satisfactorily. At 223/14:08 GMT (02/15:31 MET), power from the SSPTS Orbiter Power Converter Unit (OPCU) 1 was terminated due to EVA activity. OPCU 2 continued to provide 2.1 kW of power to the Orbiter during the EVA. After the completion of the EVA, OPCU 1 was reactivated. Approximately 6 kW was being transferred, and all current and voltage measurements continued to remain nominal.

The SRMS provided camera views for the installation of the S5 truss segment. Following the completion of EVA 1, the SRMS was maneuvered to the pre-cradle position at 223/23:08 GMT (03/00:31 MET) where it remained powered overnight with brakes-on.

The Debris Assessment Team (DAT) reported to the Mission Management Team (MMT) on the Focused Inspection sites, of which there were five, and the MMT accepted the DAT and Orbiter Project Office (OPO) recommendations and approved the five sites for the Focused Inspection on FD 5. In addition, the MMT decided that if an emergency deorbit case should arise, the crew would return in the vehicle.

With the imagery obtained during the RPM, the ET door was determined to be closed and cleared for entry.

The preliminary assessment of the downlinked Modular Auxiliary Data System (MADS) ascent data was completed. Two temperature indications on the left OMS pod were identified as off-scale high. They were the left OMS pod low-temperature reusable surface insulation (LRSI) surface forward thermocouple and the left OMS pod thermocouple BP049T (IFA STS-118-V-06 & IFA STS-118-V-07).

Flight Day 5

During the sleep period, the crew was awakened by an alarm, "Fuel Cell Amperage Low". The Fuel Cell (FC) was running cold and turned the sustaining heater on, and this dropped the fuel cell amperage below the alarm limit. The FC was running only 1- degree above the limit due to low-power operations with SSPTS. The limit was lowered to preclude a repeat.

The SSPTS performance was reviewed since activation on FD 3. All SSPTS components had been verified to function as designed and overall performance was as expected. Additionally, the review showed that the SSPTS met all pre-flight success criteria for mission extension as well as all planned project success criteria. As a result, both OPO and MOD recommended to the MMT that the mission duration be extended to 14 days. The MMT approved the recommendation. This extension included three additional docked days and a fourth EVA.

The OBSS was unberthed by the SSRMS and handed off to the SRMS to perform the focused inspection of five Thermal Protection System (TPS) damage sites of the

underside of the Orbiter. The SRMS maneuvered the OBSS to the first inspection position at 224/15:42 GMT (03/17:05 MET). The SRMS returned the OBSS to the Handoff Position two hr after starting the focused inspection. The SSRMS returned the OBSS to the starboard sill. The SRMS was maneuvered to the pre-cradle position at 224/20:10 GMT (03/21:33 MET) where it remained powered overnight with the brakes applied.

All imagery and data associated with the focused inspection had been downlinked by this time, and DAT analysis was progressing.

Flight Day 6

The crew completed the 6 hr 28 min second EVA during which Control Momentum Gyroscope (CMG) 3 was replaced. At approximately 4:30 into the EVA, EV1 received the element control workstation (ECWS) message "FAILED CO₂ SENSOR" (IFA STS-118-X-002). The data signature was indicative of that seen with previous failures of the CO₂ sensor related to excess moisture in the vent loop. Flight Rule B15-52 allowed for continuation of the EVA with a failed CO₂ sensor. The crew is trained to recognize symptoms associated with high CO₂ exposure. The EVA was completed with no additional issues.

The RMS was maneuvered from the pre-cradle position to the CMG replacement viewing position. The RMS was then maneuvered back to the pre-cradle position at the end of the EVA.

One additional Wing Leading Edge Impact Detection System (WLEIDS) Micrometeoroid Debris (MMOD) indication was reported, bringing the total count to 16 indications. No WLEIDS indications were seen during the peak of the meteorite shower. The system was monitoring with Port and Starboard group 6. When the batteries for these groups were exhausted all monitoring was discontinued until after undocking at which time other groups were used to monitor.

As of FD6, only one area remained to be cleared by the DAT; a gouge approximately 3.54 by 2.76 in. located in the torque box approximately 19 inches outboard of the wing root on the right wing. The cavity damage-site volume with the area that exposes the filler bar required that the thermal models be modified to precisely account for these effects. The Focused Inspection imagery obtained the detailed geometry of the cavity. The three smaller damage-sites had been cleared. A digital camera image, obtained during the Focused Inspection, of the right main landing gear thermal barrier showed that the barrier was intact.

Arc Jet Facility test calibration runs on undamaged tile were completed, and testing of the replicated tile damage site was to be performed after the test article became available. The precise test conditions were developed based on the Computational Fluid Dynamics (CFD) effort.

The Tile Repair Team was engaged in activities to pursue the selected repair methods should the "gouged" tile damage not be cleared for entry in the as-is condition. Additionally, the DAT team was verifying the repair method to ensure that

the method would pass the analytical, thermal, and stress loads on the vehicle during entry, this would include taking a “repaired” tile into the arc jet for testing.

Flight Day 7

The main tasks for FD 7 were the unberthing and installation of the External Stowage Platform (ESP) 3 and the Attitude Control Handover Detailed Test Objective (SDTO 12008-U).

The SSPTS continued to perform nominally.

The SRMS began the day at the pre-grapple position. SRMS operations began at 226/12:57 GMT (05/14:21 MET) when the ESP-3 Grapple procedure began. The SRMS completed a nominal grapple of the ESP-3 and began the ESP-3 Unberth operations at 226/13:39:04 GMT (05/15:02:22 MET). The SRMS unberthed the ESP-3, executing a 3 inch (nominal) bias to port during the unberthing operations to clear the OBSS Pan Tilt Unit (PTU) harness. The SRMS then maneuvered the ESP-3 to the Handoff position at 226/14:35 GMT (05/15:59 MET). The SRMS ran into a Wrist-Yaw singularity condition during the maneuver, but the crew recovered by driving the joint in the single-mode to clear the singularity. The crew completed the maneuver to handoff nominally. The SSRMS grappled the ESP-3 at 226/14:45 GMT (05/16:09 MET) and the SRMS released the ESP-3 at 3 min later. After handoff to the SSRMS, the SRMS was maneuvered to the ESP-3 Install-Viewing position. SRMS performance for the ESP-3 grapple, unberthing, handoff, and ungrapple was nominal.

The ISS was in attitude control during the robotics operations. Attitude control was transferred to the Orbiter at 226/17:46:12 GMT (05/19:09:30 MET) for the maneuver to water-dump attitude, the water dump, and the maneuver back to the Torque Equilibrium Attitude (TEA). The Digital Autopilot (DAP) performance was nominal for all Orbiter attitude-control operations. The Vernier Reaction Control System (VRCS)-to-Momentum Manager Handover Station Development Test Objective (SDTO-12008U) began at 226/21:47:23 GMT (05/23:10:41 MET). The handover was successful and Momentum Manager resumed attitude control.

The DAT presented an initial assessment for the 3.54 by 2.76 in tile-damage area. The site was the only one of the five Focused Inspections sites that had not been cleared for entry.

Arc Jet Facility testing of a representative test article of the un-repaired damage site was completed overnight. The initial inspection did not indicate any structural burn-through. A detailed inspection was to be completed after facility cool down.

Due to the concerns with the tile damage, the MMT was considering extending the mission to 17 days to add a repair EVA. The Orbiter Project looked at the Orbiter mission certification limits and determined that there were no concerns with certification limits. One possible area of concern was the S-Band Phase Modulation (PM) quad antenna Radio Frequency (RF) switch leakage that could cause data loss due to arcing in the transfer switch assemblies. A study, conducted in 1996 using a

leak rate that decreased with pressure, estimates 24 days for the switch to reach critical pressure.

Flight Day 8

The main task for FD 8 was EVA 3 to relocate the P6 Truss S-band antenna and the Crew and Equipment Translation Assembly (CETA) carts; however, the EVA was terminated earlier than planned because the EV1 crewmember reported a cut glove (IFA STS-118-X-001). The EVA duration was 5 hr 28 min.

The SRMS was placed in the P6 S-Band Antenna Structural Assembly (SASA) Relocate Viewing position with brakes on.

The SSPTS continued to perform nominally. In response to a chit from MOD, the Fuel Cell Problem Resolution Team (PRT) evaluated the level-of-performance change that was acceptable between fuel cell purges. Maximizing the time between fuel cell purges would reduce the voltage output from the fuel cells and draw more ISS power, thus increasing the cryogenic margin. The plan was to extend the Fuel Cell (FC) purge past the 0.2 V degradation that is currently in the flight rules to 0.3 V.

A small but notable decay of approximately 36 standard cubic centimeters per hour (scch) was observed in the Gaseous Nitrogen (GN₂) supply tank of left Orbiter Maneuvering Engine (OME). The decay did not impact the mission, but monitoring continued for the rest of the mission.

The DAT continued the tile-damage assessment activities. Further review of the test article from the Arc Jet Facility that simulated the un-repaired damage indicated that there was no breach of structure or any sign of tile-bond failure, and the exposed filler bar was charred but intact. There was significant damage to the downstream tile that may be attributed to the high localized-heating of the aft-cavity lip.

DAT personnel and test articles were transported to the Lockheed-Martin vacuum chamber in Denver to robotically dispense STA-54 tile-repair material into articles representing the damaged tile cavity. Once the material was dispensed into the test article, it had to cure for 24-hr in the vacuum chamber. When cured the article was to flown back to JSC for arc jet testing.

Flight Day 9

The SRMS was cradled and latched with arm power off and the heaters on.

The third on-orbit fuel cell purge was commanded at 228/11:15:32 GMT (07/12:38:50 MET). During the 94-hour purge interval, the approximate indicated voltage decay was 0.13 Vdc in fuel cell 1, 0.13 Vdc in fuel cell 2, and 0.20 Vdc in fuel cell 3. Even though the interval was increased, this level of decay was within the Flight Rule degradation requirements.

The crew reported at approximately 228/11:58 GMT (07/13:21 MET), a MMOD impact on window 2 of 1/8-in in size. Photographs of the impact and its location

were downlinked for analysis. The analysis of the window as well as any potential impact to the flight was performed and the window was cleared for entry.

The oxygen transfer to the ISS was initiated at 228/13:40 GMT (07/15:04 MET) and terminated 24 hr later. Approximately 77 lb of Oxygen was transferred to the ISS.

The test article with the STA-54 tile-repair material applied in Denver was transported back to JSC. The test article was not tested in the Arc Jet facility since the MMT decision was made to not perform the tile repair. The DAT cleared the 3.54 by 2.76 in tile-damage area for entry.

At 228/14:45 GMT (07/16:08 MET), power from Building 48 to Building 30M was lost for approximately 3 min. This resulted in the loss of power to non-critical systems, such as personal computers, lights and some workstations and services outside of the Flight Control Rooms. Commercial power was restored to the buses within 3 min, but equipment recovery was incremental and required over 2 hr to complete. The power disruption occurred when JSC Center Operations took action to prevent partial loss of the B48 power system.

Flight Day 10

The main tasks for FD 10 were EVA 4 preparation and Docked Audio Interface Unit (DAIU) troubleshooting. As a result of the potential impacts of Hurricane Dean on JSC operations, the MMT gave the Flight Control Team direction to develop a flight plan that supported a landing opportunity on Tuesday, August 21, a day earlier than was in the current plan.

The DAIU troubleshooting, using an audio-tone test indicated the possibility of a shorted cable on the Docked Air to Ground (DAG) 1 cable run. The audio tone test indicated there may be a cable short along on the DAG1 cable run. The audio tone test on ICOM A showed an expected waveform on the scope. After the troubleshooting, the DAIU was activated, however, the Intercommunications (ICOM)-A voice checks were not successful. The DAIU troubleshooting was performed in response to ISS-to-Orbiter communication problems observed on multiple missions involving different vehicles.

A Hydraulic System 3 Reservoir quantity decay of approximately 2 percent over approximately 7 days was monitored. Analysis of the reservoir quantity and temperature confirmed that the decrease in reservoir quantity was due to hydraulic system thermal gradients on-orbit. The decay was within the system allowable range of 10-percent quantity dispersion for thermal effects.

Flight Day 11

The main task for FD 11 was EVA 4, which had a duration of 5 hr 2 min, as well as completion of transfer activities in support of hatch closure. All scheduled glove inspections and post-flight glove photographs indicated no damage had been incurred during the EVA.

As a result of the potential impacts of Hurricane Dean on JSC operations, the MMT decided to shorten the mission by one day with the landing scheduled for Tuesday, August 21.

The draft Mission Evaluation Room (MER) plan for the hurricane was to activate a satellite MER at KSC. The satellite MER would begin operations on 6:00 a.m. Eastern Daylight Time (EDT) on Monday, August 20. The handover from JSC-to-KSC would occur if and when JSC closed. Eight disciplines were identified as required for entry using support from KSC personnel. Two additional MER disciplines, Passive Thermal and Global Positioning System (GPS), were also identified as required for entry; however, their tools and/or data were not available at KSC, so their support would continue at JSC through the Tuesday landing opportunities. If the Emergency Mission Control Center (EMCC) was activated, the MER GPS would support the EMCC, but Passive Thermal would have gone to the on-call status.

The SSPTS was powered down at 230/15:34 GMT (09/16:57 MET) for EVA operations and was powered back up after EVA operations were complete. At 231/09:00 GMT (10/10:23 MET), the SSPTS was deactivated in preparation for undocking.

Attitude control was handed over to Orbiter control at 230/18:45:00 GMT (09/20:08:19 MET) for water-dump operations. After completion of the water dump, the Orbiter maneuvered back to the Torque Equilibrium Attitude (TEA) completing the maneuver at 230/19:52:45 GMT (09/21:16:04 MET). Once back at the TEA, the Orbiter maintained attitude control for approximately 2 hr while leak checks and the ODS depressurization were performed.

The SRMS was powered up at 230/21:04 GMT (09/22:27 MET). It was maneuvered to the pre-cradle position at 230/21:18 GMT (09/22:41 MET) where it remained powered with brakes-on in preparation for the planned Late Inspection for any MMOD damage on the Reinforced Carbon-Carbon (RCC) leading edge and nose cap.

Hatches were closed at 230/21:06:18 GMT (09/22:29:37 MET) in preparation for undocking.

The crew reported the presence of Lithium Hydroxide (LiOH) dust associated with the STS-114 LiOH cartridges installed during the hatch closure period (IFA STS-118-V-11). The crew stated that the dust condition for the STS-114 series cartridges was significant while dust from the STS-118 cartridges was negligible. Multiple crewmembers experienced LiOH exposure symptoms while on the Middeck during the LiOH change out. The crew was told not to use any more STS-114 cartridges unless absolutely necessary.

Flight Day 12

The main activities of FD 12 were undocking and the late inspection of the RCC. As a result of the improving tropical weather forecast for the Johnson Space Center (JSC) area, all weather mission contingency plans were discontinued.

The fourth on-orbit fuel cell purge was commanded at 231/09:09 GMT (10/10:33 MET). During the 70-hour purge interval, the approximate indicated voltage decay was 0.12 Vdc in fuel cell 1, 0.14 Vdc in fuel cell 2, and 0.18 Vdc in fuel cell 3. Fuel Cell 3 alternate line temperatures indicated some trickle flow down the alternate line starting around 231/08:50 GMT (10/10:14 MET). This correlates to water-line pressure increases associated with filling water tank A. This is a common on-orbit occurrence and presents no impact to flight operations.

Orbiter took over attitude control of the mated stack at 231/10:35:51 GMT (10/11:59:10 MET) and began the maneuver to the undocking attitude at 231/10:40:09 GMT (10/12:03:28 MET). The maneuver terminated nominally at 231/11:11:48 GMT (10/12:35:07 MET).

The ODS was activated for undocking at 231/11:25:57 GMT (10/12:49:15 MET) and the ODS system operated for 48 min 59 sec until completion of the undocking sequence.

The Orbiter undocked from the ISS at 231/11:56:33 GMT (10/13:19:52 MET)

The Separation 1 maneuver was a RCS firing and was a 5.7-sec +X pulse at 231/12:19:42 GMT (10/13:43:00 MET). The Separation 2 maneuver was performed at 231/12:47:42 GMT (10/14:10:59 MET). This firing was a 6.0 sec -X maneuver. The Orbiter was in a 184 nmi by 185 nmi orbit following the Separation 2 maneuver.

The MMOD late inspection of the port, starboard, and nose-cap RCC was successfully completed. The OBSS was unberthed at 231/13:48 GMT (10/15:12 MET). The survey of the starboard RCC started at 231/14:38 GMT (10/16:02 MET), the nose-cap survey started at 231/16:14 GMT (10/17:38 MET) and the port survey began at 231/17:21 GMT (10/18:45 MET). The OBSS was berthed and latched at 231/19:24 GMT (10/20:48 MET). The SRMS was cradled, latched, powered down, and the port and starboard Manipulator Positioning Mechanisms (MPM) were stowed by 231/20:03 GMT (10/21:27 MET). All of the inspection data were downlinked for review by the DAT.

During SRMS cradle, the forward Manipulator Retention Latch (MRL) system 1 latched indication did not come on and resulted in single-motor run-time of 18.36 sec (IFA STS-118-V-08). The latch indication was obtained approximately 4 hr 21 min later. This is likely due to rigging and thermal affects on microswitches.

At approximately 232/06:36 GMT (11/07:59 MET), camera A video was downlinked via Ku-Band and Sequential Still Video (SSV), and the image appeared to have a magenta hue (IFA STS-118-V-09). A test pattern was downlinked from the camera

and appeared to be normal. This issue has been seen before on this type of camera and was no impact to the remainder of the mission.

Flight Day 13

The late inspection data review results for the RCC were presented to the MMT, and the vehicle was cleared for entry.

The Flight Control System (FCS) checkout was performed satisfactorily with one anomaly noted, and it is discussed later in this paragraph. Auxiliary Power Unit (APU) 1 was used for the checkout and the APU ran for 3 min, 16 sec. All Navigation Aids including the Microwave Scanning Beam Landing System (MSBLS) and the Global Positioning System (GPS) performed satisfactorily during the FCS Checkout. The Air Data Transducer Assembly (ADTA) 3 did not respond (communication-fault) and was bypassed (IFA STS-118-V-10). A power cycle of the ADTA 3 circuit breaker resulted in nominal operation.

The RCS hot-fire was initiated at 232/11:20:59 GMT (11/12:44:17 MET) and completed 9 min 27 sec later. All 38 RCS thrusters were fired at least twice.

An evaluation of the SSPTS showed that 1186 kWh of electricity were transferred between the ISS and the Orbiter. The overall performance of the SSPTS was very successful.

The pressure decay in the Gaseous Nitrogen (GN₂) supply tank on the left OME appeared to stop. During this reporting period, the accumulator pressure began trending downward. The initial analysis suggested that the low-pressure system leak was probably masked by a high-pressure isolation valve leak that stopped. A GN₂ system repressurization was performed before crew-sleep period to avoid a low-pressure alarm. This leak did not affect nominal OME usage. Sufficient GN₂ remained in the supply tank to support several left OME firings, but only the de-orbit maneuver was planned.

The Ku-band antenna was stowed at 232/22:13 GMT (011/23:37 MET) with nominal dual-motor operation.

Flight Day 14 and Entry Operations

The Payload Bay Doors (PLBDs) were closed nominally at 233/12:53:30 GMT (12/14:16:49 MET) in preparation for landing.

A recurrence of the Air Data Transducer Assembly (ADTA) 3 communication-fault occurred and this resulted in the ADTA being bypassed. The initial power cycle of the ADTA 3 circuit breaker did not result in nominal operation. After repeated power cycles, the last of which had a 15-sec period between the circuit breaker going from off to on, resulted in nominal operation.

The deorbit maneuver was performed on orbit 201 for the first landing opportunity at KSC, a dual-engine straight-feed firing, was performed at 233/15:25:12.054 GMT

(12/16:48:30.065 MET). The duration of the deorbit firing was 215.8 sec and the ΔV was 370.0 ft/sec. The orbit following the deorbit firing was 187.5 by 22.9 nmi.

Entry interface occurred at 233/16:00:27 053 GMT (12/17:23:45.054 MET), and entry was completed satisfactorily.

The main landing gear touchdown occurred on KSC concrete runway 15 at 233/16:32:17 GMT (12/17:55:35 MET) on August 21, 2007. Nose-gear touchdown occurred at 233/16:32:30 GMT (12/17:55:48 MET). The drag chute was deployed at 233/16:32:39 GMT (12/17:55:57 MET). Drag chute release occurred at 233/16:32:59 GMT (12/17:56:17 MET).

The drag chute was deployed late (just after nose gear touchdown) in support of the Crosswind Landing Detailed Test Objective (DTO-805), however, the crosswinds at landing did not meet the DTO criteria.

During the chute deployment, one of the 2 redundant reefing line cutters on the drag chute failed to fully sever the reefing line (IFA STS-118-V-12). Evidence reveals the line was in motion relative to the cutter when the cutter fired. Evidence of motion consisted of the cut being approximately 5 to 6 in off the target mark and off the Teflon-taped area for cutting. As a result, the cutter tried to function on a moving reefing line and that is not the design intention of the device. The cutters are designed to sever static lines only. The reefing line was in a static state until one cutter successfully severed the line and released tension, allowing the line to move. The dynamic line was a result of the successful function of first cutter firing, thereby compromising the function of the redundant unit. If neither cutter functions, 40-percent of drag chute capability is still maintained. Should the chute not deploy, the Orbiter brake system alone is capable of stopping the vehicle.

Wheels stop occurred at 233/16:33:18 GMT. The rollout was normal in all respects. The flight duration was 12 days 17 hr 56 min 36 sec. The last Auxiliary Power Unit (APU) was shutdown at 233/16:48:31 GMT (16 min 14 sec after landing).

PAYLOADS AND EXPERIMENTS

SUMMARY AND ACCOMPLISHMENTS

All of the Shuttle and International Space Station (ISS) mission objectives were successfully accomplished during this mission. A total of 100-percent of the planned transfers were completed during this mission.

The major accomplishments of the mission included the installation of the S5 Short Spacer Truss Segment (SSTS) and the External Stowage Platform (ESP) -3, and preparations for relocation of the P6 solar array/truss. As a result of the successful activation of the Station-to-Shuttle Power Transfer System (SSPTS), the mission was extended three days, and a fourth extravehicular activity (EVA) was added. The Thermal Protection System (TPS) tile damage threatened to further extend the mission, but ultimately no repair was needed and no obvious damage occurred to the Shuttle TPS during entry.

The ISS 13A.1 launch package consisted of the S5 Short Spacer Truss Segment, the Spacehab Logistics Single Module (LSM), and the External Stowage Platform-3 (ESP-3). The Orbital Replacement Units (ORUs) that were integrated onto the ESP-3 were the Space Station Remote Manipulator System (SSRMS) Pitch/Roll Joint (P/R-J), Battery Charge/Discharge Unit (BCDU), Nitrogen Tank Assembly (NTA), Control Moment Gyroscope (CMG), Ammonia Tank Assembly (ATA) Flight Support Equipment (FSE), and two unoccupied Passive Flight Releasable Attachment Mechanisms (PFRAMs).

The Ram Burn Observations (RAMBO) and Maui Analysis of Upper-Atmospheric Injections (MAUI) were flown as payloads of opportunity. The ISS Utilization payloads flown in the Middeck of the Orbiter were the Commercial Biomedical Testing Module (CBTM-02), Streptococcus Pneumoniae Expressions of Genes in Space (SPEGIS) that was located in the Microgravity Experiment Research Locker Incubator (MERLIN) rear-breather for ascent, Commercial Generic Bioprocessing Apparatus (CGBA)-5 with CGBA Science Insert – 02 (CSI-02) located inside CGBA-5, Cell Culture Module-A (CCM-A), Perceptual Motor Deficits in Space (PMDIS), and Double Coldbag used to return SPEGIS and Nutrition samples. Short Duration Bioastronautics Investigations (SDBIs) performed during the mission included Midodrine (SDBI-1503-S), Sleep Short (SDBI 1634), Promethazine (SDBI 1490B), and Latent Virus (SDBI 1493). Additional Utilization payload hardware was manifested onboard the middeck and Spacehab LSM to support ISS research during the 13A.1 stage.

FLIGHT OBJECTIVES

All of the ISS 13A.1 mission objectives were successfully accomplished during this mission with 100-percent of the planned transfers completed during this mission. The primary objectives of the mission were:

1. Install the integrated truss segment S5 to S4.

2. Transfer mandatory water per transfer priority list.
3. Transfer critical items per transfer priority list.
4. Deploy ESP-3 from the payload bay to P3.

CREW ACTIVITIES

Specific Experiment and Payload Activities

The Commercial Generic Bioprocessing Apparatus (CGBA-5), which was a new utilization facility, was transferred on FD 3 from the Orbiter middeck to the U.S. Laboratory. Launched inside the CGBA-5 was the CSI-02, an educational payload designed to interest middle school students in science, technology, engineering and math by participating in near real-time research conducted on board the ISS. The ISS Flight Engineer 2 successfully activated the CGBA-5 to preserve the CSI-02 samples at the desired temperature.

The students observed three experiments through data and imagery that was downlinked and distributed directly into the classroom via the internet. The first experiment was small seeds that were germinated on-orbit in a garden habitat, where students will investigate how gravity affects plant development. The second experiment examined crystal growth formation using specific types of proteins and enzymes. For the two crystal growth experiments, students grew crystals in their classrooms and analyzed the growth of those compared to the crystals grown in space. The third experiment examined crystal formation using silicates, which are compounds containing silicon, oxygen and one or more metals.

TRANSFER WEIGHT SUMMARY

The total cargo transferred from Orbiter to the ISS was 14,740 lbm. The internal transfer to the ISS was 3,794 lbm (150.25 MLE), which consisted of 810 lbm from the Middeck and 2,984 lbm from the Logistics Single Module (LSM). The external transfer consisted of 10,946 lbm, which were the S5 SSTS and the ESP-3. In addition, the up/down Science Payloads in the Orbiter middeck consisted of 265 lbm (5 MLE). The total transferred from the ISS to the Shuttle was 3297 lbm (130.5 MLE) of which 406 lbm went to the Middeck and 2891 lbm to the LSM.

The consumables transferred during the mission were satisfactory. The total amount of water transferred was 918.6 lbm (416.6 Liters). A total of 8 Contingency Water Containers (CWC's) and 7 Portable Water Reservoirs (PWR's) were transferred during the mission. However, during the nominal postflight microbiological analysis of the STS-118 CWC samples, the analysis results from one CWC of potable water indicated a bacterial level of 31,000 colony forming units (CFU)/1 mL. This level is well above the Medical Operations Requirements Document (MORD) acceptability limit of 50 CFU/mL. The analysis also indicated a pure culture of *Wautersia* (formerly *Ralstonia* genus) *paucula*, an opportunistic pathogen in cystic fibrosis and immunocompromised individuals. While experts feel that this organism was not an infectious disease risk to the crew, it was recommended that this water not be used for personal hygiene purposes. The ISS

crew was instructed to use CWC S/N 1081 as technical water instead of potable water. As a result, only 1 CWC of potable water and 7 CWC for technical water were provided for ISS usage.

A total of 77 lbm of oxygen and 33.8 lbm of nitrogen were transferred to the ISS Airlock High Pressure Gas Tanks (HPGT). Also, 12 Lithium Hydroxide (LiOH) canisters were transferred from the ISS to the Orbiter, and 30 new canisters were transferred from the Orbiter to the ISS.

During this first mission usage of the Station-to-Shuttle Power Transfer System (SSPTS) a total of 1186 kWh of electrical power was transferred from the ISS to the Orbiter.

SIGNIFICANT FIRSTS

The following paragraphs discuss the significant firsts of the STS-118 mission as well as the significant last flight of the Spacehab Single Logistics Module

The Station-to-Shuttle Power Transfer (SSPTS) system provided power to the Orbiter main busses transferred from the ISS while docked. The system used two Power Transfer Units (PTUs) that were installed in the existing Assembly Power Converter Unit (APCU) locations on the Shuttle vehicle. Each PTU converted 120 Vdc from the ISS Remote Power Controller Modules (RPCMs) to 28 Vdc using the two Orbiter Power Converter Units (OPCUs) for internal power usage while still using the third APCU to convert 28 Vdc to 120 Vdc for nominal payload bay power activities. The expected efficiency of the OPCUs was 92-percent, while the APCU expected efficiency was 89-percent. The average total power expected from SSPTS was 6 kW, thus minimizing the use of the Orbiter fuel cells during docked operations. When combined, the Orbiter actual average electrical power level was 13.87 kW for the mission duration.

The OV-105 Shuttle (Endeavour) is the only Orbiter that is equipped with for Three-String Global Positioning System (GPS) operation. The GPS was the prime navigational tool used during entry. This was the first Shuttle mission flown without the three Tactical Air Command and Navigation Systems (TACAN's). The GPS replaced the TACAN's to improve crew safety, abort landing site availability, reliability, performance as well as a reduction in weight.

Three Advanced Health Monitoring System (AHMS) Space Shuttle Main Engine (SSME) controllers were incorporated in the vehicle and these operated in the Redline active mode. The AHMS controller's monitored vibration redlines to initiate shut-down to avoid catastrophic engine failures. On the previous mission (STS-117), one AHMS controller was successfully flown in and operated in the Redline active mode.

Engine Cut-off (ECO) instrumentation was added to the Orbiter to provide Instrumentation measurement data on the ECO system voltages for isolation capability between the Orbiter point sensor box and sensor instrumentation. This flight approved using the instrumentation to monitor Liquid Hydrogen (LH₂) Low

Level Cut-Off (LLCO) voltage requirements for a 3 out of 4 condition between T-9 min and T-5 min.

The Solid Rocket Booster (SRB) Command Receiver Decoder (CRD), an integral part of the SRB avionics system, replaced the Integrated Receiver Decoder (IRD) and Range Safety Distributor (RSD). The CRD provided the capability to receive and decode Range Safety instructions and perform the Range Safety System (RSS) initiation/detonation functions.

For the Day of Launch I-load Update system several firsts occurred. The Automated Meteorological Profiling System (AMPS) High Resolution (HR) replaced the Jimspheres. The AMPS HR flight element provides high resolution wind measurements for Day-of-Launch I-Loads. Also this was the first flight on the LINUX platform

The Middeck Rear Breather Payload consisted of a Microgravity Experiment Research Locker Incubator/Refrigerator/Freezer (MERLIN), which is the first advanced rear-breathing Single Middeck Locker. The MERLIN provided a thermally controlled volume that was used to preserve *S. pneumoniae* Expression of Genes in Space (SPEGIS) samples during middeck ascent as well as incubated samples during docked operations.

The Voltage Boost Regulators (VBR) for Wing Leading Edge (WLE) sensors performed satisfactorily. The VBR is a printed wiring assembly that was developed for the WLE system to expand the operating temperature environment capability from 0 °F to +40 °F to -40 °F to +140 °F. The VBR was designed to draw additional current from the L91 battery to provide an output voltage that exceeded the minimum threshold voltage of the WLE sensors, thus allowing the units to operate during lower-temperature conditions.

The STS-118 mission had the highest Orbiter Maneuvering System (OMS) ballast for an ISS Mission. This ballast was approximately 3,477 lbm.

STS-118 was the first flight of an Educator in Space Astronaut (Barbara Morgan). During the mission, two educational Public Affairs events were conducted.

The Common Attachment System (CAS) operations with the External Stowage Platform (ESP)-3 were performed satisfactorily. ESP-3 was robotically deployed to the Port Truss Segment 3 (P3) CAS site and attached without EVA assistance using the External Berthing Camera System (EBCS).

Finally, this was the last planned flight of the Spacehab Logistics Single Module (LSM) for the Space Shuttle Program (SSP). SPACEHAB modules were flown on 18 Shuttle flights with the first flight being STS-57 in 1993.

SIGNIFICANT ISS ANOMALIES

All ISS subsystems performed nominally during the mission with no significant anomalies.

MISSION PAYLOAD AND EXPERIMENT PRIORITIES COMPLETED

The following table provides a listing of the payload and experiment priorities as well as the completion status of each of the items.

MAJOR ISS MISSION PRIORITIES COMPLETED

Mission priority	Mission Task	Method(s)	Complete
1	Perform robotic installation of Integrated Truss Segment (ITS) S5 on S3/S4 with EVA assistance including EVA relocation of S5 Photovoltaic Radiator Grapple Fixture (PVRGF) from launch location to keel location on S5. a. Remove S5-to-S4 Truss Attachment System (TAS) Launch Locks. b. Structurally mate S5-to-S4 TAS. c. Remove S4 soft capture pin assembly No. 3. d. Remove S4 soft capture pin assembly No. 1. e. Relocate S5 PVRGF to keel location on S5.	EVA/SRMS/SSRMS	FD 4
2	Perform mandatory water transfers.	IVA	FD3-FD11
3	Transfer all critical cargo per Transfer Priority List (TPL).	IVA	FD3-FD11
4	Deploy External Stowage Platform (ESP)-3 with Orbital Replacement Units (ORUs) from the Payload Bay (PLB) and stow it on the P3 Truss Structure. a. Disconnect Orbiter power cable from ESP-3 connector box and reconnect to KYA dummy receptacle. b. Reconfigure ESP-3 power cables for Station power at the Power Distribution Unit (PDU).	EVA/SRMS/SSRMS	FD 6 (a) FD 7 (deploy and b)
5	Transfer mission success items per Transfer Protocol List.	IVA	FD3 - FD11
6	Perform Port S-band communications system upgrade. a. Retract the P6 Photovoltaic Module Thermal Control System (PVTCS) forward Photovoltaic Radiator. b. Relocate S-band System S-band Antenna Support Assembly (SASA) from P6 to P1. c. Install the new S-band Transponder and Baseband Signal Processor (BSP) to P1. d. Activate the new S-band System.	IVA IVA	FD 8 FD 8 FD 8 FD 10
7	Relocate two Crew Equipment Translation Aids (CETA) carts to Starboard for P6 relocation.	EVA/SSRMS	FD 8 (EVA 3)
8	Cinch P6 Photovoltaic Module Thermal Control System (PVTCS) to forward Photovoltaic Radiator.	EVA/IVA	FD4 (EVA1)
9	Transfer Control Moment Gyroscope (CMG) ORU and FSE from ESP-3 to ESP-2.	EVA/SSRMS	FD 6 (EVA 2)
10	Engage the Z1 SASA Gimbal Locks.	EVA	FD 11 (EVA 4)

MAJOR ISS MISSION PRIORITIES COMPLETED

Mission priority	Mission Task	Method(s)	Complete
21	<p>The following tasks fit within the existing EVA timelines; however, they may be deferred if the EVA is behind schedule. The EVA will not be extended to complete these tasks.</p> <ol style="list-style-type: none"> a. Install External Wireless Instrumentation System (EWIS) two antennas on U.S. Laboratory. b. Install the Orbiter Boom Sensor System (OBSS) On-orbit Support Equipment (OSE) on the two S1 Zenith Trunnions. c. Retrieve failed Global Positioning System (GPS) Antenna Assembly No. 4 and install caps. d. Relocate P6 auxiliary tools bag. e. Install the Wireless Video System (WVS) External Transceiver Assembly (WETA) No. 3 on CP1. (Requires IVA adjustment of WETA alignment ring prior to EVA.) 	EVA	<p>Completed EVA 4 Completed EVA 4</p> <p>c and d completed before flight Defer to later flight Completed IVA adjust</p>
22	<p>Perform the following IVA tasks to allow for the return of on-orbit hardware:</p> <ol style="list-style-type: none"> a. Perform trouble-shooting of Docked Audio Interface Unit (DAUI) and replace if necessary. b. Perform Cycle Ergometer with Vibration Isolation and Stabilization (CEVIS) R&R. c. Perform United States (U.S.) Laboratory Window Scratch Pane replacement. d. Perform Treadmill with Vibration Isolation and Stabilization (TVIS) Skirt replacement. 	IVA	<p>FD 10</p> <p>FD 11</p> <p>FD 7</p> <p>FD 5</p>
23	Perform Detailed Test Objective (DTO) 853 In-flight evaluation for areas of CO ₂ concentration.	IVA	FD 2, FD 4, FD 6
24	<p>Perform USOS/Russian ISS payload research operations tasks.</p> <ol style="list-style-type: none"> a. Activate Commercial Generic Bioprocessing Apparatus (CGBA-5) for CGBA Science Insert (CSI)-02 specimens conditioning. 	IVA	FD 5
25	Perform imagery survey of the ISS exterior during Orbiter flyaround after undocking.	IVA	Not performed
26	Perform payload operations to support Maui Analysis of Upper Atmospheric Injections (MAUI) and Ram Burn Operations (RAMBO).	IVA/ Ground	FD 2, FD 14 (for RAMBO), MAUI not performed
27	<p>Perform program-approved EVA get-ahead tasks if time permits.</p> <ol style="list-style-type: none"> a. Connect S5 to S4 umbilical's. b. Remove S5 to S6 RTAS Launch locks. c. Open the S5 RTAS Capture Latch Assembly (CLA). d. Release Node 2 Early Ammonia Thermal Control System Loop A and B Fluid Tray Bolts(1-6, 8,9,11 and 12). e. Torque CMG FSE Shim bolts to final preload. f. Deploy S3 Upper Outboard Payload Attachment System (PAS) and S3 Upper Inboard PAS. 	EVA	<p>FD 4 FD 4 prior to Flt</p> <p>Defer</p> <p>Defer Defer</p>

Mission priority	Mission Task	Method(s)	Complete
27 (Continued)	<ul style="list-style-type: none"> g. Deploy P3 nadir un-pressurized cargo carriers attachment system. h. Retrieve 3/8" Drive Ratchets SN 1011 and 1012 from the EVA Tool Stowage Devices (ETSD) boxes for IVA inspection. i. Return General Purpose Cutter to Airlock Toolbox No. 2 (-303 version). j. Install S1-S3 Ammonia Fluid Lines. k. Install P1-P3 Ammonia Fluid Lines. l. Close P1 Radiator Beam Valve Module (RBVM) Thermal Bootie (F151). 	EVA	FD 4 and FD 6 Defer Defer Defer Defer Defer
28	Perform reboost with the Orbiter if mission resources allow and are consistent with ISS trajectory analysis and planning.	IVA Not required.	
29	Transfer O ₂ from the Orbiter to the ISS A/L HPGT (as consumables allow).	IVA	FD 10
30	Perform Station Development Test Objective (SDTO) 13005-U, ISS Structural Life Validation and Extension, during Shuttle docking (ISS Wireless Instrumentation System (IWIS) required).	IVA/ Ground	FD3
31	Perform SDTO 13005-U, ISS Structural Life Validation and Extension, during Shuttle mated reboost (IWIS required) (only if crew time available).	IVA/ Ground	No reboost performed
31.5	Perform SDTO 12008-U, Mated Momentum Manager Startup from Shuttle Vernier Reaction Control System (VRCS).	IVA/ Ground	FD 7
32	Perform SDTO 13005-U, ISS Structural Life Validation and Extension, during 13A.1 Orbiter undocking.	IVA/ Ground	Defer
33	Perform SDTO 13005-U, ISS Structural Life Validation and Extension, during S5 installation.	IVA Ground	Defer

VEHICLE PERFORMANCE

LAUNCH DELAY

The planned launch of STS-118 was delayed one day from the baseline date of August 7th. Repeated weather events, mostly lightning events, impacted vehicle processing in the days leading up to launch, and these conditions led to a decision on August 3rd to delay the launch one day.

SOLID ROCKET BOOSTERS

All Solid Rocket Booster (SRB) systems performed as expected during the launch countdown and ascent. The SRB pre-launch countdown was nominal and no SRB In-Flight Anomalies (IFAs) have been identified. No SRB Launch Commit Criteria (LCC) or Operations and Maintenance Requirements and Specifications Document (OMRSD) waivers or exceptions were written during the countdown. No SRB LCC or OMRSD violations occurred.

This is the first flight of the Command Receiver Decoder (CRD). The CRD replaced the Integrated Receiver/Decoder (IRD) and the Range Safety Distributor (RSD) with the CRD. Review of flight data indicates that the system performed as designed.

The SRB Camera System (SCS) performed exceptionally well with high quality, state-of-the-art video being captured during vehicle ascent and SRB separation. Each SRB was also equipped with a Parachute Observation camera and an ET Observation Camera. These cameras recorded images of the ET Intertank panel from lift-off through SRB separation. The Left SRB camera and VCR did not record any images of parachute deployment because of a malfunction of the video recorder. The Right SRB camera and video recorder recorded deployment of the main parachutes as planned.

Both SRBs were successfully separated from the ET and the deceleration subsystem performed as designed. Recovery ships returned the SRB's to Kennedy Space Center (KSC) for disassembly.

There was no indication of hold-down stud hang-up based on analysis of data from Orbiter accelerometers.

REUSABLE SOLID ROCKET MOTORS

The STS-118 Reusable Solid Rocket Motor (RSRM) flight motor set performed nominally and within established and predicted limits. No RSRM LCC or OMRSD violations were identified. One In-Flight Anomaly (IFA) was identified from the initial observations – Gas Penetrations through Right-Hand (RH) Nozzle Joint 2 Room Temperature Vulcanized (RTV) silicon-based sealant (IFA STS-118-M-001). Non-distinct gas penetrations were observed intermittently around the full circumference through the dog leg of Joint 2 RTV. The condition is well within family and did not

challenge previously established flight rationale. This condition did not impact the flight.

The motor performance parameters for motor set 360W097 were within Contract End Item (CEI) specification limits. Reconstructed performance parameters adjusted to a 60 °F Propellant Mean Bulk Temperature (PMBT) standard are shown in the table below. The Propulsion performance is listed in the table on the following page. The calculated PMBT was 85 °F (highest PMBT in launch history) at time of launch. The maximum trace shape variation of pressure vs. time during the 62-80 sec time frame was calculated to be 1.6-percent at 69.5 sec (left motor) and 0.80-percent at 70.5 sec (right motor). These values were within the 3.2-percent allowable limits.

RSRM PERFORMANCE PARAMETERS AT 60° F PMBT

Parameter	CEI Specification Limits, (60 °F)	Left Motor Delivered	Right Motor Delivered
Web time, sec	105.4 – 116.7	112.1	112.0
Action time, sec	115.2 – 131.2	124.0	124.0
MOP Head-End Pressure, psia	847.9 - 965.7	905.4	901.5
Maximum Sea Level Thrust, psia	2.88 – 3.26	3.03	3.02
Web Time Average Pressure, psia	629.9 -700.5	658.1	657.9
Web Time Average Vacuum Thrust, psia	2.46 -2.74	2.58	2.58
Web time total impulse, Mlbf sec	285.8 – 291.6	288.8	288.5
Action time impulse, Mlbf sec	293.7 – 299.7	296.5	296.0
ISP Average Delivered, lbf sec/lbm	266.5 – 270.3	268.4	268.1
Loaded propellant weight, lbm	>1103750	1105333	1104744

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

The ambient temperatures recorded during the 47 hr prior to launch of STS-118 varied from 79 to 89°F. The data recorded during this time frame was at the 0.0σ to +2.0σ range from historical August average hourly temperatures. At the time of launch, the ambient temperature was 86 °F. The average historical ambient temperature for the time of launch for the month of August is 80 °F.

RSRM PROPULSION PERFORMANCE

Parameter	Left Motor, (85 °F)		Right Motor, (85 °F)	
	Predicted	Actual	Predicted	Actual
Ise gates				
I-20, 10 ⁶ lbf-sec	66.61	65.59	66.40	65.51
I-60, 10 ⁶ lbf-sec	177.79	175.49	177.33	175.54
I-AT, 10 ⁶ lbf-sec	296.98	296.94	296.82	296.47
Vacuum Isp, lbf-sec/lbm	268.7	268.6	268.7	268.4
Burn rate, in./sec @ 60 °F at 625 psia	0.3696	0.3661	0.3691	0.3667
Event times, sec ^a				
Ignition interval	0.232	N/A	0.232	N/A
Web time ^b	107.2	109.2	107.5	109.2
50 psia cue time	117.2	118.7	117.4	118.5
Action time ^b	119.3	120.9	119.6	120.9
Separation command	121.9		121.9	
PMBT, °F	85	85	85	85
Maximum ignition rise rate (psia/10 ms)	90.8	N/A	90.8	N/A
Decay time, sec (59.4 psia to 85 K)	3.1	3.1	3.1	3.2
Tailoff impulse imbalance differential ^c	Predicted N/A		Actual 248.7	

^aAll times are referenced to ignition command time except where noted by footnote b.

^bReferenced to liftoff time (ignition interval).

^cImpulse 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 14 hr 54 min during the launch countdown. Power was applied to the heating elements 30-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 15 hr 3 min during the launch countdown. Power was applied to the heating elements 19-percent (average) of the time during the LCC time frame of the countdown.

The aft skirt purge was activated three times during the countdown for a total of 11 hr 13 min. It was not necessary to thermally condition the aft skirt region prior to launch to achieve the nozzle/case joint seals minimum LCC temperature of 75 °F. Therefore, it was also not necessary to thermally condition the flex bearings to meet the 60 °F mean bulk temperature requirement.

During the LCC time frame, the left-hand and right hand motor nozzle/case joint sensor temperatures ranged from 85 to 90 °F and 85 to 91 °F, respectively. The Flex Bearing Mean Bulk Temperature (FBMBT) was calculated to be 86 °F.

All Ground Environmental Instrumentation (GEI) and Operational Flight Instrumentation (OFI) performed within established requirements.

EXTERNAL TANK

The External Tank (ET) identification was Super Lightweight Tank (SWLT) ET-117. All objectives and requirements associated with 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. No ET LCC or OMRSD violations occurred.

During the countdown, less than typical ice/frost was observed for most of the vehicle ET surface with temperatures ranging from 70 to 88 °F. All ice/frost formations were within NSTS 08303, "Ice/Debris Inspection Criteria." Some TPS defects were noted, but all were typical and acceptable except for one observation. One TPS crack was observed at Xt 1973 on the Liquid Oxygen (LO₂) feedline inboard base closeout. This condition violated LCC ICE-01, and documentation was taken to address the issue. Flight rationale was developed and a waiver was approved for the violation. No other LCC or OMRSD violations were reported.

ET separation was nominal. Since Main Engine Cutoff (MECO) occurred within expected tolerances, entry and breakup were within the predicted footprint at latitude 36.904 degree South and longitude 159.217 degree West.

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 average SSME specific impulse tag value was 451.97 sec at 104.5-percent power level.

No LCC or OMRSD violations were noted during the countdown to launch. Engine "Ready" was achieved at the proper time, all LCC's were met, and thrust build up was nominal. Flight data indicate nominal SSME performance during startup, mainstage, throttling, and shutdown. The High Pressure Oxidizer Turbopump (HPOTP) and High Pressure Oxidizer Fuel Turbopump (HPFTP) temperatures were well within specifications throughout engine operation. The commanded Max Q throttle-down was a one-step throttle to 74-percent (prediction was 72-percent), which indicates Adaptive Guidance Throttling (AGT) was initiated. Propellant dump operations data and the time of MECO were T + 505 sec. No SSME Failure Identifiers (FIDs) occurred during the countdown and launch. Block II Engines 2047, 2051, and 2045 were in positions 1, 2, and 3 respectively.

There were no first flight design changes. However, STS -118 was the first flight with the Advanced Health Monitoring System (AHMS) controller in redline active mode for all engines. The initial review of the AHMS vibration measurements indicates nominal performance. No FIDs were reported from start of preparation through propellant dump on all engines.

SSME had one observation during launch. There was a shift in calculated volumetric fuel flow at approximately 54 sec on SSME 2. This occurred during the throttle bucket while the engine was throttled to 74-percent.

SHUTTLE RANGE SAFETY SYSTEM

The Shuttle Range Safety System (SRSS) closed-loop testing was completed as scheduled during the STS-118 launch countdown. There were no OMRSD or LCC violations.

All SRSS Safe and Arm (S&A) devices were armed and system inhibits 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.

There was documentation taken for one issue during the SRSS Power Up/Closed-Loop test at approximately T-30 min. The Terminal Count Test Sequencer (TCTS) (Ground Support Equipment) experienced a handshake error. The SRSS ground power was subsequently shut down, switched to the backup GSE system B and re-powered. The SRSS Closed-Loop test was performed again and passed satisfactorily. No flight hardware issues were noted.

ORBITER SYSTEMS

Main Propulsion System

The Main Propulsion System (MPS) performed satisfactorily during the STS-118 mission. No in-flight anomalies were identified during the review and analysis of the data. There were no LCC or OMRSD violations.

The LO₂ and Liquid Hydrogen (LH₂) Engine Cutoff (ECO) sensors passed all pre-flight checkouts and the ECO voltage measurements were within expected ranges. However two ECO issues were noted during the countdown and flight. These issues were:

1. The LO₂ ECO sensor voltages increased from 4.4 V to 5.6 V at the beginning of LO₂ fast fill, but the voltage rise stayed within the expected range.
2. The LH₂ ECO Sensor 3 voltage momentarily registered Off-Scale High (OSH), which is 32 V, during ascent at 1 min 1 sec.

The overall Gaseous Hydrogen (GH₂) system in-flight performance was nominal. All three flow control valves performed nominally. The cycle count for Engine 1 was 1 cycle, the count for Engine 2 was 3 cycles and the count for Engine 3 was 9 cycles.

The LH₂ pre-pressurization cycle count was 11 cycles with 14 cycles being the LCC limit. Engine inlet net positive suction pressure requirements were met throughout powered flight.

This was the first flight of the design change to the ECO Point Sensor system measurements. This new instrumentation enabled detection of the output voltage of the LO₂ ECO and LH₂ liquid-level cutoff sensors.

The Gaseous Oxygen (GO₂) fixed-orifice pressurization system performed as predicted. Reconstructed data from engine and MPS parameters closely matched the actual ET ullage pressure measurements.

The LO₂ inlet pressure transducer was biased by approximately 15 psia on the MPS 3 engine. This issue did not impact the operation of the engine or the overall mission. On the previous flight of this engine, the transducer bias was approximately 4 psia. As a result, the transducer was replaced following the STS-118 mission.

Hazardous Gas Concentrations

The maximum hydrogen concentration level in the Orbiter aft compartment, with the normally elevated system backpressure used for fastfill, was 162 ppm (corrected) (System A was used to determine the maximum concentration). This compares favorably with previous data for this Orbiter. Preliminary data indicate that the LO₂ system performed as planned. The aft hazardous gas concentrations during the STS-118 loading are shown in the following table.

HAZARD GAS CONCENTRATIONS

Launch		
Parameter	Peak, ppm	Steady State, ppm
Helium	9117	6000
Hydrogen	125	100
Oxygen	32	22

Gas Sample Analysis

All six redesigned gas sampler system bottles collected samples but two of the bottle pressures were low (right-hand 1 and right-hand 2). The remaining four measured pressures were within the range of acceptable pressures. A summary of bottle pressure and gas concentration for STS-118 is given in the following table.

SUMMARY OF BOTTLE PRESSURES AND GAS CONCENTRATION

Bottle no.	Position	Pressure, psia	Helium, %	Measure Oxygen, %	Hydrogen, %
1	RH1	1.28	0.48	2.30	0.06
2	LH1	1.37	0.43	2.23	0.06
3	RH2	1.23	0.52	2.39	0.05
4	LH2	0.82	0.41	4.90	0.08
5	LH3	0.17	0.43	3.85	0.27
6	RH3	0.06	1.74	1.35	1.19

The estimated firing leak rates for all sample bottle data from this flight are summarized in the following table. The maximum allowable firing leak rate on ascent is 57,000 scim.

HYDROGEN FIRING LEAK RATES

Bottle no.	Position	Hydrogen Firing Leak Rate, scim
1	RH1	1410
2	LH1	1480
3	RH2	1140
4	LH2	1230
5	LH3	1210
6	RH3	1940

The measured sample bottle pressures indicated the redesigned orbiter aft fuselage gas sampler system successfully collected four of the six samples. Two bottles had low pressures. The bottle right-hand 1 was well below the acceptable pressure range and bottle right-hand 2 was slightly low. The results listed in the following table are an average of three runs, with standard deviations.

AFT FUSELAGE SAMPLE BOTTLE GAS ANALYSIS

S/N	Position	Actual Pressure, torr	Ar, %	Air From Ar, %	He, %	CO, %	CH ₄ , %	CO ₂ , %	O ₂ From Air, %	O ₂ , %	H ₂ , %	H ₂ , Pyro Corrected, %
1121 Flt 0	RH1	65.92	0.12	12.63	0.48	0.01	<0.01	0.01	2.65	2.30		0.06
1106 Flt 1	LH1	70.64	0.12	12.31	0.43	0.01	<0.01	0.01	2.59	2.23	0.06	0.06
1130 Flt 0	RH2	63.38	0.11	11.7	0.52	0.01	<0.01	0.01	2.47	2.39	0.05	0.05
1108 Flt 1	LH2	42.32	0.22	23.50	0.39	0.01	<0.01	0.01	4.90	5.10	0.07	0.07
1109 Flt 1	LH3	8.89	0.06	5.90	0.38	<0.01	<0.01	0.01	1.23	4.00	0.21	0.27
1131 Flt 0	RH3	3.04	0.02	1.61	1.74	<0.01	<0.01	0.02	0.34	1.35	1.19	1.18

Purge, Vent and Drain

The Purge Vent and Drain (PV&D) system performed nominally during the STS-118 launch countdown. During the loading, purge flow rates and temperatures were as expected with nominal system performance:

The PV&D system is not active on orbit, but performed nominally during entry and landing. Purge was initiated within the 30-min requirement of receiving the upper aft safety clears, however, the purge initiation was beyond the 45 minutes data trend notice (DTN) from landing, so a DTN was generated.

Reaction Control System

The Reaction Control System (RCS) performed satisfactorily throughout the mission with an in-flight anomaly identified that did not impact the mission. This anomaly is discussed in a later paragraph.

The table on the following page shows the Tyvek release data.

TYVEK COVER RELEASE TIMES AND ALPHA/BETA ANGLES

Thruster Cover	MET, sec	Velocity, mph	Alpha, deg	Beta, deg
F1D	3.7	42.4	-5	9
F3D	4.4	50.5	-2	8
F2D	6.1	74.6	1	6
F4D	6.2	76.5	0	5
F1L	7.4	94.3	0	6
F3F	8.1	105.1	1	5
F3L	8.2	105.8	1	5
F1U	8.2	105.8	1	5
F4R	8.3	107.9	1	5
F1F	8.3	108.4	1	5
F2R	8.5	110.8	1	5
F3U	10.1	136.7	3	3
F2F	10.3	140.1	3	3
F2U	10.3	140.5	3	3
F3D Piece	16.0	~237	70	0

Note: This partially attached piece was identified as anomalous performance and is discussed below.

Ground imagery showed that when Reaction Control System thruster F3D's Tyvek rain cover released at 4.39 sec MET (approximately 56 mph), a small piece remained attached to the thruster lip (image observed at 220/22:36:52 GMT, approx 10 sec MET) (IFA STS-118-V-05). This piece separated at approximately 16 sec MET (approximately 240 mph). Imagery showed that the piece did not impact the Orbiter.

The RCS firings, times initiated, Differential Velocities (ΔV s), and firing times are listed in the table on the following page.

RCS MANEUVERS AND FIRING DATA

Maneuver	Time of Ignition, GMT	ΔV , ft/sec	Length, sec
RCS Window Protect	220/22:38:44	N/A	2.08
ET Separation	220/22:45:29	N/A	6.0
NC-3	222/01:51:37	2.6	11.3
NCC	222/14:17:37	1.89	8.5
Out of Plane Null	222/15:48:38	N/A	0.80
MC2	222/16:11:18	1.39	6.0
MC3	222/16:28:16	1.53	6.6
MC4	222/16:38:17	0.73	3.2
ISS Docking	222/18:22:00		
ISS Undocking	231/11:56:36		
Separation 1	231/12:19:42		5.7
Separation 2	231/12:47:42		6.0
RCS Hotfire	232/11:20:59		
FRCS Dump	233/15:00:13		57.6

The RCS preflight propellant load was 4250 lb of oxidizer and 2673 lb of fuel, for a total of 6923 lb of propellant loaded for the mission. The residual propellants, as calculated by the Primary Avionics Software System (PASS), were 2506 lb. The propellant used was 4818 lb, which included 401 lb used from the OMS during RCS interconnect operations.

The RCS propellant loading for the left and right pod was 100 percent and the loading for the forward RCS was 72.34-percent and 71.81-percent for the oxidizer and fuel, respectively. The propellant residuals after landing are shown in the following table.

RCS RESIDUAL PROPELLANTS

Loading	KSC reported amount		PASS model amount	
	%	lbs	%	lbs
Forward oxidizer	1.8	24	0.1	1.4
Forward Fuel	0.0	0	0.3	2.6
Left Pod Oxidizer	58.2	786	57.7	779.0
Left Pod Fuel	58.4	496	58.7	499.0
Right Pod Oxidizer	55.6	751	55.1	743.9
Right Pod Fuel	56.4	479	56.5	480.3

Attitude control responsibilities between the ISS and Shuttle are summarized in the following table.

CONTROL RESPONSIBILITIES BETWEEN ISS AND SHUTTLE

Control Responsibility	Start, GMT	End, GMT	Comments
ISS Capture	222/18:01:53	222/18:27:48	DAP FREE DRIFT
Docked	222/18:27:48	222/18:32:56	DAP Local Vertical Local Horizontal
Station	222/18:32:56	222/18:33:01	DAP FREE DRIFT
Orbiter	222/18:33:01	222/18:43:20	DAP AUTO - Maneuver to torque equilibrium attitude
Station	222/18:43:20	222/18:43:24	DAP FREE DRIFT
Orbiter	222/18:43:24	222/18:50:21	DAP AUTO
Station	222/18:50:21	222/18:50:25	DAP FREE DRIFT
Orbiter	222/18:50:25	222/18:59:52	DAP AUTO
Station	222/18:59:52	222/18:59:55	DAP FREE DRIFT
Orbiter	222/18:59:55	222/19:07:42	DAP AUTO
Station	222/19:07:42	226/17:46:12	DAP FREE DRIFT - Completion of TEA Maneuver
Orbiter	226/17:46:12	226/17:58:11	DAP AUTO A12/VERN
Orbiter	226/17:58:11	226/19:58:39	DAP A15/AUTO/Vernier - Simultaneous Dump
Station	226/19:58:39	226/19:59:12	DAP FREE DRIFT
Orbiter	226/19:59:12	226/21:50:22	DAP AUTO
Station	226/21:50:22	230/18:47:28	DAP FREE DRIFT
Orbiter	230/18:47:28	230/18:54:04	DAP AUTO
Station	230/18:54:04	230/18:54:53	DAP FREE DRIFT
Orbiter	230/18:54:53	230/19:46:14	DAP AUTO – Water Dump
Station	230/19:46:14	230/19:47:22	DAP FREE DRIFT
Orbiter	230/19:47:22	230/19:53:20	DAP AUTO
Station	230/19:53:20	230/19:54:02	DAP FREE DRIFT
Orbiter	230/19:54:02	230/22:09:49	DAP AUTO
Station	230/22:09:49	231/10:39:01	DAP FREE DRIFT
Orbiter	231/10:39:01	231/11:28:50	DAP AUTO
Station	231/11:28:50	231/11:30:40	DAP FREE DRIFT
Orbiter	231/11:30:40	231/11:53:40	DAP AUTO
Station	231/11:53:40	231/11:54:08	DAP FREE DRIFT (ISS Physical Separation – Disengaging of Latches)
Station	231/11:54:08	231/11:56:37	STILL IN FREE DRIFT
Orbiter	231/11:56:37	231/12:19:42	DAP AUTO – Undocking (+Z)
Orbiter			Fly around – cancelled
Orbiter	231/12:19:42	231/12:47:42	ISS Sep1 (+X)
Orbiter	231/12:47:42		ISS Sep2 (-X)

RCS pressurization and propellant isolation valves were configured for entry at 233/14:51:05 GMT. Heaters were configured for entry at 233/15:06:10 GMT. The forward RCS Dump (4 thrusters) was initiated at 233/15:00:13.8 GMT and lasted 57.6 sec. The dump consumed 32.2-percent Pressure-Volume-Temperature (PVT) (709.6 lb) of the forward RCS propellant.

The primary thrusters were fired 2824 times, for a total firing time of 904.56 sec. The vernier thrusters were fired 8632 times, with a firing time of 12291.16 sec.

Orbital Maneuvering System

The overall performance was satisfactory with no OMRSD or LCC deviations or violations. Pressure/temperature data during coast periods indicated no detectable leakage. One minor problem was identified during the mission; it is discussed in a later paragraph in this section and had no impact on the mission.

OMS CONFIGURATION

Vehicle/equipment	Flight	Orbital Maneuvering Engine (OME)	Ancillary data
Left Pod (LP) 03	31 st	L-OME S/N 107	1 st rebuilt flight, 17 th flight
Right Pod (RP) 04	27 th	R-OME S/N 113	1 st rebuilt flight, 4 th flight

The OMS firings and interconnect options are given in the following tables.

OMS MANEUVERS

Maneuver designation	Configuration	Time of ignition, GMT	Firing time, sec	ΔV , ft/sec interconnect usage, percent
Assist	Dual Engine	220/22:38:58.4	91.2	N/A
OMS-2	Dual Engine	220/23:13:42.8	165.0	253.0
OMS-3 (NC-1)	Dual Engine	221/01:36:14.8	52.0	79.8
OMS-4 (NC-2)	Dual Engine	221/14:36:18.2	15.4	23.9
OMS-5 (NC-4)	Right Engine	222/13:45:44.1	15.0	11.4
OMS-6 (TI)	Left Engine	222/15:15:19.2	8.8	6.9
Deorbit	Dual Engine	233/15:25:12.0	215.8	370.0

PROPELLANT USAGE DATA

Parameters	Left OMS Pod		Right OMS Pod	
	Oxidizer	Fuel	Oxidizer	Fuel
Loaded, lbm	7707	4674	7704	4661
Residual, lbm (aft gage)	895	688	967	562
Residual, lbm (burn time integration)	944*	537*	987	536
Residual, lbm (SODB flow rate)	927	559	945	575

*Due to a data dropout during the OMS-6 firing, the Left Pod Burntime Integration estimates the 8.8 sec OMS-6 propellant usage using SODB flowrates for OME S/N 107.

A small but notable decay of approximately 36 standard cubic centimeters per hour (scch) was observed in the Gaseous Nitrogen (GN₂) supply tank of the left Orbiter Maneuvering Engine (OME). The decay did not impact the mission nor did it affect nominal OME usage. Sufficient GN₂ remained in the supply tank to support several left OME firings, but only the de-orbit maneuver remained.

Interconnect usage of the OMS propellants is shown in the following table.

RCS PROPELLANT INTERCONNECT USAGE

Parameter	Interconnect usage, percent	Interconnect usage, lb
Left Interconnect	2.293	296.96
Right Interconnect	0.803	103.99

Auxiliary Power Unit System

The Auxiliary Power Unit (APU) system performance was nominal throughout the STS-118 mission. One In-flight Anomaly was identified from the STS-118 data and the anomaly is discussed in a following paragraph. The run times and fuel consumption for the APUs during are summarized in the following tables.

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)	00:18:44	00:03:16	01:00:36	01:22:36
2 (311)	00:19:01	00:00:00	01:28:11	01:47:12
3 (306)	00:19:16	00:00:00	01:00:59	01:20:15

APU FUEL CONSUMPTION

APU (S/N)	Ascent, lb	FCS Checkout, lb	Entry, lb	Total, lb
1 (304)	47	12	125	184
2 (311)	50	0	179	229
3 (306)	49	0	119	168

At approximately 221/20:36 GMT (0/22:00 MET), the APU 3 (S/N 306) seal cavity drain line pressures began to slowly decay (IFA STS-118-V-04). The initial pressure decay rate was approximately 1 psi/day adjusted for temperature, and was seen on two separate pressure transducers. There was no mission impact as a result of the pressure decay. The decay rate was below the threshold for liquid leakage. 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 post shutdown. The drain system

decay is believed to be an external leak of GN₂ into the aft fuselage. Mass spectrometer survey was run post flight, the leak was found to be at the TP37 valve on the back side of the stem, no leaks noted at APU 3. The valve was replaced.

Hydraulics/Water Spray Boiler System

The Hydraulic (HYD) and Water Spray Boiler (WSB) system performance was nominal throughout the STS-118 mission. No HYD/WSB related in-flight anomalies were identified from the mission data. All File IX Requirements were met during STS-118.

The STS-118 mission was the third flight (1st flight on OV-105) to use the water additive Propylene Glycol Monomethyl Ether (PGME) in all three WSB water tanks to preclude post-ascent freezing in the boiler Heat Exchanger (Core).

The Engine 2 Pitch Thrust Vector Controller (TVC) actuator switching valve measurement did not indicate switching from the primary (HYD system 2) to the standby (HYD System 1) when APU 1 was activated in preparation for launch. This was caused by the one sample per second data sample rate for the switching valve indicator. Since APUs 1 and 2 were started within one sec of each other, the data did not indicate switching from the Primary (HYD System 2) to the Standby (HYD System 1) when APU 1 was powered up in preparation for launch, and this phenomenon has been observed on previous flights. Review of the secondary Differential Pressure (ΔP) for the Engine 2 Pitch actuator indicates that the switching valve did actually switch.

During Entry operations, WSB 3 exhibited a temperature overshoot of the APU 3 lubrication oil outlet temperature to 205 °F approximately 22 min after WSB spray start, indicating water pooling in the WSB core. The cooling rapidly recovered, and the total elapsed time from onset of the cooling overshoot to temperature recovery was approximately 5 min.

Water & PGME/H₂O usage during Ascent for spray cooling was as follows (specification. is no-greater-than 8 lb/sys):

System 1 = 3.7 lbs PGME/Water

System 2 = 3.8 lbs PGME/Water

System 3 = 3.4 lbs PGME/Water

HYD/WSB performance during entry was nominal. The WSB Vent Heater performance on all three systems was also nominal. The brake line heaters likewise functioned nominally. Water Spray Boiler usage during entry for spray cooling was as follows (specification is no-greater-than 45 lb/sys):

System 1 = 18.9 lbs (PGME/H₂O)

System 2 = 34.4 lbs (PGME/H₂O)

System 3 = 24.8 lbs (PGME/H₂O)

Power Reactant Storage and Distribution System

The Power Reactant Storage and Distribution System (PRSD) system performance was nominal during the STS-118 mission. One in-flight anomaly was identified and it is discussed in a later paragraph.

The PRSD supplied the fuel cells with 2088 lb_m of oxygen and 263 lb_m of hydrogen for the production of electrical energy. At the mission extension day power level of 13.45 kW, a 131-hour mission extension was available. The main reason for the large cryogenics consumable margin was the Station-to-Shuttle Power Transfer System (SSPTS) supplied 1182 kWh of power to the Orbiter. The total oxygen supplied to Shuttle and ISS Environmental Control Life Support System (ECLSS) was 266 lb_m from PRSD. Shuttle ECLSS used 189 lb_m and 77 lb_m was transferred to ISS.

The Orbiter landed with 1567 lb_m of oxygen and 193.8 lb_m of hydrogen remaining in the PRSD system. A 170-hour mission extension capability existed at landing, based upon the PRSD O₂ landing quantities and an average flight power of only 10.0 kW. This larger amount of oxygen (the limiting reactant) resulted from the SSPTS supplying 1182 kWh to the Orbiter.

The loading of the five PRSD tank sets was performed on August 6, 2007. The prelaunch reactant boiloff rate averaged 0.063 lb_m/hr-tank for hydrogen and 0.18 lb_m/hr-tank for oxygen. The tank quantities at the end of loading, launch, and landing are listed in the following table.

PRSD OXYGEN AND HYDROGEN TANK QUANTITIES

Oxygen	Tank 1, %	Tank 2, %	Tank 3, %	Tank 4, %	Tank 5, %	Total Mass, lb
Loaded	101.4	101.8	101.4	101.8	100.9	3962
Launch	100.1	100.5	100.5	100.9	100.1	3921
Landing	61.1	28.2	71.2	6.3	33.9	1567
Hydrogen	Tank 1, %	Tank 2, %	Tank 3, %	Tank 4, %	Tank 5, %	Total Mass, lb
Loaded	102.3	102.3	101.5	102.8	102.3	470.3
Launch	98.8	99.3	99.3	99.7	99.3	4567
Landing	59.5	62.1	74.9	11.7	2.4	193.8

At 221/08:08 GMT (00/09:32 MET), the oxygen tank 2 heater control pressure indication went from a reading of 833 psia to Off-Scale-Low (OSL) (IFA STS 118-V-01). As a result, oxygen tank 2 heaters could not be operated in "Auto" or "Paired" mode. It was operated in manual mode for the remainder of the flight. Other than requiring use of the manual mode, the anomaly did not impact the flight. Post-flight troubleshooting isolated the problem to Cryogenics Control Box 2, which was removed and replaced.

Fuel Cell System

Fuel Cells

The overall performance of the Fuel Cell system was nominal for STS-118. The fuel cell orbiter electrical power level averaged 10.0 kW and the total orbiter load averaged 324 amps. STS-118 was the first flight of SSTPS, which supplied 1182 kWh to the Shuttle while docked to ISS. The SSTPS converts power from the 120 Vdc ISS electrical system to supplement fuel cell power to the Orbiter 28 Vdc buses. No in-flight anomalies were identified from the review and analysis of the data.

Fuel Cell startup was initiated on August 8, 2007 at 220/07:03:16 GMT and was completed at 220/09:01:35 GMT. Startup and prelaunch operations were nominal. Fuel cell operating times, which are the times accumulated on the fuel cells prelaunch, on-orbit, and postlanding, were 335:12:41 (hr:min:sec) for fuel cell 1, 335:05:32 for fuel cell 2, and 334:07:06 for fuel cell 3. The end-of-mission accumulated operating times for these fuel cells are 1711 hr, 335 hr and 781 hr, respectively.

When combined, the Orbiter average electrical power level was 13.87 kW for the mission duration. During the 305.94-hour mission, the fuel cells produced 3061 kWh of electrical energy and 2351 lb_m of potable water. The fuel cells consumed 2088 lb_m of oxygen and 263 lb_m of hydrogen. Five fuel cell purges were performed, occurring at approximately 17, 87, 181, 251, and 299 hr MET.

The actual fuel cell voltages (200-A load) at the end of the mission were 0.10 V below predicted for fuel cell 1, 0.10 V below predicted for fuel cell 2, and 0.15 V below predicted for fuel cell 3. The voltage margins above the minimum performance curves at 200 A at the end of the mission were 0.90 V above minimum for fuel cell 1, 1.10 V above minimum for fuel cell 2, and 0.90 V above minimum for fuel cell 3.

The overall thermal performance of the fuel cell water relief, water line, and reactant purge heater systems was nominal. System A on the Water Relief and Water Line Systems was used during pre-launch, ascent, and up to 231/13:14 GMT (10/14:37 MET), at which time the system was reconfigured to the B system until the end of mission.

During SSPTS operation at low power levels (12 to 13 kW total Orbiter power), the fuel cell coolant stack-exit temperatures were about 186-187 °F. One fuel cell 3 sustaining heater cycle was observed at 224/07:40:48 GMT (03/09:04:06 MET) as a result of the stack exit temperature reaching the 183.5 °F turn-on point. Also, the fuel cell product water line temperatures typically ran from 5-10 °F cooler during SSPTS operation because of the reduced product water production rate at the lower fuel cell loads. Additionally, the fuel cell Hydrogen/Water (H₂/H₂O) pump motor status increased 2 to 3 bits between purges where typically it is 1 bit. This is an indication that slightly more water is accumulating in the pump housing and increasing the load on the motor, but that condition was not an issue.

The Fuel Cell Monitoring System (FCMS) was used to monitor individual cell voltages prelaunch, on-orbit, and postlanding and provided satisfactory data. Full-rate on-orbit data was recorded for 12 min and 44 sec beginning at approximately 5 hr after launch; and there were no issues. The prelaunch baseline Cell Performance Monitor (CPM) values for fuel cell 1 were 6, 4, and 42 mV, for fuel cell 2 were 4, 2, and 12 mV, and for fuel cell 3 were 2, 6, and 12 mV.

Station to Shuttle Power Transfer System (SSPTS) Operation

The SSPTS transferred and converted power from the 120-Vdc ISS electrical system to the Orbiter 28-Vdc power buses. The system was activated when docked to the ISS, which can transfer up to approximately 6.4 kW of power to the Orbiter. The SSPTS was deactivated during EVA's as a safety precaution. The SSPTS supplied 1182 kWh of power to the Orbiter. The configuration of the Orbiter for acceptance of the power from the ISS was that power was supplied to fuel cell 1, main bus A, and fuel cell 2, main bus B, which are connected to SSPTS Power Transfer Units (PTUs) 1 and 2, respectively. SSPTS power was transferred to fuel cell 3, main bus C through a main bus A-to-C bus-tie.

When set at maximum output, SSPTS attempts to regulate Orbiter bus voltage at 31.8 Vdc up to its maximum output of about 6.4 kW. The fuel cells assume the remainder of the Orbiter electrical load. Based on observations during STS-118, SSPTS utilization can be maximized with lower performing fuel cells. This requires less power from the fuel cells and in turn uses less cryogenics which in turn increases the cryogenics consumable margins. The Flight Control Team requested, through a chit, an evaluation that went beyond the 0.2 Vdc decay before purging the fuel cells to maximize SSPTS and consume less cryogenics. After an evaluation of the past mission data as well as discussions with the vendor, a recommendation was made to allow an 0.3-V decay before purging.

Electrical Power Distribution and Control System

The Electrical Power Distribution and Control System (EPDC) performed nominally during all mission phases of the STS-118 mission. All File IX requirements were met. One In-flight Anomaly, which post-flight troubleshooting determined to be attributable to the EPDC system is discussed later in this section. The data review and analysis of all available EPDC measurements identified no abnormal conditions.

STS-118 was the first flight of the SSPTS. All SSPTS measurements were monitored daily. The SSPTS transferred 1182 kWh of energy during docked operations based on data sampled every 10 sec.

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 Pyrotechnic Controller Functions

In addition, during a SSPTS operational portion of the flight, the following additional parameters were monitored and analyzed:

1. Assembly Power Converter Unit (APCU) voltages and currents
2. Orbital power convert 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
6. OPCU trips

At 221/08:18 GMT (00/09:42 MET, the cryogenic Oxygen (O₂) tank 2 control pressure indication went from a nominal reading of 833 psi to an Off-Scale-Low (OSL) reading (IFA STS-118-V-01). Initial ground troubleshooting indicated no signal from the Cryogenic Controller Box 2. The mission impact was a loss of automatic heater control for O₂ tank 2; resulting in manual control. Post-flight troubleshooting has isolated the problem internal to the O₂ Tank 2 Cryogenic controller and the controller was replaced.

Orbiter Docking System

This Orbiter Docking System (ODS) performed satisfactorily during all phases of flight. The active ODS parameters were monitored throughout the flight, thus indicating nominal operation throughout the duration of the flight. Heater checkouts were successfully performed.

The ODS was activated at 221/23:26:06 GMT (01/00:49:25 MET). Power-on time for the avionics was 9 min, 17 sec. Ring extension to the initial position was nominal, beginning at 221/23:29:55 GMT (01/00:53:14 MET) and ending 3 min, 40 sec (dual motor time) later. The ODS ring extension activity was nominal. The ODS was declared ready for docking operations.

The ODS was activated at 222/17:26:02 GMT (01/18:49:21 MET) and was deactivated after the avionics had operated for 57 min 18 sec. The Orbiter captured the ISS at 222/18:01:55 GMT (01/19:25:14 MET). The system was allowed to dampen out for approximately 14 min, 27 sec. Ring retraction was started at 222/18:16:22 GMT (01/19:39:41 MET). Ring retraction, using dual motors, proceeded nominally for 3 min, 16 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 222/18:23:54 GMT (01/19:47:13 MET), at which time docking operations were complete.

The ODS Heaters/DCU were powered on at approximately GMT 230/11:30:00 (9/12:53:19 MET). to support Shuttle and ISS Thermal Control System team's monitoring of temperatures in the pressurized mating adaptor (PMA) during a temperature characterization test.

The ODS was activated for undocking at 231/11:25:57 GMT (10/12:49:15 MET) and the ODS system operated for 48 min 59 sec for complete the undocking sequence. The Orbiter was undocked from the ISS at 231/11:56:33 (10/13:19:52MET).

Atmospheric Revitalization and Active Thermal Control System

The Atmospheric Revitalization System (ARS) and Active Thermal Control System (ATCS) performed nominally throughout the mission, and all of the File IX requirements were satisfied. The radiators were not deployed this flight.

The Orbiter cabin Partial Pressure Carbon Dioxide (ppCO₂) was maintained through the use of dual Lithium Hydroxide (LiOH) canister change during both pre- and post-sleep phases during undocked operations. During the docked phase of the mission, the canister change frequency decreased to a single canister change during the pre-sleep activity. Cabin temperature and humidity were 78 °F average and below 35 percent, respectively, throughout the flight duration.

The Carbon Dioxide Monitor (CDM) DTO 853 was flown on this mission. Previous mission crews had reported experiencing stuffiness and headache symptoms possibly resulting from high levels of carbon dioxide (CO₂). The purpose of the DTO was to use the CDM to evaluate for CO₂ pockets on the Orbiter middeck.

A total of 61 Lithium Hydroxide (LiOH) canisters were taken on the mission. 9 ISS canisters that were nearing their certification life expiration were transferred to the Orbiter from the ISS stockpile and used during the docked portion of the mission. 9 Orbiter canisters were transferred to the ISS to replace those transferred to the Orbiter.

There was one in-flight anomaly identified during the post-flight crew debriefings. The crew reported notable LiOH dust associated with use the of older Shuttle-ISS stockpile canisters, specifically two STS-114 canisters (IFA STS-118-V-11). The problem may be associated with length of time the canisters are stowed in the ISS and/or the ISS storage location. The canisters may be experiencing some level of vibration, which may contribute to increased dust. Workarounds may include manifesting additional masks, manifesting a different mask and implementing a more frequent ISS stockpile-rotation schedule.

Pre-evaporative cooling was observed with a FES outlet temperature decrease from 86 °F to 68 °F. The FES performed nominally through post-insertion. FES duct temperatures were nominal and within family throughout the flight. The post-flight

evaluation of the Supply FES Accumulator Water Feedline Temperature heater-sensor measurement A showed that the heater was cycling nominally; however, the temperature peaked more than 50 percent of the time above the File IX limit of 110 °F. This is attributed to environmental effects and the sensor position in relation to a heater wrap which is causing a slightly biased elevated temperature reading.

After landing, the Ammonia Boiler System (ABS) B secondary controller was activated for pre-Government Furnished Equipment (GSE) Freon loop cooling. When the B ammonia tank depleted, the scheduled ABS A secondary was activated and remained on until ground cooling was initiated. Both systems showed nominal operation.

The post-flight inspection showed a MMOD strike on radiator port panel 4, and the strike resulted in an inner facesheet hole that was 0.2-in in diameter. The integrity of Freon loop 1 and the radiator thermal performance was not affected.

Atmospheric Revitalization Pressure Control and Airlock Systems

The Atmospheric Revitalization Pressure Control System (ARPCS) performed without issues during all phases of the STS-118 mission. All pre-launch and in-flight checkout requirements were performed nominally. Shuttle oxygen was provided to the ISS upon docking to raise the overall ISS/Shuttle stack pressure to 14.42 psi. Before hatch closure prior to undocking, the ISS pressure was raised to 14.66 psia. The Orbiter supplied 33 lbm of nitrogen to the ISS in a tank-to-tank transfer. A total of 77 lbm of oxygen was transferred to the ISS oxygen tanks.

The Orbiter airlock was not utilized as all of the EVAs were performed through the ISS airlock as planned. The ODS hatch valves were used during the docked operations. After docking, the vestibule/PMA₂ pressurization and leak check was performed successfully without issue.

Supply and Waste Water Management System

The Supply Water and Waste Management System (SWWMS) 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 Flash Evaporator System (FES), water transfer to the ISS and the overboard nozzle-dump system. Three supply-water nozzle dumps were performed at a nominal dump rate of 1.55 percent (2.55 lb) per minute. The line heater maintained the supply water dump line temperature between 75.5 °F and 94.8 °F throughout the mission.

Four wastewater (from waste tank) nozzle dumps at an average rate of 1.97 percent per minute (3.25 lb/min) were performed. As a result of condensate separation/collection, two Contingency Water Containers (CWC's) of Shuttle condensate water were filled and dumped overboard through the wastewater dump nozzle. The wastewater dump line temperature was maintained between 55 °F and 78 °F throughout the mission.

The vacuum vent line temperature was maintained between 58 °F and 79 °F.

Eight CWC's were filled with supply water and transferred to the ISS, for a total of 778.9 lbm. In addition, seven Portable Water Reservoirs (PWR's) of iodinated water were filled and transferred to ISS for a total 139.7 lbm

At: 229/20:40:43 GMT (08/22:04:02 MET) and 229/22:05:42 GMT (08/23:29:01 MET), the supply water tank B quantity sensor showed quantity dropouts at a tank quantity of 43 percent and 32 percent, respectively. The tank dropped to 30 percent and 3 percent, respectively for 1 sec and recovered. The Tank B dropouts have been observed during previous flights of this vehicle. This problem did not affect the mission.

Smoke Detection and Fire Suppression System

The Smoke Detection and Fire Suppression (SDFS) system performed nominally throughout the mission. The Smoke Detection test was performed on FD 1 Smoke detector check accomplished. All Smoke detection sensors in the A and B circuits passed after the retest on the Smoke Detection circuits. Use of the Fire Suppression system was not required.

Flight Software

The flight software performed nominally throughout the STS-118 mission with the exception of a number of errors, most of which are explained. None of these errors impacted the successful completion of the mission.

Two General Purpose Computer (GPC) errors occurred during the R-Bar Pitch Maneuver (RPM) and these errors were explained by a Primary Avionics Software System (PASS) User Note. The errors that occurred were caused by trying to use a non-normalized quaternion. This happens when the Inertial Measurement Unit (IMU) gimbal angles are small. Additionally, one or more PASS GPC errors normally occur at wheel stop during most missions. This is an explained condition resulting from vehicle 'Rock-Back' braking after rollout, and is documented in a PASS User Note. A total of eight PASS GPC errors occurred post landing during STS-118.

Random single-memory hits are expected to occur at a rate of several per day or in single bursts of several errors. The GPC Error Detection and Correction Code (EDAC) and periodic memory scrubbing successfully detected and corrected all soft errors.

Data Processing System Hardware

The review and analysis of Data Processing System (DPS) parameters have been completed and no abnormal conditions were identified. DPS did work two issues of note:

A Backup Flight System (BFS) fault message occurred during pre-launch operations when the BFS did not annunciate the anticipated Class 3 SM Alert payload alarm.

This occurred when the BFS was moded from Standby to Run indicating that the Emergency Bus Voltage values received from the Pulse Code Modulation Master Unit (PCMMU) was within the fault detection limits. Lack of this fault message annunciation is not an LCC condition and the countdown continued nominally. Further investigation determined the Spacehab module had been powered up during the countdown and the valid measurement for the bus voltage was retained in the Payload Data Interleaver (PDI). The stale value was then used for fault processing by the BFS.

The PASS Flight Software (FSW) assessed a transient PDRS ABE fault summary message that was received during the direct drive of the Shoulder Yaw (SY) joint during the Remote Manipulator System (RMS) checkout. The joint did drive properly with no accompanying light on the A8 panel. Utilizing the data available, analysis of the PASS FSW showed that the PASS RMS software operated in accordance with the established requirements and annunciated the fault message in response to a temporary SY Built In Test Equipment (BITE) condition while the SY joint was being commanded in direct drive Mode.

Multifunction Electronics Display System

The Multifunction Electronics Display System (MEDS) performed satisfactorily throughout the STS-118 mission. No issues or in-Flight anomalies were identified from the data or the crew debriefings. The Integrated Display Processor (IDP) 2 annunciated a single IDP 2 “BITE FAIL” / “OST SCSI/MSU Fail” message approximately 20 min after launch. The IDP performed nominally; Mass Storage Unit (MSU) errors do not affect IDP performance. The PLT2 Multifunction Display Unit had been deactivated 53 sec earlier and caused an attempt to write to the IDP’s MSU. The write attempt failure caused the subsequent IDP BITE FAIL message.

Displays and Controls System

The Displays and Control (D&C) system functioned nominally during all phases of the STS-118 mission. One in-flight anomaly occurred during the mission and it is discussed in the following paragraph.

The crew reported that during the lamp test, the lights on the left side of the Caution and Warning (C&W) Annunciator located on the F7 panel would not illuminate when taking the panel Annunciator Lamp Test switch to the Left position (IFA STS-118-V-02). The signature was clarified on FD 2 after a second lamp test confirmed that the panel switch would not illuminate the 20 lights on the left side of the F7 panel when taken to the Left position. The 20 lights on the right-hand side of the F7 panel illuminated when this switch was taken to the Right position. Both halves of the F7 panel lights illuminated when the crew used the panel O6 Annunciator Lamp Test switch. This anomaly did not impact the mission. The Panel O8 switch is criticality of 3/3 as this switch is for testing the lights only. The panel O6 lamp test switches, which provide the same function as panel O8 switches, are working nominally. The crew used the O6 Annunciator Lamp Test switch when required.

Flight Control System

The Flight Controls System (FCS) performed nominally during all phases of the STS-118 mission. The FCS hardware/effector systems performed nominally during ascent through APU shutdown. At all times, the SRB TVC, MPS TVC, and the 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 were identified. The outputs of the four accelerometer assemblies (AAs) also tracked one another normally. Reaction jet driver (RJD) operation was also normal with no thruster failures or other anomalies noted. Display Driver Unit (DDU) and controller operations were nominal as well. Both the Rotational Hand Controller (RHC) and the Transitional Hand Controller (THC) were used and exhibited normal channel tracking.

The FCS 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-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 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 the threshold and TVC actuator positions and GPC commands following each other closely.

Air Data Transducer Assembly

The Air Data Transducer Assemblies (ADTA's) performed nominally during all operational phases. One In-Flight Anomaly was identified during the deorbit preparations and the anomaly is discussed in a later paragraph.

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 activation were nominal.

There was no insight into ADTA performance during the ascent phase until after the elevons were parked during the post-insertion period. Power-on for elevon park occurred at 221/02:36:32 GMT (00/03:59:50 MET). All ADTA 1, 3, and 4

mode/status words were nominal. However, the ADTA 2 mode status word was indicating a discrete-inputs fault. This is an explained condition that arises from an ADTA power-on transient latching the MDM input discrete signal voltages. The ADTA will continue to operate nominally with this BITE condition and the BITE can be cleared. This phenomenon did not impact the operations of the system during the flight.

During FCS checkout, the activation of ADTA 1, 2, and 4 was nominal. However, ADTA 3 was communication-faulted after power up and the unit required a power cycle and I/O Reset to return to normal operational status (IFA STS-118-V-10). All 16 transducer outputs showed nominal responses.

Air data probes were deployed at approximately Mach 4.7, 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 Redundancy Management (RM) failures occurred during deployment through wheels-stop.

Inertial Measurement Unit and Star Tracker System

The Inertial Measurement Unit (IMU) system performed satisfactorily throughout the STS-118 mission. No in-flight anomalies or problems were identified during the analysis of the data. The IMU's required only one adjustment of the onboard IMU accelerometer compensations during the mission. Also, three adjustments were performed for the IMU drift compensation values.

The Star Tracker (ST) performed nominally during the STS-118 mission in acquiring navigation-stars. The -Y ST acquired navigation-stars 1352 times, but also missed a navigation-star 1536 times (53.1 percent) during the mission. This condition did not impact the mission.

The -Z ST acquired a star 73 times and missed a star 32 times (30.4 percent). Data showed that these stars were missed during docking and undocking activities. This condition also did not impact the mission.

Global Positioning System Navigation

The Global Positioning System (GPS) operation during the STS-118 mission was nominal. This flight of OV-105 was the first Shuttle flight using 3-string GPS, and without a Tactical Air Navigation (TACAN) system.

All three GPS strings were activated prior to launch. The power-up sequence was modified slightly in that the Miniature Air-to-Ground Receiver's (MAGR's) were powered on prior to the GPS Input/Output (I/O) being activated. This sequence eliminated any potential time-out errors which could have been generated by the GPC's polling un-powered MAGR receivers. The GPS receivers all remained operational until 12 min 48 sec after landing.

After undocking from the ISS, the GPS string 1 upper preamplifier and the GPS string 3 lower preamplifier were powered down for approximately 21 hr to gather data on the antenna performance of GPS strings 1 and 3. Analysis of the data has shown very similar antenna performance when compared with the predictions.

During entry, the GPS high Figure of Merit (FOM) period that is usually encountered in the Plasma region cleared well before the GPS incorporation into Primary Avionic Software System (PASS) Navigation (NAV). No issues arose during the critical phase of entry (below 140,000 feet altitude) where the GPS satellite geometry is less dynamic.

In accordance with pre-flight planning, the GPS state vector was incorporated into the PASS only after performance confirmation with high-speed C-band tracking. This occurred at approximately 22 min after Entry Interface, at approximately 140,000 ft altitude. The effect was that the PASS navigation state vector and as expected, residuals were reduced significantly. The PASS navigation state vector residuals remained consistently low from GPS incorporation through MLS incorporation. The GPS state vector was intentionally not taken directly to the Backup Flight System (BFS) to keep the two systems independent; however, the PASS navigation state vector was transferred to the BFS at approximately 62,000 ft altitude.

Communications and Tracking System and Navigation Aids

The Communications and Tracking systems performed nominally throughout the STS-118 mission, and no problems or IFA's were identified from the data.

The Navigation Aids (NAVAIDS) performed nominally throughout the mission and all File IX requirements were satisfied. In addition, S-Band system 1 was in operation for 23 hr 25 min, which also satisfied the File IX requirement.

Operational Instrumentation/Modular Auxiliary Data System

The Operational Instrumentation/Modular Auxiliary Data System (OI/MADS) system performed satisfactorily with the exception of two MADS measurements, which are discussed in following paragraphs. In addition, the Fuel Cell Measurement System (FCMS) performed nominally.

At approximately 220/22:37:50 GMT (00/00:01:09 MET), the MADS data for the left OMS pod forward surface temperature began several steps (up-down-up) and then drifted to OSH (Off Scale High) (IFA STS-118-V-06). The measurement is of the lowest criticality and its loss did not impact the successful completion of the planned mission. In addition, the backup measurements remained stable throughout the mission.

At approximately 220/22:38:30 GMT (00/00:01:49 MET), the MADS data for the left OMS pod temperature stepped to OSH (IFA STS-118-V-07). The measurement is of the lowest criticality and its loss did not impact the successful completion of the

planned mission. In addition, the backup measurements remained stable throughout the mission.

Mechanical and Hatches System

The Payload Bay Doors Drive and Latch Systems, Ku-Band Deployment System, Radiator Drive and Latch System, Remote Manipulator System (RMS) Manipulator Positioning Mechanisms (MPM) and Orbiter Boom Sensor System (OBSS) MPMs performance during the flight was nominal. Two in-flight anomalies were identified and are discussed in the following paragraphs.

During final hatch closure for flight, one of two latch over-center limit switches indicated infinite resistance and the indication should have been less than 2.0 ohms (IFA STS-118-V-13). Execution of the preplanned troubleshooting procedure verified proper latch rigging, however, the failed limit switch could not be recovered with the hatch closed. The launch proceeded with one of two switches operational.

KSC completed the side-hatch mechanism rigging checks on OV-105, and it appears that the rigging on both limit switches did not meet the specification requirements. The latch 1 switch was set to a gap that was too small, which explains why the switch would not transfer on launch day. The latch 18 switch was set to a gap that was too large, such that it is almost guaranteed to transfer even if some of the latches were not over-center.

At least three previous occurrences of this type of failure have occurred on launch day. In each case, launch proceeded with one of two limit switch indications. The limit switches are used only during pre-launch hatch closure. There was, therefore, no concern for the rest of the mission.

During ET door closure, all four door-closed indications failed to indicate the doors were closed. All "ready-to-latch" indications were obtained, and the uplock latches for both doors were driven to the fully-latched positions. The correct latch indication was later received, and this issue was determined to be an explained condition.

During the Manipulator Release Latch (MRL) latching, as part of RMS powerdown on FD 12, the forward MRL System 1 latch indication was not obtained (IFA STS-118-V-08). The latch indication was obtained approximately 4 hrs and 21 mins later. A more detailed discussion of this anomaly is provided in Appendix B.

Landing and Deceleration System

The landing and deceleration system performed satisfactorily. The nose landing gear tires were in good condition and performed nominally. The main landing gear tires also appeared nominal. This is the first flight of OV-105 as equipped with the new improved main landing gear tires. There was the appearance of tread cord materials on areas of the tire's surface which is a known expected condition characteristic of the new tire design. A late drag chute deployment (deploy after nose gear touchdown) was implemented, so as to perform the Crosswind Development Test Objective (DTO), however the crosswind at landing did not meet

requirements for the DTO 805, as the crosswind were less than 10 knots. Main parachute deployment and jettison occurred nominally. The following table presents the pertinent data on the landing of the STS-118 Orbiter.

LANDING PARAMETERS

Parameter	From threshold, ft	Speed, keas ^a	Sink rate, ft/sec	Pitch rate, deg/sec
Main landing gear touchdown	1297.1	218.4	-5.88	N/A
Nose landing gear touchdown	5612.1	164	N/A	-5.39
Parameter		Data		
Brake Initiation speed		121.0 keas		
Brake-on time		35.09 sec		
Rollout distance		10649.3 (wheel stop)		
Rollout time		60.63 sec		
Runway		KSC 15 (Concrete)		
Orbiter weight at landing		221660.1 lb		
Parameter	Maximum Brake Pressure, psia	Total Brake Energy, M ft-lb		
Left inboard	1107.3	16.18		
Left outboard	1082.5	17.30		
Right inboard	1169.4	19.76		
Right outboard	1011.2	15.86		

^aKnots equivalent air speed

The post-flight debris team noted an anomalous condition for one of the reefing line cutters not cutting the reefing line on the parachute (IFA STS-118-V-12). This is one of two cutters and only one is required for nominal chute deployment. An inspection of the flown parachute at the KSC Parachute Refurbishment Facility indicated no other anomalies.

Aerothermodynamics, Integrated Heating and Interfaces

Data and inspections reports indicated that the overall performance of the Orbiter TPS was nominal. The lower surface structural temperature data indicated normal entry heating and was within the range expected for this weight and inclination. The recorded temperatures are within the flight experience of OV-105. The temperatures experienced at P1 (137.7 °F), P4 (80.5 °F), P5 (83.0 °F) and S1 (153.5 °F) had the most temperature rise; however, the maximum temperatures at P4 and P5 were at 30 minutes after wheel stop. The temperature rise at B2 is near the maximum experienced by the OV-105 vehicle.

Based on STS-118 MADS data and the best estimate trajectory, the Boundary Layer Transition (BLT) onset time was 1319 sec after Entry Interface (EI) or Mach 6.2

based on the centerline location of X/L = 0.6. Although the surface thermal sensors at both forward and aft outboard of the wings indicated a symmetrical BLT, the sensors aft inboard of the wings as well as the aileron deflections and yaw thruster firings indicated that the vehicle's right wing has an asymmetrical BLT at approximately Mach 8.2.

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)	137.7	121.5
Lower fuselage forward left-hand (B2)	195.7	182.1
Lower fuselage forward mid left-hand (B3)	169.3	170.9
Lower fuselage mid center (B4)	143.0	144.6
Lower fuselage mid aft center (B5)	179.8	173.8
Lower fuselage aft center (B6)	187.8	161.3
Left-wing center (LW)	119.4	136.3
Right wing center (RW)	127.3	136.5
Port side FRCS forward (P1)	137.7	116.4 ^b
Port side fuselage forward center (P2)	96.0	102.7
Port side fuselage forward mid center (P3)	85.6	87.3
Port side fuselage mid aft center (P4)	80.5 ^a	94.8 ^{ab}
Port side fuselage aft center (P5)	83.0 ^a	77.1 ^{ab}
Starboard side FRCS forward (S1)	153.5	127.1 ^b
Starboard side fuselage forward center (S2)	119.4	118.5
Starboard side fuselage forward mid center (S3)	101.2	77.4
Starboard side fuselage mid-aft center (S4)	85.6	84.7
Starboard side fuselage aft center (S5)	80.5	69.4
Lower body flap center	106.4 ^a	80 ^a
Right-hand OMS pod side forward (RP)	80.5 ^a	66.8 ^a
Left-hand OMS pod side forward (LP)	88.2	74.6
Right-hand PLBD forward	83 ^a	130.2 ^a
Left-hand PLBD forward	83 ^a	135.3 ^a
Right-hand PLBD aft	90.8 ^a	120.4 ^a
Left-hand PLBD aft	88.2 ^a	117.8 ^a
Right wing upper center	106.4 ^a	123.3 ^a
Left wing upper center	114.2 ^a	138.7 ^a
Forward RCS center	103.8 ^a	82.5 ^a
Forward fuselage upper center	80.5	94.8

^a Maximum temperature occurred at 30 minutes after wheel stop.

^b Maximum temperature rise experienced by the vehicle

Post flight inspection of the Orbiter Endeavour (OV-105) TPS following the STS-118 mission indicated these local heating environments:

1. Forward RCC – The gap filler installed between the chin panel and nose cap was drastically shrunken resulting in a void between the gap filler and the respective RCC components. A new gap-filler was ordered for refurbishment of the chin panel installation.
2. NLGD and MLGD - Thermal barriers and tiles appeared to have nominal degradation.
3. ET doors – Thermal barriers, tiles, edge members and all other TPS components on and across the doors perimeter interface were in nominal post-flight condition. No adverse heating effects were noted at or downstream of the two adjacent large damage sites, which were extensively analyzed during the mission.
4. Protruding horseshoe gap filler at right Panel 22 was still protruding and is now folded over with approximately the same dimensions. There was no charring, discoloration or other signs of over-temperature conditions at this location or downstream.
5. The damage that was noted on-orbit on the tile at the right chine remained unchanged.
6. The exposed filler bar of the large and deep tile damage had minor category 1 char indication (about 1100 °F).
7. All three tile damage sites (aft of the large damage) noted on-orbit in the region of the Orbiter returned in nominal condition with no noticeable growth, charring, or over-temperature conditions.
8. The “frayed” thermal barrier on the right-side MLGD was not in fact a fray. No signs of thermal barrier degradation or contamination were at this location.
9. Both elevon-cove protruding gap fillers noted on orbit were not actually protruding, but had frayed threads.

The Damage Assessment Team (DAT) conducted best estimate reconstruction damage analyses. The analysis was able to successfully reconstruct the post-flight observed conditions. The analysis results indicated that the cavity likely transitioned with the global vehicle transition around Mach 6.5. The filler bar temperature indications were consistent with mean or below mean cavity heating bump factors.

Lessons learned from this evaluation were the following:

1. Three of the significant damage assessment inputs, that drive the TPS/structure temperatures are:
 - a. Cavity geometry and its approximation in modeling.
 - b. BLT zone time and BLT in cavity.
 - c. Cavity heating bump factors.
2. In-flight the analysis process is designed to protect for uncertainties in these inputs.
3. It is expected that mean assessments will yield results representative of most post-flight results, however, there is no confidence during a flight that this will be the case when the vehicle lands.

4. The end to end DAT process is designed to provide a higher than mean confidence assessment.

Recommendations from the post-mission lessons learned were:

1. Perform detailed review of existing RTF BLT experimental data to potentially define criteria for BLT inside tile damage cavities.
2. Perform detailed review of relevant Orbiter tile damage/surface T/C flight data to understand when tile damage does not cause BLT (e.g. the inverse problem).
3. Review minimum DAT transition Mach number for potential refinement.
4. Investigate feasibility of refining turbulent bump factors.
5. Perform “best estimate” integrated analyses during mission in order to understand sensitivity to uncertainties.

Thermal Control System

The Thermal Control System (TCS) performed nominally during STS-118. During the mission, the Orbiter passive TCS maintained all subsystem temperatures within acceptable limits. The Beta angle range was from +50.9 degrees to -10.7 degrees, which occurred at the end of the mission. The primary docked attitude consisted of Orbiter biased tail-to-earth, top on velocity vector (-XLV -ZVV), pitch up 23 or 24 deg. The longest attitude was 94.84 hr (Bias -XLV -ZVV). The Orbiter was docked to PMA-2.

There were no TCS hardware issues. All heater systems performed normally, with no failures or other issues. This was the first flight of the Station Shuttle Power Transfer System (SSPTS), which performed nominally thermally.

Thermal Protection System

Tile and Blanket Flight Assessment

The starboard-wing survey started at 221/17:11 GMT (00/18:34 MET) and was completed 83 min later. The nose-cap survey was started at 221/19:17 GMT (00/20:40 MET) and was completed 35 min later. The port-wing survey was started at 221/19:57 GMT (00/21:20 MET) and was completed 91 min later. Based on the analysis of the survey results, the Focused Inspection meeting determined that a requirement did exist for a FD 5 focused inspection of four Thermal Protection System (TPS) tile locations and a frayed thermal barrier around the Main Landing Gear Door (MLGD). The DAT reported to the MMT on the Focused Inspection sites, of which there were five, and the MMT accepted the recommendations and approved the five sites for the inspection on FD 5.

On FD 5, the OBSS was unberthed by the SSRMS and handed off to the SRMS to perform the focused inspection of five TPS damage sites of the underside of the Orbiter. The inspection imagery obtained the detailed geometry of the 3.54 by 2.76 in cavity on the Orbiter TPS. A photograph showing the picture obtained during the focused inspection is provided on the following page. The DAT 's analytical assessment of the tile damage site showed that the filler bar was exposed and this

condition required that thermal models be modified to precisely account for these effects. As a result, new tests were required in the Arc Jet Facility and in a vacuum chamber.



The three smaller damage-sites were cleared. A digital camera image, obtained during the Focused Inspection, of the right main landing gear thermal barrier showed that the barrier was also intact.

Arc Jet Facility test calibration runs on undamaged tile were completed, and testing of the replicated tile damage site was performed after the test article became available. The precise test conditions were developed based on the Computational Fluid Dynamics (CFD) effort.

The Tile Repair Team was engaged in activities to pursue the selected repair methods should the "gouged" tile damage not be cleared for entry in the as-is condition. Additionally, the DAT team was verifying the repair method to ensure that the method will pass the analytical, thermal, and stress loads on the vehicle during entry.

Arc Jet Facility testing of a representative test article of the un-repaired damage site was completed. The initial inspection did not indicate any structural burn-through. A

detailed inspection was completed after facility cool down. The review of the test article from the Arc Jet Facility that simulated the un-repaired damage indicated that there was no breach of structure or any sign of tile-bond failure, and the exposed filler bar was charred but intact. There was significant damage to the downstream tile that may be attributed to the high localized-heating of the aft-cavity lip.

In addition, the DAT personnel and test articles were transported to the Lockheed-Martin vacuum chamber in Denver to robotically dispense STA-54 tile-repair material into articles representing the damaged tile cavity. There is one 24- by 24-in tile array and four 6- by 6-in tile arrays plus other supporting equipment being transported. The test article was cured for 24-hr in the vacuum chamber.

As a result of the test results, the MMT decided that a repair of that site would not be performed during an EVA.

RCC Flight Assessment

The Leading Edge Structure System (LESS) Problem Resolution Team (PRT) cleared the Reinforced Carbon-Carbon (RCC) for the mission.

The total count was 16 Micrometeoroid Debris (MMOD) indications for the Wing Leading Edge Impact Detection System (WLEIDS). No WLEIDS indications were seen during the peak of the meteorite shower. The system, during the peak of the meteorite shower, was monitoring with Port and Starboard group 6. When the batteries for these groups were exhausted, monitoring was stopped, and the WLEIDS MMOD monitoring with other groups was not restarted until after undocking.

The MMOD late inspection of the port, starboard, and nose-cap RCC was successfully completed. The OBSS was unberthed at 231/13:48 GMT (10/15:12 MET). The survey of the starboard RCC started at 231/14:38 GMT (10/16:02 MET), the nose cap survey started at 231/16:14 GMT (10/17:38 MET) and the port survey began at 231/17:21 GMT (10/18:45 MET). All of the inspection data were downlinked for review by the DAT.

The late inspection data review results for the RCC were presented to the MMT, and the vehicle was cleared for entry.

Post-Landing Assessment

The Orbiter TPS sustained a total of 188 lower surface hit of which 28 had a major dimension of one in. or larger. The window tiles sustained 12 hits, none larger than 1 in. The LH OMS pod sustained 8 hits, none larger than 1 in. The RH OMS pod sustained 10 hits, 3 greater than 1 in. The total vehicle sustained 237 hits with 40 greater than 1 in. The table on the following page summarizes all of the major areas of the hits.

SUMMARY OF IMPACT SITES FOR EACH ORBITER SURFACE

Orbiter Surface	Impacts > 1in.	Total impacts
Lower surface	28	160
Upper Surface/Window	0	12
Right side	7	29
Left side	2	18
Right OMS pod	3	10
Left OMS pod	0	8
Totals	40	237

A TPS plug from the drag chute door was found 20 ft from the door. A metal part tag from the Left-Hand (LH) main landing gear was found at the 4400-ft level on the centerline.

Both reefing lines were still attached to the main parachute. One line had been tied off to a ring and did not separate. The other line did not fully cut even though the pyrotechnic cutter had fired. The remaining drag parachute components and hardware appeared to have functioned nominally.

The damage caused to two tiles by the debris release from the liquid oxygen feedline bracket did not appear to grow significantly. The damage grew slightly due to the loss of an adjacent putty repair aft of the damage.

Tire material loss on the main landing gear and nose landing gear tires was nominal.

The main landing gear door corner tiles did not have any chips. The RH nose landing gear door had a 2 in by ½ in chip off of the side of one tile.

The LH and RH ET/Orbiter (EO) umbilical pyrotechnics appeared nominal. There did not appear to be any umbilical plate warping.

The Orbiter nose-cap as well all the leading edge 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 base heat shield tiles had very little damage between the engines, especially as compared to STS-117. The Toughened Unipiece Fibrous Insulation (TUF) tiles that were installed on OV-105 account for this improvement.

There were small damage sites to two of the tiles on the underside of the vertical stabilizer. This is most likely drag-parachute-induced tile damage. The rudder speed brake trailing edge did not appear to have any tile damage.

Windows 3, 4, and 5 appeared to have some hazing on them. Windows 4 and 5 each appeared to have a small streak on the surface.

Windows

The crew reported at approximately 227/11:58 GMT (07/13:21 MET), a MMOD 1/8-in impact on window 2. Photographs of the impact and its location were downlinked for analysis. The analysis of the window as well as any potential impact to the flight was performed and the window was cleared for entry.

The analysis of the windows identified a scratch and a low-velocity impact exceeding 0.0007 in. in depth on window 7 and the window was scrapped. On window 8, two bruises were identified, which are not allowed. The remaining windows have been sent to the NASA Shuttle Logistics Depot (NSLD) for final inspection completion. A thicker window modification is being implemented on the vehicle.

Waste Collection System

The Waste Collection System (WCS) performed satisfactorily and no significant issues were reported by the crewmembers.

EXTRAVEHICULAR ACTIVITY

The crew performed four Extravehicular Activities (EVAs) on STS-118. The baseline plan included three scheduled spacewalks to complete maintenance and assembly tasks. However, the Mission Management Team (MMT) decided to extend the mission and add a fourth EVA as a result of the abundance of power provided by the Station-to-Shuttle Power Transfer System (SSPTS). The airlock-campout-prebreathe protocol was utilized in preparation for all of the EVAs.

FIRST EXTRAVEHICULAR ACTIVITY

The first EVA was satisfactorily completed with all EVA 1 objectives being achieved. The duration of the first EVA was 6 hr and 17 min.

Space Shuttle EVA crewmembers EV 1 and EV 2 completed the first EVA on Flight Day (FD) 4. The primary objective of EVA 1 was to install the S5 short spacer truss segment. The EVA crew provided guidance cues to the Intravehicular crewmember as the Space Station Remote Manipulator System (SSRMS) was maneuvered into the S5 position. The crew then removed launch locks and secured bolts on all four corners of the truss to complete the final structural attachment. All bolting operations were completed nominally. Upon successful installation of the S5 truss, the EV 1 and EV 2 crewmembers moved the Photovoltaic Radiator Grapple Fixture (PVRGF) from its launch location to the S5 keel to avoid clearance concerns with the S4 Beta Gimbal Assembly (BGA), and thus allow the Solar Array Wing (SAW) to rotate as designed. Before leaving the S5 worksite, the crew completed several get-ahead tasks in preparation for installation of the S6 truss segment during the upcoming STS-119 mission. The EV 1 crewmember mated S4-to-S5 umbilicals while the EV 2 crewmember removed the S5 launch locks and opened the S5 Capture Latch Assembly (CLA).

Next, the crew translated to the P6 truss segment to monitor the retraction of the forward Photovoltaic Radiator (PVR). Once retracted, the EV 1 and EV 2 crewmembers cinched the radiator in its stowed position, as required for P6 relocation during the STS-120. The crew also performed additional get-ahead tasks, which included inspecting the structural integrity of P6 pip pins and relocating the foot restraints for future EVAs.

SECOND EXTRAVEHICULAR ACTIVITY

The second EVA was satisfactorily completed and all required EVA 2 tasks were completed. The major task of the second EVA was the successful removal and replacement of the Control Moment Gyroscope (CMG) 3 on FD 6. The total time of the second EVA time was 6 hr and 28 min.

The EV 1 and EV 2 crewmembers began the second EVA by egressing the Quest Airlock and translating to the Z1 truss to remove the failed CMG. The crewmembers peeled back the thermal shroud and released CMG 3 by unfastening six bolts. The failed CMG was then temporarily stowed on a Z1 handrail while the EVA crewmembers translated to the Orbiter payload bay to retrieve the new CMG from its

launch location on the External Stowage Platform-3 (ESP-3). The EVA crewmembers removed the CMG Integrated Assembly (IA) from the ESP-3 by releasing the bolt that secured the IA to the pallet.

The SSRMS was used to maneuver the EVA 2 crewmember, carrying the CMG IA, from the payload bay to the ESP-2 near the airlock. With assistance from the EV 1 crewmember, the EV 2 crewmember secured the CMG IA onto ESP-2 and removed the new CMG from its Flight Support Equipment (FSE). Riding the SSRMS, EV 2 then delivered the new CMG to Z1 and, together with EV 1, installed it in its final location on the Z1 truss. Installation was performed nominally, all connectors were mated, and the thermal shroud was reattached. The failed CMG was secured in the FSE on ESP-2 where it will remain until the CMG IA is returned to Earth on the STS-122 mission. Before ingressing the airlock, the crew photographed the Materials ISS Experiments (MISSE) to enable ground evaluation of the payloads prior to their retrieval on a subsequent EVA.

At approximately 4:30 into the EVA, EV1 received a message indicating a failed CO₂ sensor. The data signature was indicative of that seen with previous failures of the CO₂ sensor related to excess moisture in the vent loop. One Flight Rule allows for continuation of the EVA with a failed CO₂ sensor. The crew is trained to recognize symptoms associated with high CO₂ exposure. The EVA was completed with no additional issues.

THIRD EXTRAVEHICULAR ACTIVITY

The third EVA was performed by Rick Mastracchio (EV1) and Expedition 15 Flight Engineer Clay Anderson (EV3) on FD 8. The primary objectives of this EVA included upgrading the S-Band communications system and preparing the ISS for the STS-120/10A mission.

While performing a routine glove inspection between tasks, the EV 1 crewmember noted a small hole in the Vectran layer of his Extravehicular Mobility Unit (EMU) glove near his left thumb. All suit data appeared nominal; however, per existing flight rules, the EVA was terminated and EV 1 was instructed to return to the airlock and connect to the umbilicals. The EV 3 crewmember completed the P6 transponder retrieval task and then retreated to the Airlock for repressurization. As a result, the third EVA was shortened to 5 hr and 28 min, one hr shorter than planned. Due to the early termination of the EVA, the crew was not able to complete two scheduled tasks.

The EVA began with EV 1 ingressing a foot restraint on the end of the SSRMS and riding the arm to the top of the P6 truss segment. There the S-band Antenna Sub-Assembly (SASA) was unbolted and disconnected and then relocated it to its new home on the P1 truss. The EV 3 crewmember worked in parallel to install a new and improved S-band Transponder and Baseband Signal Processor (BSP) on P1. Both tasks were completed without any problems.

Next, EV 1 and EV 3 worked together to relocate two Crew and Equipment Translation Aid (CETA) carts from the port side to the starboard side of the Mobile

Transporter (MT). This relocation was necessary to support the P6 relocation that will be performed on the STS-120 mission. EV 3 was tethered to and grasping the first cart while EV 1 released the cart from the truss rails. The SSRMS then maneuvered EV 3 and the CETA cart to the starboard side of the MT where EV-1 provided visual cues for the installation. The second CETA cart was subsequently relocated in a similar fashion. Once securely fastened onto the rails, the CETA carts were re-coupled to the MT.

Upon completion of the CETA cart moves, EV 3 proceeded to the P6 truss segment to retrieve the P6 transponder. The Z1 gimbal locks and MISSE retrieval were deferred to EVA 4.

Once inside the ISS, the crew took photographs of the EV 1 crewmember's glove damage and downlinked the images to the ground for evaluation. The ground team performed an extensive video review of the EVA to determine the cause of the damage; however, no conclusive results could be drawn.

FOURTH EXTRAVEHICULAR ACTIVITY

Because of the pending threat to Mission Control posed by Hurricane Dean, the MMT accelerated the Orbiter undocking by one day and this resulted in a shortened fourth EVA on FD 11. In an effort to complete the highest priority requirements in a limited amount of time, EVA 4 tasks were rearranged. The crew returned to the Airlock, completing the EVA in a total time of 5 hr and 2 min. All scheduled glove inspections and post-flight glove photographs indicated no damage had been incurred.

The Z1 gimbal locks and MISSE retrieval tasks that had been deferred from the third EVA were added into the fourth EVA timeline; however, the Micrometeoroid Orbital Debris (MMOD) shield and Wireless External Transceiver Assembly (WETA) installation tasks were omitted. The MMOD shields were unseated during the STS-117 mission and are currently being held in place by limited-life tethers. Analysis has shown that the tether life can be extended to early 2008. The WETA is highly desired prior to the STS-119 mission. Due to the need dates associated with these two tasks, they were deferred to a future EVA.

As part of the preparatory work prior to this EVA, photographs were taken of EV 1 and EV 3 crewmembers gloves to verify the integrity of the protective layers. The ground team deemed both pairs of gloves to be acceptable for use. As an additional safety measure, extra glove inspections were incorporated into the fourth EVA timeline following long hand-over-hand translations.

The EV 2 and EV 3 crewmembers egressed the airlock ahead of schedule to begin the fourth EVA. For their first task, the crewmembers translated along the starboard truss structure and installed the Orbiter Boom Sensor System (OBSS) support equipment on the S1 truss. These jack-stands will allow for the temporary stowage of the OBSS between the STS-123 and STS-124 missions.

The two crewmembers then proceeded to separate worksites. EV 3 translated to the airlock where the MISSE scientific payloads were removed from their stowage locations on the crew-lock and high-pressure gas tank handrails. The EV 2 crewmember maintained frequent communications with the ground team as the four bolts to lock the Z1 SASA were tightened, thereby preventing the SASA from gimbaling. This task was required to hold it in place for its return on the STS-120 mission. This task required more time than scheduled, as several iterations were required to ensure the bolts received the proper torque.

The final task of the fourth EVA was to install two External Wireless Instrumentation System (EWIS) antennas on the Laboratory end-cone. These antennas are needed to provide important structural data to the ground team. As part of the installation, the crewmembers removed two handrails and displaced an MMOD shield so that the connectors could be mated. The shield was successfully reseated and the antennas were installed as planned.

REMOTE MANIPULATOR SYSTEM AND ORBITER BOOM SENSOR SYSTEM

The Shuttle Remote Manipulator system (SRMS) performed nominally during the mission. No issues or In-Flight Anomalies (IFA's) were identified during the flight or as a result of the post-flight data analysis.

STS-118 was the 75th flight of the Shuttle Remote Manipulator System (SRMS), the 18th flight of S/N 201 SRMS, the 6th flight of the Orbiter Boom Sensor System (OBSS), and the 3rd flight of this specific Inspection Boom Assembly (IBA).

SRMS initialization and power-up began at 221/01:19 GMT (00/02:43 (MET) on FD1. The port and starboard Manipulator Positioning Mechanisms (MPMs) were deployed and the SRMS shoulder brace was released. The SRMS checkout began at 221/02:30 GMT (00/03:54 MET). During the Direct Drive test in the SRMS checkout, the crew received a PDRS ABE Systems Management (SM) alert while driving the shoulder yaw joint. After review of the data, the crew was asked to complete the checkout, and the SRMS performance during the rest of the checkout was nominal. The alert did not recur during the flight. The SRMS was then maneuvered to the pre-cradle position and powered down.

On FD 2, the SRMS unberthed the OBSS to perform the port and starboard wing leading edge (WLE) Reinforced Carbon-Carbon (RCC) and nose-cap surveys. The surveys began at 221/15:39 GMT (00/17:03 MET) and were completed at 221/22:10 GMT (00/23:34 MET). The SRMS berthed the OBSS, and the SRMS was maneuvered to the pre-cradle position.

On FD 3, the Orbiter docked with the ISS with the SRMS in the pre-cradle position. The SRMS then grappled the Flight Releasable Grapple Fixture (FRGF) of the S5 truss at 222/19:59 GMT (01/21:42 MET), then unberthed and handed the S5 Truss off to the Space Station Remote Manipulator System (SSRMS). The SRMS ungrappled the truss at 222/21:34 GMT (01/22:58 MET) and then the SRMS was maneuvered to the S5 Install Viewing position.

On FD 4, the SRMS provided viewing support as the SSRMS was used to install the S5 truss. Upon completion of the S5 truss installation, the SRMS was maneuvered to the pre-cradle position.

On FD 5, the SSRMS grappled and unberthed the OBSS for the Focused Inspection activities. The SSRMS handed off the OBSS to the SRMS, where OBSS was grappled at 224/14:34 GMT (03/15:58 MET). The Focused Inspection activities were completed at 224/18:50 GMT (03/20:14 MET). After the scans were complete, the SRMS/OBSS was maneuvered back to the handoff position. The SSRMS grappled and berthed the OBSS, and the SRMS was maneuvered to the pre-cradle position.

On FD 6, the SRMS was maneuvered to the Control Moment Gyroscope (CMG) remove-and-replace viewing position. Following completion of the CMG activities, the SRMS was moved to the pre-cradle position.

On FD 7, the SRMS grappled the External Stowage Platform 3 (ESP-3) at 226/13:13 GMT (05/14:42 MET) and maneuvered ESP 3 to a position to hand off the ESP-3 to the SSRMS. After releasing the ESP-3, the SRMS was maneuvered to the ESP-3 installation-viewing position.

On FD 8, the SRMS was maneuvered from the ESP-3 Installation Viewing position to the P6 S-Band Antenna Structural Assembly (SASA) Relocation-Viewing position. Upon completion of viewing support, the SRMS was cradled, latched, and powered down.

On FD 9 and 10, the SRMS remained cradled and latched with no SRMS activities except for a brief power-up twice a day to acquire SRMS and OBSS temperature data. On FD 11, the SRMS was powered up and maneuvered to the Pre-cradle position.

On FD 12, after the Orbiter had undocked from the ISS, the SRMS grappled the OBSS. The Late Inspection surveys started at 231/14:31 (10/15:55 MET) and were completed at 231/18:32 GMT (10/19:52 MET). After the OBSS was berthed and latched, the SRMS was also cradled, latched, and powered down. Both sets of MPMs were stowed and this completed the SRMS activities for the mission.

WING LEADING EDGE IMPACT DETECTION SYSTEM

The Wing Leading Edge Impact Detection System (WLEIDS) performed well for ascent impact monitoring, allowing a final ascent report to be published at 12 hr Mission Elapsed Time (MET). Most of the reported impact indications were near to the reporting threshold of 1.0 Grms. Micrometeoroid Orbital Debris (MMOD) monitoring did detect 16 impact indications, all of which were reported during the mission.

A recommendation was made to not perform a focused inspection of the Reinforced Carbon-Carbon (RCC) by the Orbiter Project Office (OPO) to the Mission Management Team (MMT) based on the ascent findings from all systems including WLEIDS. A focused inspection for the MMOD impact indications was likewise not recommended. A late-mission inspection survey was used to clear the vehicle for entry.

ASCENT MONITORING

All units triggered and began data recording on Space Shuttle Main Engine (SSME) ignition. The port wing units began recording within 0.10 sec of each other and the starboard wing units began recording within 0.15 sec of each other. The summary of all probable impacts above 1.0 Grms for this flight is shown in the following table.

SUSPECTED ASCENT DEBRIS IMPACTS ABOVE 1.0 Grms

Times		Location			Magnitude		Criteria				Impact [†]	
MET	DET	Wing	RCC	Unit-Channel	Max. Grms	Max. G	Transient	Local	Spectral	Shock	In-Flt	Post-Flt
71.8	80.9	Port	4-5	1164-J2	1.4	3.4	+	+	+	+	U	P
106.0	115.1	Port	5-6	1155-J3	1.0	3.2	+	+	+	+	P	P
118.0	127.1	Port	6-7	1073-J3	1.2	4.2	+	+	+	+	P	P
119.0	128.1	Port	5-6	1155-J3	1.2	4.2	+	+	+	+	P	P

[†] Data Analysis Finding: P=probable, Q=questionable, N=no, U=unfound

A total of 3 impact probable cases above 1.0 Grms (all on the port wing) were found and reported during the flight. Post-flight analysis identified one additional probable impact above 1.0 Grms. This impact indication was not found by reviewing the summary data during the flight because it was close to the aero-acoustic noise floor around the time of Max Q. Automatic scanning of the full set of post-flight raw data allowed this impact indication to be detected. Automatic scanning of post-flight data acquired from 10 to 500 sec Mission Elapsed Time (MET) revealed a total of 102 probable ascent debris impacts on the wing leading edge of which 63 were on the port and 39 were on the starboard wing and ranged from 0.1 to 1.4 Grms.

ON-ORBIT MONITORING

For this mission, the WLEIDS recorded 20 valid triggers, 16 of which satisfied all impact criteria. Of the 16 that satisfied the impact criteria, 10 occurred in the period from initial activation until docking at approximately 43 hr MET. Monitoring during the peak of the Perseids meteor shower resulted in a single indication, and no

indications were found in the post-undocking time-frame. Detailed results were presented at the Flight Day 4, 5, and 6 OPO meetings and summarized at the Flight Day 10 OPO and Mission Management Team (MMT) meetings.

The MMOD monitoring capability was limited because of the lack of continuous wing coverage associated with battery/thermal considerations, gaps in coverage of Ku-band antenna communications and the time required to request units be brought out of and placed into the MMOD monitoring mode.

The summary of all WLEIDS MM/OD probable impacts for this flight is shown in the following table.

SUSPECTED MMOD IMPACTS

Times	Location			Magni- tude	Criteria				Impact [†]		
	GMT	Wing	RCC		Unit- Channel	Max. G	Tran- sient	Loc- al	Spec- tral	Sh- ock	In- Flt
221/19:09:29	Port	11-13	1174-J3	0.8	+	+	+	+	+	P	P
221/19:23:03	Port	11-13	1174-J3	0.9	+	+	+	+	+	P	P
221/19:45:42	Port	16-18	1186J2	0.7	+	+	+	+	+	P	P
221/20:28:32	Port	13-16	1186-J1	1.8	+	+	+	+	+	P	P
221/21:02:13	Port	11-13	1174-J3	0.6	+	+	+	+	+	P	P
222/09:04:24	Starboard	5-6	1152-J3	0.8	+	+	+	+	+	P	P
222/10:39:57	Starboard	1-2	1152-J1	1.2	+	+	+	+	+	P	P
222/14:30:40	Starboard	5-6	1152-J3	0.6	+	+	+	+	+	P	P
222/15:14:40	Starboard	1-2	1152-J1	1.4	+	+	+	+	+	P	P
222/15:21:54	Starboard	1-2	1152-J1	0.6	+	+	+	+	+	P	P
223/01:55:52	Port	5-6	1155-J3	0.6	+	+	+	+	+	P	P
223/04:54:35	Port	7-8	1176-J1	0.6	+	+	+	+	+	P	P
223/07:25:55	Port	1-2	1155-J1	2.0	+	+	+	+	+	P	P
223/20:22:55	Port	5-6	1155-J3	0.7	+	+	+	+	+	P	P
223/21:28:28	Port	5-6	1155-J3	0.5	+	+	+	+	+	P	P
224/19:15:00	Port	17-19	1190-J2	1.5	+	+	+	+	+	P	P

[†] Data Analysis Finding: P=probable, Q=questionable, N=no, U=unfound

ANOMALIES

No ascent data anomalies (data spikes) were found during the mission. However, automatic scanning of postflight ascent data revealed six data anomalies listed in the following table. One of them is above 1.0 Grms, and its magnitude is the highest observed in the Shuttle missions.

ASCENT DATA ANOMALIES

Time (s)		Location			Magnitude		Criteria				Anomaly [†]	
MET	DET	Wing	RCC	Unit-Channel	Maximum Grms	Maximum G	Transient	Local	Spectral	Shock	In-flight	Post-flight
78.5	87.7	Port	15-16	1192-J1	2.5	5.7	+	+	-	-	U	P
95.3	104.4	Starboard	17-18	1198-J2	0.6	1.5	+	+	-	-	U	P
131.6	140.8	Port	9-10	1174-J2	0.2	0.6	+	+	-	-	U	P
356.0	365.1	Port	10-11	1184-J2	0.2	0.4	+	+	-	-	U	P
546.6	555.8	Starboard	19-20	1200-J3	0.6	1.4	+	+	-	-	U	P
563.3	572.4	Port	7-8	1176-J1	0.1	0.2	+	+	-	-	U	P

[†] Data Analysis Finding: P=probable, Q=questionable, N=no, U=unfound

Four anomalies were detected and reported during on-orbit monitoring. This was the first mission in which data anomalies were encountered during on-orbit monitoring. Automatic scanning of post-flight ascent data did not reveal additional anomalies.

ON-ORBIT DATA ANOMALIES

Time	Location			Magnitude		Criteria				Anomaly [†]	
GMT	Wing	RCC	Unit-Channel	Maximum Grms	Maximum G	Transient	Local	Spectral	Shock	In-flight	Post-flight
221/22:40:08.6	Port	14-15	1186-J1		0.82	+	+	-	-	P	P
221/22:41:03.9	Port	14-15	1186-J1		0.88	+	+	-	-	P	P
221/22:43:35.5	Port	14-15	1186-J1		0.94	+	+	-	-	P	P
221/23:58:35.9	Starboard	19-20	1197-J3		1.73	+	+	-	-	P	P

[†] Data Analysis Finding: P=probable, Q=questionable, N=no, U=unfound

Unit 1172, which began on-orbit monitoring with apparent nominal behavior, experienced excessive triggering when nearing the end of its monitoring period. At that time, it collected 10872 acquisitions and force-triggered Units 1184 and 1196 for a combined total of 149 times before termination. This was the only other anomalous behavior observed.

SUPPLEMENTAL DATA COLLECTED

No supplemental data were collected.

CONCLUSIONS

The WLEIDS system performed well for ascent impact monitoring, and most of the reported impact indications were near the 1.0 Grms reporting threshold.

The MMOD monitoring capability was limited because of the lack of continuous wing coverage associated with battery/thermal considerations, gaps in coverage due to lack of Ku band antenna communications, and the time required to request units be brought out of and placed into MMOD monitoring mode.

MMOD monitoring did detect 16 impact indications, all of which were reported during the mission. A recommendation not to perform a focused WLE inspection for RCC was made by the OPO based on the ascent findings from all systems including WLEIDS. A focused inspection for the MMOD impact indications was likewise not recommended. The planned late-mission survey inspection cleared the vehicle for entry.

GOVERNMENT FURNISHED EQUIPMENT/FLIGHT CREW EQUIPMENT

The overall performance of the Government Furnished Equipment/Flight Crew Equipment was satisfactory; however, there were three In-flight Anomalies (IFA's) identified and they did not impact the successful completion of the mission. The anomalies are described in the following paragraphs and a more detailed description is contained in Appendix B of this report.

At GMT 232:06:36 (11/07:59 MET), Camera A was downlinked via Ku-Band analog TV and SSV. The image from both sources appeared magenta. A test pattern was downlinked from the camera and it appeared normal (IFA STS-118-V-09).

During the chute deployment, one of the 2 redundant reefing line cutters on the drag chute failed to fully sever the reefing line (IFA STS-118-V-12). Evidence reveals the line was in motion relative to the cutter when the cutter fired. Evidence of motion consisted of the cut being approximately 5 to 6 in off the target mark and off the Teflon-taped area for cutting. As a result, the cutter tried to function on a moving reefing line and that is not the design intention of the device. The cutters are designed to sever static lines only. The reefing line was in a static state until one cutter successfully severed the line and released tension, allowing the line to move. The dynamic line was a result of the successful function of first cutter firing, thereby compromising the function of the redundant unit. If neither cutter functions, 40-percent of drag chute capability is still maintained. Should the chute not deploy, the Orbiter brake system alone is capable of stopping the vehicle.

One of the Payload and General Support Computer (PGSC) dropped off of the onboard network (IFA STS-118-S-001). The crew performed troubleshooting, but the PGSC could not be seen on the network from the ground. The crew then replaced the Communications (COMM) card 3 and restarted the PGSC, and the ground verified that the PGSC was on the network and operating properly.

DEVELOPMENT TEST OBJECTIVES

DTO 805 Crosswind Landing Performance - The crosswind at landing did not meet requirements for Development Test Objective (DTO) 805, as the crosswind was less than 10 knots. The DTO was attempted during landing and the Commander corrected for a significant gust near the surface. Initial analysis of the wind-tower data showed the requirement for a greater than 10-knot crosswind at main gear touchdown was not achieved.

DTO 853 In-Flight Evaluation for Areas of Carbon Dioxide (CO₂) Concentration - This DTO was performed by the Shuttle crew during the FD2, FD4 and FD6 crew sleep to crew wake periods. Evaluation had been planned pre-flight for FD 10 and 11, but were deleted due to battery issues with the Carbon Dioxide Monitor (CDM). On FD 12, a fresh battery from the ISS CDM Kit was installed to assure test data would be preserved for ground evaluation.

Station Development Test Objective (SDTO) 12008-U - The Momentum Management (MM) startup from Shuttle Vernier Reaction Control System (RCS) Station Development Test Objective (SDTO) 12008-U was successfully performed on FD 7 after returning to the nominal ISS/Orbiter mated-attitude following a water-dump performed under Orbiter attitude control. The gimbal angles on the Control Moment Gyroscope (CMG) were positioned to align the momentum vectors for the anticipated attitude. The momentum peaked at approximately 35-percent shortly after the handover and then settled to the expected levels. The Space Shuttle Program propellant used was only 18/28 lbm for the Forward/Aft RCS. The planned usage was 88/88 lbm). The SDTO was designed to develop a method for direct Orbiter-to-ISS MM attitude control in response to the Service Module computer failures experienced during the STS-117 mission.

POSTLAUNCH PAD INSPECTION

The post launch inspection of the Main Launch Platform (MLP) -1, Pad A Flight Service Structure (FSS), and Pad A apron was conducted on 8-9 August 2007 from Launch +2.5 hr to 6.0 hr (2100 to 0030 EDT). The inspection proceeded relatively quickly after Safing Teams secured the Pad. Poor lighting conditions prevented same day inspection of the infield and perimeter areas.

No flight hardware was found other than minimal SRB nozzle throat plug foam and Room Temperature Vulcanizing (RTV) material.

Orbiter lift-off lateral acceleration data indicated a maximum of 0.11g. Hold-down stud hang-ups are typically noted with lateral accelerations above 0.19g.

Inspections of the SRB holddown posts (HDPs) were performed and are as follows:

- HDP 1 – EA934 poured sidewalls are nominal with some visible voids present (acceptable) and without any delamination from the shoe. Phenolic shim is nominal without visual blistering and 1 of 2 firing lines were present with about 1 ft remaining. No galling or chatter marks were noted in the chamfer of the thru hole.
- HDP 2 – EA934 poured sidewalls are nominal with some visible voids present (acceptable) and without any delamination from the shoe. Phenolic shim is nominal without visual blistering. Approximately 2-ft of Range Safety System (RSS) cable was present and firing lines were not present. No galling or chatter marks were noted in the chamfer of the thru hole.
- HDP 3 – Showed nominal indications of erosion on the RTV coated blast shield with proper closure.
- HDP 4 – Showed nominal indications of erosion on the RTV coated blast shield with proper closure.
- HDP 5 – EA934 poured sidewalls are nominal with some visible voids present (acceptable) and without any delamination from the shoe. Phenolic shim had visual blistering on Northwest (NW) area and minor scratch on East area and firing lines were not present. No galling or chatter marks were noted in the chamfer of the thru hole.
- HDP 6 – EA934 poured sidewalls are nominal with some visible voids present (acceptable) and without any delamination from the shoe. Phenolic shim is nominal without visual blistering. Approximately 2-ft of firing lines were present. Minor erosion was present on East corner of shoe. No galling or chatter marks were noted in the chamfer of the thru hole.
- HDP 7 – Showed nominal indications of erosion on the RTV coated blast shield with proper closure.
- HDP 8 – Showed more than typical indications of erosion on the RTV coated blast shield with proper closure and RSS cable was missing.

Inspections of the GN₂ purge lines were performed and were as follows:

1. The left probe was slightly bent to the southwest and about 75% of the protective tape layering was remaining. The exposed portion of braiding had no erosion damage.
2. The right-hand probe was standing straight and about 30 percent of the protective tape layering was remaining. The exposed portion of braiding had no erosion damage.

Both SRB T-0 Ground Carrier Assemblies (GCA's) appeared to be in nominal condition with proper demate. The left-hand had some protrusion on the 5J1 electrical connector with a minor crack in the 1J1 electrical connector. The right-hand had some protrusion on the 3J1 and 4J1 electrical connectors.

The LO₂ and LH₂ Tail Service Masts (TSM) appeared undamaged and both bonnets appeared to have closed properly. The LH₂ bonnet had both the North and South curtain exposed.

The Main Launch Platform (MLP) deck was in excellent condition with some SRB water baggie rope near HDP 6 and a paper property identification tag. The Northeast corner bridge pivot pins were loose, brackets bent and the guard rail chains experienced excessive erosion. The Northeast high-speed camera lens was noted to be damaged. Typical blast erosion was observed in and around the SRB flame holes. All sound suppression shims appeared to be in place.

The GH₂ vent line Ground Umbilical Carrier Plate (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 Flight Service Structure (FSS). The External Tank (ET) GUCP 7-inch GH₂ 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. The deceleration cable was in nominal configuration. The GH₂ vent line blanket was mostly torn away by plume impingement. The ET GUCP exhibited minimal blast damage and the pyrotechnic bolt fired nominally. A unistrut clamp bracket was located on the GUCP frame plate (sitting in the plate).

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. Some corrosion scaling was noted inside and behind basket 7.

The GO₂ Vent Arm at the 255-ft level, vent hood, ducts and structure appeared to be in nominal condition. The East (port side) GO₂ vent flexible duct aluminized blanket showed blast damage. The upper and lower shock absorbers had visible excessive corrosion and the latch mechanism locked properly.

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

1. Some pieces of SRB throat plug material were found on the Pad apron.
2. Three medium pieces of concrete and two small pieces of fondue fire material were found on the west and east side of the Pad surface.
3. A $\frac{3}{4}$ -in bolt and nut (facility) was obtained on the West PAD surface to the West of the elevators.
4. A $\frac{3}{8}$ -in SS roll pin was obtained on the West PAD surface near side 1 of FSS.
5. A roll of yellow vinyl tape with tether was located near side 1 of the FSS in the elevator area.
6. A clip was located on the West PAD surface near the guard rails of the South flame trench.
7. Two welding rods (each approx. 4-in in length) on East PAD surface.
8. An Orbiter Television (OTV) cable (approximately 30-ft in length) on East PAD surface Southeast of the MLP was damaged.
9. Two East PAD surface stadium lights were inoperable.
10. A water baggie rope was obtained for data logging on East PAD surface.
11. At the 95-ft level, a lid on a manifold box on side 2 of FSS was missing and located about 200 yards southwest of 95-ft level on PAD apron (near Firex pump station).
12. At the 115-ft level, an entire tie-wrap and water baggie rope was found near the 115-ft sign.
13. At the 135-ft level, an Orbiter Work Platform (OWP) was locked and in place. A small hook spring was obtained.
14. At the 175-ft level, a pneumatic regulator cover was located from FSS side 2.
15. At the 195-ft level, rust scaling was found in and behind basket 7.
16. At the 215-ft level, an OTV conduit line (center of 3) on FSS side 1 has an approximately 1-in corrosive produced hole.
17. At the 235-ft level, a loose clip and screw and minor rust scaling (quarter sized) was found.
18. At the 275-ft level, a GN_2 supply valve for Guide Vane Assembly (GVA) was left in the open position without ball-pin installed.

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-118 vehicle. Numerous observations were made, and these are presented in the following list.

1. At -00:02:06 MET, a streak in the plume of Space Shuttle Main Engine (SSME) 1 was seen. Initial evaluation suspects that the plume was a result of transient contamination or Foreign Object Damage (FOD).
2. Tyvek cover F3D tore into two pieces at approximately 4.39 sec MET. The remnant remained attached to the thruster and releases at approximately 16 sec MET. The remnant was noted falling aft along the Orbiter fuselage over the port Orbital Maneuvering System (OMS) pod but does not appear to contact vehicle.
3. A piece of External Tank (ET) umbilical purge material possibly contacted the body flap and fell aft into the plume. Photo analysis concluded that it was umbilical purge baggie material.
4. Debris was seen released from near the top of the LO₂ feedline.
5. Debris from LO₂ feedline bracket on starboard side at Xt 1377 passes in front of thrust strut and does not impact the Orbiter. No foam loss is observed in either Orbiter umbilical still images or crew handheld imagery. Comparison of on-orbit imagery with Baseline Configuration Imagery (BCI) suggests that there was no foam loss from the 1377 flange foot. The foam loss is from the outboard side of the 1377 bracket.
6. Particle spray was seen originating from the starboard wing, outboard of the ET/Orbiter aft umbilical struts, and falls aft near the Orbiter outboard. Possible debris impact was identified two frames prior to the spray event. Radar had a time correlation with estimated material ice. Orbiter reported that the spray event was consistent for ice impact. The SRB Forward Skirt Aft Pointing Camera (SRF210) video shows foam debris liberating from XT1623 LO₂ feedline bracket and impacting thrust strut breaking into multiple debris pieces which subsequently strike the Orbiter thermal Protection System (TPS).
7. A flexible rope-like object was seen flapping near the aft left SRB nozzle at 94.962 sec. KSC noticed a similar flexible rope-like object flapping near the aft right SRB nozzle at 100.868 sec. The objects are seen at the milk-can connector on the left SRB and the triple Booster Separation Motor (BSM) on the right SRB. The material liberated from the right location traveled outboard with no contact to the vehicle. The left remained intact. It is reported that a rope-like material seen behind the right SRB aft skirt, flaps, detaches and falls aft into plume.
8. It was noted at 00:01:38.2 MET that a single piece of debris appeared to contact the Orbiter on the starboard side of the wing chine and produce a light spot on the fuselage tile (possibly tile coating being liberated as a result of the impact). During the R-Bar Pitch Maneuver (RPM) review, a small damage site was identified but later cleared.
9. At 00:01:49 MET, a light spot appears on the Orbiter fuselage tile.

10. A single piece of dark-colored debris is seen at 00:01:52 MET near LH₂ umbilical, then falls aft and possibly contacts the body flap. No evidence of damage was seen during the RPM review.
11. An unusual amount of debris seen in field of view at 00:01:54 MET.
12. Several pieces of debris, which appear to be from the ET attach structure, travel aft underneath the left wing. Analysis could not tell if they impacted the left wing due to overexposure.
13. Dark debris from aft of ET attach fixture appeared to impact underside of the Orbiter on the body flap.
14. A single piece of debris first seen at 00:02:30.7 MET near the starboard bipod, inboard of the LO₂ feedline, traveled up toward the Orbiter and fell aft along the starboard fuselage then appeared to travel over starboard wing. No contact with the Orbiter was identified, but a shadow from the debris was noted.
15. A single piece of debris was seen at 00:02:52.9 MET outboard of the port bipod leg, traveling in the +Z direction toward the fuselage, and appeared to contact the Orbiter (as indicated by the debris changing direction). Debris then fell aft along fuselage and under the wing. This was confirmed as not a debris concern as the time was well past Aerodynamic Sensitive Transport Time (ASTT).

APPENDIX A
STS-118 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	220/22:31:53.137 220/22:31:54.297 220/22:31:55.290
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	220/22:36:13.939 220/22:36:14.099 220/22:36:14.259 220/22:36:14.459
Main Engine Start	SSME-3 Start Command Accepted SSME-2 Start Command Accepted SSME-1 Start Command Accepted	220/22:36:35.443 220/22:36:35.562 220/22:36:35.683
SRB Ignition	SRB Ignition Command	220/22:36:41.989
Throttle Up 104.5 Percent	SSME-3 Command Accepted SSME-2 Command Accepted SSME-1 Command Accepted	220/22:36:45.839 220/22:36:45.839 220/22:36:45.839
Throttle Down to 72 Percent	SSME-2 Command Accepted SSME-3 Command Accepted SSME-1 Command Accepted	220/22:37:14.799 220/22:37:14.800 220/22:37:14.800
Maximum Dynamic Pressure (Max Q)	Derived Ascent Dynamic Pressure	220/22:37:32
Throttle Up to 104.5 Percent	SSME-3 Command Accepted SSME-2 Command Accepted SSME-1 Command Accepted	220/22:37:36.400 220/22:37:36.400 220/22:37:36.401
Both SRMs to less than 50 psi	RH SRM Chamber Pressure LH SRM Chamber Pressure	220/22:38:40.469 220/22:38:40.669
End SRM Action	RH SRM Chamber Pressure LH SRM Chamber Pressure	220/22:38:42.789 220/22:38:42.789
SRB Separation Command	SRB Separation Command Flag	220/22:38:45
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	220/22:38:45.07 220/22:38:45.07 220/22:38:45.11 220/22:38:45.11
OMS Assist Ignition	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	220/22:38:55.3 220/22:38:55.4
OMS Assist Cutoff	R Engine Bipropellant Valve Position L Engine Bipropellant Valve Position	220/22:40:26.8 220/22:40:26.9
Throttle Down for 3g	SSME-2 Command Accepted SSME-3 Command Accepted SSME-1 Command Accepted	220/22:44:06.006 220/22:44:06.007 220/22:44:06.010
3G Acceleration	Total Load Factor (g)	220/22:44:17.6
Throttle down to 67percent for Cutoff	SSME-2 Command Accepted SSME-3 Command Accepted SSME-1 Command Accepted	220/22:45:01.047 220/22:45:01.048 220/22:45:01.052
SSME Shutdown	SSME-2 Command Accepted SSME-3 Command Accepted SSME-1 Command Accepted	220/22:45:07.407 220/22:45:07.408 220/22:44:07.412
Main Engine Cutoff (MECO)	MECO Command Flag MECO Confirmed Flag	220/22:45:07 220/22:45:09
ET Separation	ET Separation Command Flag	220/22:45:29
APU Deactivation	APU-1 Gas Generator Chamber Pressure APU-2 Gas Generator Chamber Pressure APU-3 Gas Generator Chamber Pressure	220/22:50:35.219 220/22:50:51.324 220/22:51:08.547

APPENDIX A
STS-118 MISSION EVENTS

EVENT	DESCRIPTION	ACTUAL GMT
OMS 1 Ignition	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	Not Required
OMS 1 Cutoff	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	Not Required
OMS 2 Ignition	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	220/23:13:42.8 220/23:13:42.9
OMS 2 Cutoff	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	220/23:16:27.9 220/23:16:28.0
Payload Bay Doors Open	Right Payload Bay Door Open 1 Left Payload Bay Door Open 1	221/00:11:46 221/00:13:06
OMS 3 Ignition	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	221/01:36:15.8 221/01:36:15.8
OMS 3 Cutoff	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	221/01:37:07.2 221/01:37:07.2
OMS 4 Ignition	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	221/14:36:18.2 221/14:36:18.2
OMS 4 Cutoff	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	221/14:36:33.8 221/14:36:34.0
OMS 5 Ignition	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	221/13:45:59.4
OMS 5 Cutoff	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	221/13:45:44.2
Docking	Capture	222/18:01:56
Undocking	Undocking Complete	231/11:56:27
Flight Control System Checkout – APU 1 Start	APU-3 Gas Generator Chamber Pressure	232/10:22:03.113
APU 1 Stop	APU-3 Gas Generator Chamber Pressure	232/10:25:17.650
Payload Bay Door Close	Left Payload Bay Door Close Right Payload Bay door Close	233/12:46:58 233/12:52:28
APU Activation	APU-2 Gas Generator Chamber Pressure APU-1 Gas Generator Chamber Pressure APU-3 Gas Generator Chamber Pressure	233/15:20:09.215 233/15:47:30.121 233/15:47:31.038
Deorbit Maneuver Ignition	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	233/15:25:12.1 233/15:25:12.1
Deorbit Maneuver Cutoff	L Engine Bipropellant Valve Position R Engine Bipropellant Valve Position	233/15:28:47.9 233/15:28:48.1
Entry Interface	Orbital Altitude Referenced to Ellipsoid	233/16:00:27
Blackout End	Data Locked (High Sample Rate)	No Blackout
Terminal Area Energy Management (TAEM)	Major Mode Code (305)	233/16:25:50
Main Landing Gear Contact	Main Landing Gear Right Hand Tire Pressure Main Landing Gear Left Hand Tire Pressure	233/16:32:17 233/16:32:17
Main Landing Gear Weight on Wheels	Main Landing Gear Right-Hand Weight on Wheels Main Landing Gear Left Hand Weight on Wheels	233/16:32:17 233/16:32:19
Nose Landing Gear Contact	Nose Landing Gear Left Hand Tire Pressure 1	233/16:32:29
Nose Landing Gear Weight on Wheels	Nose Landing Gear Weight on Wheels	233/16:32:29
Drag Chute Deployment	Drag Chute Deploy 1 CP Volts	233/16:32:30.3
Drag Chute Jettison	Drag Chute Jettison 2 CP Volts	233/16:32:59.0
Wheels Stop	Velocity with respect to Runway	233/16:33:16

APPENDIX A
STS-118 MISSION EVENTS

EVENT	DESCRIPTION	ACTUAL GMT
APU Deactivation	APU-1 Gas Generator Chamber Pressure	233/16:48:05.371
	APU-2 Gas Generator Chamber Pressure	233/16:48:17.884
	APU-3 Gas Generator Chamber Pressure	233/16:48:30.417

APPENDIX B IN-FLIGHT ANOMALIES

INTRODUCTION

This appendix contains listings and discussions of each of the In-Flight Anomalies (IFAs) that were identified for the STS-118 mission.

1. Orbiter
2. Solid Rocket Booster
3. Reusable Solid Rocket Motor
4. External Tank
5. Space Shuttle Main Engine
6. Systems Engineering and Integration (SE&I)

APPENDIX B
STS-118 IN-FLIGHT ANOMALIES
ORBITER ANOMALIES

IFA Number	Title	Comments
STS-118-V-01	PRSD Cryogenics O ₂ Tank 2 Control Pressure Off-Scale Low	<p>At 221/08:18 GMT, the Cryogenics O₂ Tank 2 Control Pressure indication went from a nominal reading of 833 psi to an off-scale low reading of 515L. It was during crew sleep and the Tank 2 heaters were off at the time. Troubleshooting confirmed loss of auto heater control. The plan for the rest of the mission was to use manual heater- operation as required for O₂ Tank 2. The crew used O₂ Tank 1 during crew sleep periods to minimize manual heater-operations and associated crew interaction as much as possible. Post-flight troubleshooting isolated the problem internal to the controller. The controller will be replaced.</p>
TS-118-V-02	Panel 08 Annunciator Lamp Test Switch Left Position Fail	<p>At 000/02:50 MET, the crew reported that during the LAMP TEST (ORB OPS, EPS) the lights on the left side of the Caution and Warning Annunciator located on the F7 panel would not illuminate when taking the panel O8 ANNUNCIATOR LAMP TEST switch to Left position. The signature was clarified on FD 2 after a second Lamp Test confirmed that the panel O8 ANNUNCIATOR LAMP TEST switch would not illuminate the 20 lights on the left side of the F7 panel when taken to the Left position. The 20 lights on the right-hand side of the F7 panel illuminated when this switch was taken to the Right position. Both halves of the F7 panel lights illuminated when the crew utilized the panel O6 ANNUNCIATOR LAMP TEST switch.</p> <p>The initial troubleshooting post-flight repeated the anomaly. It was determined that a discontinuity existed in the circuit going to panel 08. Additional troubleshooting (open panel 08, demate/inspect connector 30P9085 and perform a pull test on pin No.77) will be scheduled after the OMS pod functional test is completed.</p>

APPENDIX B STS-118 IN-FLIGHT ANOMALIES

IFA Number	Title	Comments
STS-118-V-03	TPS Tile Anomalies	<p>A Focused Inspection was requested for the following five locations (listed in priority order): In addition, the gap filler and blanket anomalies that were noted are shown in items 6 through 9.</p> <ol style="list-style-type: none"> 1. Tile damage aft of the starboard Main Landing Gear Door (MLGD) located at X=1260.82, Y=123.04, and Z=268.75. Detection ID: D-118-RPM-600_2-001. 2. Frayed forward portion of thermal barrier on starboard MLGD located at X=1041.74, Y= 129.77, Z=275.01. Detection ID: D-118-RPM-944-001. 3. Tile damage aft of a larger tile damage site located at X=1284.16, Y=125.16 , Z=268.57. Detection ID: D-118-RPM-600_2-002. 4. Tile damage aft of the larger tile damage site located at X=1275.67, Y=133.64 , Z=269.56. Detection ID: D-118-RPM-600_2-003. 5. Tile damage aft of the larger tile damage site located at X=1309.61, Y=133.64 , Z=269.13. Detection ID: D-118-RPM-600_2-004. 6. Blanket pulled back from tile on the starboard OMS pod and located at X=1339.52, Y=58.36, Z=516.37. Detection ID: D-118-AFD-540-002. 7. Pillow Gap Filler that is protruding on the port OMS pod and located at X=1315.3, Y= -95.54, Z=476.57. Detection ID: D-118-AFD-550-007. 8. Small corner of a blanket is protruding at X=442.18, Y=62.88, Z=430.69. Detection ID: D-118-RPM-140-002. 9. Pillow Gap Filler is protruding just forward of the starboard elevon cove and located at X=1375.75, Y=432.91, Z=298.42. Detection ID: D-118-RPM-652ROL-001. 10. Pillow Gap Filler is protruding on port outboard elevon and is located at X=1392.04, Y= -424.67, Z=298.39. Detection ID: D-118-RPM-752-001. 11. Yellow shim is protruding on the starboard MLGD and is located at X=1111.26, Y=144.49, Z=274.28.. 12. Gap Filler Detection Location: Design gap filler is protruding on port OMS Pod, X=1327.66, Y= -115.75, Z=471.78. ID: D-118-AFD-550-005. 13. Gap Filler Location: Gap filler is protruding on port OMS pod, X=1327.03, Y= -88.3, Z=501.02. Detection ID: D-118-AFD-550-006. 14. Horse collar Gap Filler. Location: Horse collar gap filler frayed at starboard Panel # 20, X=1304.26, Y=429.98, Z=301.33. Detection ID: D-118-IDC-600-4-001. 15. Horseshoe Gap Filler. Location: Horseshoe Gap Filler is Protruding Aft of Starboard RCC Panel #22, X=1362.62, Y=454.95, Z=301.38. Detection ID: D-118-RPM-600-3-001.
STS-118-V-04	APU 3 Seal Cavity Drain Line Pressure Decay	<p>At approximately 0/22:00 MET, APU 3's (S/N 306) seal cavity drain line pressures began to slowly decay. The decay was seen in data from both pressure transducers. The pressure decay was approximately 1 psi/day adjusted for temperature.</p> <p>During post-flight testing, the mass spectrometer leak checks were performed, and the leak was found at the TP37 valve on the back side of the stem. No leaks were noted at APU 3. The valve will be replaced during turnaround operations.</p>

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STS-118 IN-FLIGHT ANOMALIES

IFA Number	Title	Comments
STS-118-V-05	FRCS thruster F3D Tyvek Cover Remained Partially Attached	<p>Ground imagery showed that when the FRCS thruster F3D's Tyvek rain cover released at 4.39 sec MET (approximately 56 mph), a small piece remained attached to the thruster lip. (The image was observed at 220/22:36:52 GMT, approximately 10 sec MET). This piece separated at approximately 16 sec MET (approximately 240 mph). Imagery shows that the piece did not impact the Orbiter. No vehicle or mission impacts ensued nor were any crew responses required.</p> <p>The Problem Resolution Team (PRT) investigated and found that the probable causes indicate the material lacked the strength to withstand the localized stress load. Previous test failures suggest that this was likely along the reinforcement edge at the single-ply. The investigation is complete, although no specific cause of the tear was found. The recommendation for STS-120 is to fly as is with the thickest covers that are available. No problems were experienced during STS-120. The Debris Transport Analysis is in work to determine what, if any, changes for the long term are required.</p>
STS-118-V-06	MADS LOMS Pod LRSI Surface Forward Thermocouple Off-Scale High	<p>At approximately 220/22:37:50 GMT, the left OMS surface forward sensor began several steps (up-down-up) and then drifted to Off-Scale High (OSH). The backup measurements were functional throughout ascent.</p> <p>The measurement is Criticality 3/3 and is used for housekeeping data and trending purposes. The sensor of the Thermocouple Temperature Transducer has a range of 0 to 1740 °F. The wire combination is Chromel/Alumel with a K wire symbol. The thermocouple is attached to a 1 channel temperature compensation Thermocouple Reference Junction (TRJ) for accuracy. The measurement is routed to the MADS PCM for commutation and recorded on MMU1/SSR1 and the MADS Tape Recorder.</p> <p>Troubleshooting has isolated the problem to a thermocouple in the tile. Replacement of this instrumented tile will be deferred to the next flow.</p>
STS-118-V-07	MADS LOMS Pod Thermocouple BP049T OSH	<p>At 220/22:38:30 GMT, the left OMS Pod Thermocouple BP049T stepped to OSH (Off Scale High) during ascent. The backup measurements were functional throughout ascent. The measurement is Criticality 3/3 and is used for housekeeping data and trending purposes. The Thermocouple Temperature Transducer has a range of 0 to 1300 °F. The wire combination is Chromel/Alumel with a K wire symbol. The thermocouple is attached to a 1-channel temperature compensation 1 Thermocouple Reference Junction (TRJ) for accuracy. The measurement is routed to the MADS PCM for commutation and recorded on MMU1/SSR1 and the MADS Tape Recorder. Troubleshooting isolated the problem to a bad ground on the instrumented tile. The replacement of this tile will be deferred to the next flow.</p>

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STS-118 IN-FLIGHT ANOMALIES

IFA Number	Title	Comments
STS-118-V-08	Port Forward MRL LAT System 1 Indication Delayed	<p>During RMS powerdown, when the MRLs were latched, the Forward System 1 LAT microswitch remained off. All other microswitches, including the Forward System 2 LAT microswitch showed the LAT state after 6 sec, with a corresponding expected AC current signature. The onboard port RMS retention latches talk-balk (driven off of the System 1 microswitches only) did not change state, and this is the expected condition for this failure case. The crew attempted to latch the MRLs for a total of 18 sec. Approximately 4 hrs 21 mins later, the microswitch state changed to indicate LAT. No mission impact occurred as a result of this condition.</p> <p>Troubleshooting was performed on the ground and no anomalies were noted. The PRT recommendation was to fly this installation as is.</p>
STS-118-V-09	Camera A Magenta Hue	<p>At 232:06:36 GMT, Camera A was downlinked via Ku-Band analog TV and SSV. The image from both sources appeared magenta. A test pattern was downlinked from the camera and it appeared normal. No mission impact.</p>
STS-118-V-10	ADTA 3 Communication Fault During FCS Checkout	<p>Air Data Transducer Assembly (ADTA) 3 was bypassed after the G2/G8 transition during the FCS checkout at 232/10:17:56 GMT. The circuit breaker status for ADTA 3 was nominal (closed). A GNC I/O RESET was performed with no change observed. With ground controller concurrence, a circuit breaker power cycle on panel O16:E followed by a GNC I/O RESET. ADTA 3 was recovered on the power cycle and performed nominally during FCS checkout.</p> <p>The ADTA 3 communications fault occurred again during operations in OP3. An extended powerdown recovered the unit, and it performed nominally during entry.</p> <p>Troubleshooting did recreate the anomaly while flexing the power wire connected to the ADTA 3 circuit breaker at panel O16. ADTA3 is now in question since there was a power spike at power-up that indicates that the ADTA was getting power. The troubleshooting verified that the ADTA was not communicating. The unit will be replaced.</p>
STS-118-V-11	LiOH Dust on Canisters	<p>The crew reported notable LiOH dust that was associated with the use of older Shuttle-ISS stockpile canisters, specifically the STS-114 canisters. The problem may be associated with length of time the canisters are stowed on the ISS and/or ISS storage location. (The canisters may be experiencing some level of vibration, which may contribute to increased dust. Workarounds will include manifesting additional masks, manifesting a different mask and implement a more frequent ISS stockpile rotation schedule.</p>

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STS-118 IN-FLIGHT ANOMALIES

IFA Number	Title	Comments
STS-118-V-12	Pyrotechnic Reefing Line Cutter Did Not Sever the Reefing Line	<p>One of the two redundant reefing line cutters on the drag chute failed to fully sever the reefing line. Approximately half of the line's cross-section was cut. Evidence reveals the line was in motion relative to the cutter when the cutter fired. Evidence of motion consists of the cut approximately 5 to 6 in. off the target mark and off the Teflon-taped area for cutting. Other evidence of line motion is the fraying of the cut portions of the line.</p> <p>Full deployment of the drag chute is accomplished by using mechanically actuated pyrotechnic cutters to sever a reefing line. A lanyard pulls a sear in the cutter and initiates the unit. There is a 3.0-4.8 sec delay from the time the sear is pulled until the blade strokes.</p> <p>Evidence indicates that the cutter tried to function on a moving reefing line which is not the design intention of the device. The cutters are designed to sever static lines only. The reefing line was in a static state until one cutter successfully severed the line and released tension, allowing the line to move. The dynamic line was a result of the successful function of first cutter firing, thereby compromising the function of the redundant unit. The relative function times between each cutter may have also contributed to the issue.</p> <p>The reefing line is made of Kevlar, which can deform cutting blades in off-nominal conditions. As the reefing line moved, the blade edge was deformed and was continuously exposed to fresh Kevlar. This caused the blade cutting edge to be dulled further and momentum to be decreased. These conditions propagated to a point where the cutter could not sever the line.</p> <p>These conclusions are based on the witnessed blade damage, evidence of line movement (cutter functioned outside of targeted area) and line fraying. Also, there was zero evidence of compromised output performance.</p>

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STS-118 IN-FLIGHT ANOMALIES

IFA Number	Title	Comments
STS-118-V-13	Side Hatch Limit Switch Resistance Failure	<p>During final hatch closure for flight, one of two latch over-center limit switches indicated infinite resistance (should be <2.0 ohms). Execution of the preplanned troubleshooting procedure verified proper latch rigging, but was unable to recover the failed limit switch with the hatch closed. Launch proceeded with one of two switches operational.</p> <p>The purpose of the limit switches is to indicate that the latch mechanism is in the fully-latched and over-center position. If a limit switch fails to close, a pre-planned troubleshooting procedure is invoked to verify proper rigging of the latches. If proper rigging can be confirmed, launch may proceed with Material Review Board (MRB) approval. Otherwise, the launch will be scrubbed. There have been at least three previous occurrences of this type of failure on launch day. In each case, the launch proceeded with one of two limit-switch indications. The limit switches are used only during pre-launch hatch closure. There is, therefore no concern for the rest of the mission.</p> <p>KSC IPR 123V-0002 was opened on this anomaly and deferred until after the flight. Post-flight troubleshooting consisted of checking the limit switch and latch mechanism rigging against the rigging specification.</p> <p>KSC completed the side hatch mechanism rigging checks on OV-105, and it appears that the rigging on both limit switches were out of specification. The latch 1 switch is set to a gap that is too small, which explains why we were never able to get it to transfer on launch day (false negative indication). The latch 18 switch, on the other hand, is set to a gap that is too large, such that it is almost guaranteed to transfer even if some of the latches are not over-center (false positive indication).</p>

**APPENDIX B
STS-118 IN-FLIGHT ANOMALIES**

SOLID ROCKET BOOSTER ANOMALIES

There were no in-flight anomalies recorded for the Solid Rocket Boosters.

**APPENDIX B
STS-118 IN-FLIGHT ANOMALIES**

REUSABLE SOLID ROCKET MOTOR ANOMALIES

IFA Number	Title	Comments
STS-118-M-001	Gas Penetrations Through Nozzle Joint 2 RTV	Non-distinct gas penetrations were observed around the full circumference in joint 2 through the Room Temperature Vulcanizing (RTV) on both RSRM-97 A and B nozzles. This recurring observation for most flight and static test motors has not been PRACA reportable because it was considered an in-family condition. However, recent changes in the ground rules (NSTS 08126) now make this PRACA reportable. Because this condition occurred between cryogenic-tanking and booster separation, it has been identified as an in-flight anomaly. Closure of this PRACA item constitutes closure of the IFA. Gas penetration through joint 2 RTV is not consistent with original design intent, but is not unexpected at this point in the program with the accumulated flight experience. This phenomenon is well understood and each occurrence is carefully evaluated for any challenge to flight rationale and level of risk assessment. This non-optimum performance of the RTV thermal barrier constitutes an unsatisfactory condition per the PRACA guidelines. This anomaly is closed as an explained condition.

APPENDIX B STS-118 IN-FLIGHT ANOMALIES

EXTERNAL TANK ANOMALIES

IFA Number	Title	Comments
STS-118-T-001	XT 1973 Inboard LO ₂ Feedline Bracket Base Fitting TPS Crack	<p>A crack in the TPS PDL foam closeout at the XT-1973.5 Feedline Bracket inboard base fitting was observed by the KSC Final Inspection Team during the T-3 hour hold inspection. This condition is a violation of Launch Commit Criteria (ICE-01 as this condition is not contained in the NSTS 08303 Ice/Debris Inspection acceptance criteria. This condition was determined to be acceptable and not a constraint to the launch of STS-118 after rationale was presented to the MMT, clearing the vehicle for flight. Upon review of Orbiter Umbilical Well imagery, the crack did not manifest itself in a foam loss event on STS-118, as the base fitting closeout remained intact. Typical erosion is not uncommon on the forward-facing planes of the closeout.</p> <p>Based on visual inspection, TPS cracking observed at the XT-1973.5 LO₂ feedline support fitting closeout was most likely attributed to the articulation of the LO₂ feedline during ET loading. As the LO₂ is loaded, the bracket at XT-1973.5 shrinks and moves aft approximately 0.35 inch in relation to the ET primary structure. Then, as the LH₂ tank chills and contracts, the bracket moves back forward 0.04 in. No offset had been observed at the base, which is an indication that the TPS had been adequately bonded to the substructure.</p> <p>If the crack had communicated with the substrate, the most probable TPS failure mechanism for this condition would have been cryopumping. Foam loss due to this mechanism was considered unlikely due to the size of the crack (i.e. adequate vent path). In the event a cryopumping-induced failure was to occur, the timing of the release would be well beyond the LH₂ tank liquid level analysis for STS-118, which showed the liquid level passed the XT-1973.5 at approximately 450 sec. MET.</p> <p>This anomaly is closed as an explained anomaly.</p>
STS-118-T-002	STS-118 Film Found TPS Loss at Station 1623 Outboard LO ₂ Feedline Support Bracket & TPS Orbiter Impact	<p>Post launch camera and film review showed loss of TPS material at the 1377 and 1623 outboard (O/B) LO₂ Feedline support yokes. The forward SRB camera captured TPS liberation from the Station 1623 O/B LO₂ feed;ine yoke at approximately 58 sec Mission Elapsed Time (MET). The video shows the travel of the liberated mass down the ET, then deflect off of the +Y Thrust Strut, and then break (separate) into several pieces, of which one piece impacted the Orbiter. Post launch imagery review shows that the liberation from the Sta. 1377 yoke did not impact the Orbiter. TPS from the Xt 1623 LO₂ Feedline Bracket Yoke did impact the Orbiter below the starboard main landing gear door.</p>

**APPENDIX B
STS-118 IN-FLIGHT ANOMALIES**

EXTERNAL TANK ANOMALIES

IFA Number	Title	Comments
STS-118-T-002 (Continued)	STS-118 Film Found TPS Loss at Station 1623 Outboard LO ₂ Feedline Support Bracket & TPS Orbiter Impact	<p>This impact did damage two of the Orbiter TPS tiles creating a 3.5 in. by 2.0 in. gouge that did expose a 1.0 in. by 0.2 in. strip of underlying felt. The velocity of the debris at impact was estimated to be 215 ft/sec.</p> <p>The dimensions of the foam loss event at Station 1377 are approximately 4.11 in. length by 3.82 in. width by 1.8 in. deep at the maximum, with a mass of 0.028 lb. The estimated loss event time is 40 sec MET. This event is within the NSTS 60559 requirement for LO₂ feedline Yoke foam loss (0.037 lb) for MET less than or equal to 135 sec</p> <p>The most probable cause for this event is cracking of the TPS, which was due to mechanical interference with gap ice coupled with aerodynamic shearing.</p> <p>Actions have been taken through testing and analysis in an effort to prevent the loss of ET foam on future flights. An interim closure has been established for this anomaly.</p>
STS-118-T-003	Post-Launch Camera and Film Review Showed LH ₂ Acreage Foam Loss at Station 1163	<p>Foam loss from the T-1163 LH₂ ET acreage appears to have liberated for the most part in a single piece, as evidenced by its consistent shape in the separation imagery. The ET camera, however, shows that this event may have occurred in two pieces, one being significantly smaller than the other, at approximately 151 sec MET (Note that this is virtually identical to the nature of release of the STS-117/ET-124 event at this location).</p> <p>The foam loss was modeled as a single piece worst-case, and using as-built thickness data. From the model, the liberation mass is estimated as 0.026 lbm using the as-sprayed material density of 2.5 lb/ft³. There are multiple repair and sand-and-blend sites in the vicinity of the foam loss event. However, a detailed review of the separation and pre-launch photography showed that this event was neither attributed to nor associated with any repair or sand-and-blend operation. No repairs or sand-and-blend areas lie in the footprint of the foam loss event. Prelaunch assessment did not identify any unusual ice/frost formations or vapors during the loading, nor did KSC IR imagery identify anything unusual in the area.</p>
STS-118-T-004	Post-Launch Camera and Film Review Showed Loss of LH ₂ Acreage Foam at Station 1871	<p>Post-launch camera and film view showed loss of LH₂ Acreage foam at Station 1871 adjacent to the inboard LO₂ Feedline support bracket. The dimensions of the foam loss event at Station 1871 are 8.21 in. length by 7.93 in. width by 0.75 in. depth, with a mass of 0.029 lbm (a combined mass of several pieces). The loss event time was approximately 535 seconds MET. This event occurred post ET separation. This anomaly is closed.</p>

**APPENDIX B
STS-118 IN-FLIGHT ANOMALIES**

SPACE SHUTTLE MAIN ENGINE ANOMALIES

No in-flight anomalies were identified for the Space Shuttle Main Engines.

APPENDIX B STS-118 IN-FLIGHT ANOMALIES

SYSTEM ENGINEERING AND INTEGRATION ANOMALIES

IFA Number	Title	Comments
STS-118-I-001	Unexpected Debris/Expected Debris Exceeding Mass Allowable Prior to Pad Clearance (Liftoff Debris)	<p>During the STS-118 launch, approximately 50 KSC debris sources were identified (of which 24 were assessed to have integrated concerns) from liftoff imagery and postflight inspections.</p> <p>Debris release mitigated for identified potential sources of critical debris:</p> <ol style="list-style-type: none"> 1. Removed items and 2. Added inspections of system level components (e.g. LO₂ Tail Service Mast (TSM) side platform and cable tray cover securing). <p>Ongoing mitigations include Foreign Object Damage (FOD) awareness, routine inspections and monitoring for facility corrosion. Two debris sources were determined not to be a threat to the Shuttle due to their location or time of release. This anomaly is closed.</p>
TS-118-I-002	Foam Loss at Xt 1623 and Xt1377 outboard of the LO ₂ Feedline Bracket Yoke.	<p>The post-launch camera and film review of the STS-118/ET-117 launch showed loss of TPS material at the Xt1377 and Xt1623 outboard LO₂ Feedline support yokes. The estimated loss event time is 58 sec MET. The forward Solid Rocket Booster (SRB) camera captured the TPS liberation from Station Xt1623 O/B LO₂ feedline yoke at approximately 58 sec MET. The video showed the liberated mass traveling down the External Tank, deflecting off of the +Y Thrust Strut, breaking into several pieces resulting in multiple impacts to the Orbiter aft of the starboard Main Landing Gear Door. One of the impacts resulted in a 3.5 in. long by 2.0 in. wide damaged area across two lower surface tiles with the deepest part of the impact leaving an exposed 1.0 in. by 0.2 in. long strip of underlying filler bar felt. The dimensions of the foam loss event at Station Xt1623 were approximately 3.8 in. long by 3.5 in. wide by 1.8 in. deep at the maximum, with a mass of 0.023 lbm. Post launch imagery review showed that the liberation from the Station Xt1377 yoke did not impact the Orbiter. Six damage sites were identified from R-Bar Pitch Maneuver (RPM) imagery in the immediate area of the observed impacts. The largest damage was across two tiles creating the 3.5 in. long by 2.0 in. wide gouge with the 1.0 in. long by 0.2 in. long strip of underlying felt. Impact reconstructions showed that the impact mass was inconsistent with the observed Orbiter tile damage when compared against current foam/tile testing. This suggested a mixed debris event such as foam/ice or foam/SLA. The available imagery (SRB camera video stills) does not conclusively indicate whether or not SLA or ice was liberated with the foam debris. Chemical analysis of the impact site on the Orbiter shows that there were no traces of ablator (SLA). It is not possible to determine from the imagery whether or not ice was attached to the foam debris from the Xt1623 LO₂ Feedline Bracket Yoke. However, it is possible for ice to be attached to the foam debris and liberate with the foam debris.</p>

APPENDIX B

STS-118 IN-FLIGHT ANOMALIES

IFA Number	Title	Comments
STS-118-I-002 (Continued)	Foam Loss at Xt 1623 and Xt1377 outboard of the LO ₂ Feedline Bracket Yoke	The damage reconstruction from the STS-118 impact combined with preliminary mixed debris impact testing of foam and ice suggests that mixed debris sources can cause significant damage that can lead to possible catastrophic failure. Due to the early time of release it was determined that the most probable cause for the STS-118 liberation event was cracking of the TPS due to mechanical interference caused by ice buildup in the gap between the yoke and upper outboard monoball closeout followed by Aerodynamic shearing. This anomaly is an interim closure because of the continuing activities to prevent the loss of foam from the areas in this anomaly.
STS-118-I-003	ET Foam LH2 Acreage Loss	The LH ₂ Tank Acreage Aft of +Y Bipod fitting closeout at Xt 1163. A piece of LH ₂ acreage foam was missing from just below the +Y bipod fitting, at Xt 1163. The ET LO ₂ feedline video indicates a release event at 150.7 sec MET that does not appear to impact the vehicle. The Starboard SRB Forward Skirt Aft Pointing camera video does not provide additional data because the release event occurs after SRB separation. The WLEIDS analysis reports that there is not a correlating indication to this event, nor is there any correlation to RADAR events. ET estimates dimensions to be approximately 9.95 in. long by 4.34 in. wide by 1.25 in. deep, with a mass of 0.026 lbm. The ET Corrective Action Team recommended a series of additional inspections of ET hardware. A visual and tactile inspection was performed on ET-120 aft of the +Y Bipod on the LH ₂ acreage while scaffolding was in place in the KSC ET Checkout Cell in the VAB. Three defects not related to the Xt-1163 foam loss event were found and subsequently repaired via sand and blend operations. This anomaly is closed.
STS-118-I-004	F3D Partial Tyvek Cover Release	While part of the Tyvek cover on thruster F3D released at approximately 4.4 sec MET, a second piece remained. It was observed releasing at approximately 16.5 sec MET, an exceedance of the 170 mph requirement. It was concluded from this investigative work that the most probable cause of the tear was insufficient material strength to withstand the stress load produced by the extreme flight environment associated with the F3D cover location. DAT analysis for window and TPS [Tile and Reinforced Carbon-Carbon (RCC) revealed: a. No transport to windows after Mach 0.4 (approximately 465 ft/sec) b. OMS pod impacts possible up to approximately 600 ft/sec c. RCC and lower surface tile impacts likely throughout Mach 2.5 Impact testing based was performed on Windows, RCC and Tile. Impact testing for Windows resulted in damage below the critical damage threshold. No detectable damage was observed on RCC impact test panels. For Tile, releases occurring above 600 ft/sec resulted in unacceptable damage. However, release is expected well before these velocities based on low bond-strength and localized CFD analysis. This anomaly is closed.

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STS-118 IN-FLIGHT ANOMALIES

IFA Number	Title	Comments
STS-118-I-005	Rope-like Objects Flapping near Aft Left SRB and Right SRB Nozzle	The observation aft of the right SRB is believed to be Viton-coated Nylon from the SRB Aft Skirt Thermal Curtain. The SRB thermal curtains functioned as designed. There were no observations noted by the assessment teams to suggest premature performance degradation of the curtains. Closed as an explained anomaly.
STS-118-I-006	SSRMS Movement Prior to Shuttle Ku-Band Mask	The crew was ahead in their activities and, with Mission Control Center (MCC) concurrence, commanded the Space Station Remote Manipulator System (SSRMS) movement 18 min prior to Shuttle Ku-band antenna radiation masking being enabled. The SSRMS was left unprotected for 18 min. The plan is to update Flight Controller Operations Handbook (FCOH) Standard Operating Procedure (SOP) to ensure MCC awareness of Ku-Band masking. This anomaly is closed
STS-118-I-007	BFS Loss of Class III Alert from Spacehab	A payload Class 3 fault message was anticipated for the Spacehab parameter "EMERGENCY BUS VOLTAGE", but was not seen upon BFS being moded from Standby to Run. The lack of the message indicates that BFS received data that was within limits. Source was stale data from an unanticipated power-on of Spacehab module during launch countdown to install a tape into a video recorder. This anomaly was closed as an explained condition.
STS-118-I-008	Contamination in SSME LOX Dome	During the STS-118 standard post-flight Power-Head borescope inspections, rust colored contamination was noted in the Main Injector Liquid Oxygen (LO ₂) Dome area of Space Shuttle Main Engines (SSME) 2047, 2051, and 2045. Engine position 1 (Eng. 2047) had more contamination than the other two engine domes. Swab samples were taken and sent to the contractor for the SSME's for analysis. A summary of the analysis showed the spots varied in diameter from approximately 0.020 in. to 0.05 in. with a height of 0.001 in. or less. Chemical analysis identified the particles as consisting of major iron and oxygen with major-to-minor silicon and minor-to-trace chloride and trace phosphorus and sulfur. The particles ranged in size from approximately 0.0012 in. (30 microns) to approximately 0.0020 in. (50 microns) in size. Based on the analysis, the particles are identified as most likely corrosion product (rust). The source of the particles could not be determined at the present time. However, it should be noted that the contamination source is most likely external to the SSME engine as this type of material is not used in the engine.

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IFA Number	Title	Comments
STS-118-I-008 (Continued)	Contamination in SSME LOX Dome	<p>Functional Criticality of the Nonconformance Generically, metallic contamination in the LO₂ system can cause a catastrophic event. The contamination that was found is well within the allowable size limit of the LO₂ system (800 microns). However, the STS-118 contamination source is unknown and therefore, the potential for future contamination above the allowable limit is a concern. The Main Propulsion System (MPS) has filters to preclude contamination in excess of the allowable limit (Oxygen filters: LO₂ Tanker - 25 microns; Main Launch Platform (MLP) - 175 microns; ET - 800 microns; GN₂: MLP - 10 microns; SSME - 20 microns; and Helium: Orbiter 25 - microns.)</p> <p>Particles like those found on STS-118 are not a hazard to flight. The contamination is within the operational limit of 800 microns. No MPS performance anomalies were experienced during STS-118.</p> <p>The particles were assessed from both an impact ignition and orifice clogging perspective. Unlimited quantity of particles below 250 microns will not cause LO₂ hardware failures. This suggests that the contamination controls are working properly. The composition of the particles indicates the most probable source of the oxidized iron particles is low alloy based steel such as 4100-series or carbon steel. These steels are not used in LO₂ system components, indicating the contamination is not a result of internal LO₂ system.</p> <p>This anomaly is interim closed for final closure prior to STS-123, because the same Main Launch Platform is not being used for the next mission.</p>

APPENDIX C

DOCUMENT SOURCES

MER DAILY REPORTS

The following STS-118 MER Daily Reports by Malise Fletcher, Lead MER Manager:

First Daily Report (Ascent Plus 2-Hour Report), dated August 9, 2007
Second Daily Report, dated August 9, 2007
Third Daily Report, dated August 10, 2007
Fourth Daily Report, dated August 11, 2007
Fifth Daily Report, dated August 12, 2007
Sixth Daily Report, dated August 13, 2007
Seventh Daily Report, dated August 14, 2007
Eighth Daily Report, dated August 15, 2007
Ninth Daily Report, dated August 16, 2007
Tenth Daily Report, dated August 17, 2007
Eleventh Daily Report, dated August 18, 2007
Twelfth Daily Report, dated August 19, 2007
Thirteenth Daily Report, dated August 20, 2007
Landing Plus 2 Hour Report, dated August 21, 2007
Landing Plus 2 Day Report, dated August 23, 2007

ET/SRB/RSRM/SSME REPORTS

STS-118 Executive Summary SRB and SRSS, David W. Morr, MSFC-USA, October 17, 2007
STS-118 SRB, RSRM and ET Console Flash Report, David W. Morr, USA-Huntsville, October 17, 2007
STS-118 Initial Event Times, David W. Morr, MSFC-USA, August 8, 2007
STS-118 Final Event Times, David W. Morr, MSFC-USA, August 16, 2007
STS-118 RSRM-97 FET Executive Summary, L. J. Manuel, MSFC-Huntsville, July 10, 2007

ORBITER REPORTS

STS-118 Launch + 2 Day Report Ascent Performance Report, David Blake, Boeing-Houston, August 9, 2007
STS-118 Landing and Deceleration Report, Thomas L. Hoffman, Boeing-Houston, September 11, 2007
STS-118 ADTA Report, Howard A. Damoff, Boeing-Houston, September 12, 2007.
STS-118 Communications and Tracking Report, Martha M. May, Boeing-Houston, September 11, 2007
STS-118 Ascent Hazard Analysis Report, Lillian P. Gibson, Boeing-Houston, October 10, 2007
STS-118 Displays and Controls and Lighting Report, Q. P. Ngo, Boeing-Houston, September 12, 2007
STS-118 Shuttle Remote Manipulator System, Leissa Smith, MDA-Houston, October 22, 2007, 2007
STS-118 HYD/WSB/Actuators Final Report, Charles A. Rittrivi, Boeing-Houston, September 10, 2007
STS-118 PRSD System Mission Report, Johnny D. Wong, Boeing-Houston, September 12, 2007
STS-118 Main Propulsion System Report, Trina A. Martingano, Boeing-Houston, September 11, 2007
STS-118 Ingress/Egress Hatch Report, Jeffrey A. Goodmark, Boeing-Houston, August 8, 2007

STS-118 Mechanical Systems Report, Jeff Goodmark, Boeing-Houston, September 12, 2007
STS-118 Auxiliary Power Unit System, Christopher N. Adi, Boeing-Houston, September 12, 2007
STS-118 OI/MADS Mission Reports, Dwight A. Favors, Boeing-Houston, September 10, 2007
STS-118 OI/MADS MUX and Timing Report, Bruce S. Woods, Boeing-Houston, September 11, 2007
STS-118 Data Processing System Integrated Report, Lynna Wood. Boeing-Houston, September 11, 2007
STS-118 ATCS Post-Flight Mission Report, Carmelo Asuncion, Boeing-Houston, September 10, 2007
STS-118 Life Support Systems Report (ARPCS and Airlock Systems; Supply Water and Waste Water Management, and Fire and Smoke Detection System), Isaac Andu, Boeing-Houston, September 11, 2007
STS-118 Orbiter Docking System Summary, Robert E. Davis, Boeing-Houston, October 1, 2007
STS-118 OMS Report, Donald E. Varanauski, Boeing-Houston, September 12, 2007
STS-118 RCS Mission Report, Mickie Equia, Boeing-Houston, September 12, 2007
STS-118 Final Aeroheating Report, Dennis C. Chao, Boeing-Houston, November 16, 2007
STS-118 Fuel Cells Mission Report, Johnny D. Wong, Boeing-Houston, September 12, 2007.
STS-118 Global Positioning System Report, Ray Nuss, NASA-JSC September 11, 2007
STS-118 Thermal Control System Report, Mark J. Flahaut, NASA,JSC, November 4, 2007.
STS-118 Thermal Control System Summary, Dan Reynolds, Boeing-Houston, November 5, 2007
STS-118 Mechanisms and MPMs, Link Salvador, Boeing-Houston, September 12, 2007
STS-118 Purge, Vent and Drain Report, F. Merheb, Boeing-Houston, November 15, 2007
STS-118 Flight Controls Mission Report, Donald E. Marquith, Boeing-Houston, September 12, 2007
STS-118 Final Mission Events List, Vernon C. Hill, ESCG-Houston, received August 21, 2007.
STS-118 WLE IDS Post Flight Report, Jon N, Maynard, Boeing-Houston, November 9, 2007.

OTHER REPORTS

STS-118 CSR Report, Shelby j. Lawson, NASA-JSC, November 14, 2007
STS-118 Final Debris Hits, Thomas F. Ford, NASA-KSC, October 16, 2007
STS-118 ExtraVehicular Activity Report for EVA 2, Chun H. Yau, Hamilton Standard, August 13, 2007
STS-118 ExtraVehicular Activity Report for EVA 3, Shannon L. Cagle, Hamilton Standard, .August 15, 2007
STS-118 ExtraVehicular Activity Report for EVA 4, Shannon L. Cagle, Hamilton Standard, August 18, 2007
STS-118 ExtraVehicular Activity Mission Report, Bridget R. Ziegelaar, NASA-JSC, October 12, 2007

APPENDIX D

ACRONYMS AND ABBREVIATIONS

Acronyms	Explanation
ABE	Arm Based Electronics
ABS	Ammonia Boiler System
Ac	Alternating current
ADTA	Air Data Transducer Assembly
AGT	Adaptive Guidance Throttling
AHMS	Advanced Health Monitoring System
AMPS	Automated Meteorological Profiling System
APFR	Articulating Portable Foot Restraint
APCU	Auxiliary Power Converter Unit
APU	Auxiliary Power Unit
ARPCS	Atmospheric Revitalization Pressure Control System
ARS	Atmospheric Revitalization System
ASTT	Aerodynamic Sensitive Transport Time
ATA	Ammonia Tank Assembly
ATCS	Active Thermal Control System
BCDU	Battery Charge/Discharge Unit
BCI	Baseline Configuration Imagery
BFS	Backup Flight System
BGTS	Beta Gimbal Transition Structures
BGA	Beta Gimbal Assemblies
BLT	Boundary Layer Transition
BITE	Built In Test Equipment
BSM	Booster Separation Motor
BSP	Baseband Signal Processor
CAS	Common Attachment System
CDR	Commander
CDT	Central Daylight Time
CEI	Contract End Item
CETA	Crew Equipment Transition Aid
CFD	Computational Fluid Dynamics
CFU	Colony Forming Units
CGBA	Commercial Generic Bioprocessing Apparatus
CLA	Capture Latch Assembly
CMG	Control Moment Gyroscope
COMM	Communications
CPM	Cell Performance Monitor
CRD	Command Receiver Decoder
C&W	Caution and Warning
CWC	Contingency Water Container
DADS	Day of Launch Ascent Design System
DAG	Docked Air-to-Ground
DAIU	Docked Audio Interface Unit
DAP	Digital Autopilot
DAT	Damage Assessment Team

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ACRONYMS AND ABBREVIATIONS

Anomaly	Explanation
D&C	Display and Control
DDU	Data Display Unit
DMHS	Dome Mounted Heat Shield
DOLILU	Day of Launch I Loads Update
DPS	Data Processing System
DTO	Development Test Objective
ΔP	Differential Pressure
ΔV	Differential Velocity
EBCS	External Berthing Camera System
ECLSS	Environmental Control and Life Support System
ECO	Engine Cutoff
ECWS	Element Control Work Station
EDAC	Error Detection and Correction
EDT	Eastern Daylight Time
EI	Entry Interface
EMCC	Emergency Mission Control Center
EMU	Extravehicular Mobility Unit
EO	ET/Orbiter
EPDC	Electrical Power Distribution and Control
ESP	External Stowage Platform
ET	External Tank
EVA	Extravehicular Activity
EWIS	External Wireless Instrumentation System
FBMBT	Flexible bearing mean bulk temperature
FC	Fuel Cell
FCS	Flight Control System
FD	Flight Day
FES	Flash Evaporation System
FID	Failure Identifiers
FOD	Foreign Object Damage
FOM	Figure of Merit
FRGF	Flight Releasable Grapple Fixture
FSE	Flight Service Equipment
FSS	Flight Service Structure
FSW	Flight Software
GCA	Ground Carrier Assemblies
GEI	Ground environmental instrumentation
GFE	Government Furnished Equipment
GMT	Greenwich Mean Time
GN&C	Guidance, Navigation and Control
GPS	Global Positioning System
GSE	Ground Support Equipment
GUCP	Ground Umbilical Carrier Plate

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ACRONYMS AND ABBREVIATIONS

Acronym	Explanation
GVA	Guide Vane Assembly
H ₂ /H ₂ OHD	Hydrogen/Oxygen
HGDS	Holddown Post
HPFTP	Hazardous Gas Detection System
HPGT	High Pressure Turbopump
HPOTP	High Pressure Gas Tank
HR	High-pressure oxidizer turbopump
HYD	High Resolution
IAPFR	Hydraulic
IBA	International Articulating Portable Foot Restraint
	Inspection Boom Assembly
ICOMM	Intercommunications
IDP	Integrated Data Processor
IFA	In-flight anomaly
I/O	Input/output
IMU	Inertial Measurement Unit
IRD	Integrated Receiver Decoder
ISS	International Space Station
ITS	Integrated Truss Segment
ITS-S5	Integrated Truss Segment – Starboard 5
IVA	Intravehicular
JSC	Johnson Space Center
Km	Kilometer
KSC	Kennedy Space Center
KYA	Keel Yoke Assemblies
lbm	pound-mass
lb/min	pound per minute
LCC	Launch Commit Criteria
LESS	Leading Edge Structure System
LH	Left-Hand
LiOH	Lithium Hydroxide
LLCO	Low-Level Cutoff
LSM	Logistics Single Module
MADS	Modular Auxiliary Data System
MAUI	Maui Analysis of Upper Atmosphere Injections
MAGR	Miniature Airborne-to-Ground Receiver
MBS	Mobile Remote Services Base System
MC	Midcourse Correction
MCC-H	Mission Control Center-Houston
MDCA	Main Distribution Control Assembly
MECO	Main Engine Cutoff
MEDS	Multifunction Electronic Display System

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ACRONYMS AND ABBREVIATIONS

Anomaly	Explanation
MER	Mission Evaluation Room
MERLIN	Microgravity Experiment Research Locker Incubator
MET	Mission Elapsed Time
MISSE	Materials International Space Station Experiment
MLE	Middeck Locker Equivalent
MLGD	Main Landing Gear Door
MLP	Mobile Launch Platform
MLS	Microwave Landing System
MM	Momentum Manager
MMOD	MicroMeteoroid Orbital Debris
MMT	Mission Management Team
MORD	Medical Operations Requirements Document
MPM	Manipulator Positioning Mechanism
MPS	Main Propulsion System
MRL	manipulator release latch
MSBLS	Microwave Scanning Beam Landing System
MSU	Mass Storage Unit
MT	Mobile Transporter
NASA	National Aeronautics and Space Administration
NAV	Navigation
NAVAIDS	Navigation Aids
NC	Nominal Correction (Maneuver)
NCC	Nominal Corrective Combination (Maneuver)
NSLD	NASA Shuttle Logistics Depot
NTA	Nitrogen Tank Assembly
OAA	Orbiter Access Arm
OBSS	Orbiter Boom Sensor System
ODS	Orbiter Docking System
OFI	Operational Flight Instrumentation
OI	Operational Instrumentation
OME	Orbital Maneuvering Engine
OMRSD	Operational Maintenance and Requirements Specification Document
OMS	Orbital Maneuvering System
OPCU	Orbiter Power Converter Unit
OPF	Orbiter Processing Facility
OPO	Orbiter Project Office
ORGA	Orbiter Rate Gyro Assembly
ORU	Orbital Replacement Unit
OSE	On-Orbit Support Equipment
OSH	Off-Scale-High
OSL	Off-Scale-Low

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ACRONYMS AND ABBREVIATIONS

Acronyms	Explanation
OTV	Operational Television
OV	Orbiter Vehicle
OWP	Orbiter Work Platform
PASS	Primary Avionics Software System
PDGF	Power and Data Grapple Fixture
PEC	Passive Experiment Container
PDU	Power Drive Unit
PFRAM	Passive Flight Releasable Attachment Mechanisms
PGME	Propylene Glycol Monomethyl Ether
PGSC	Payload and General Support Computer
PiP	Plug in Place
PLBD	Payload Bay Door
PM	Phase Modulation
PMA	Pressurized Mating Adapter
PMBT	propellant mean bulk temperature
PMDIS	Perpetual Motor Deficit in Space
ppCO ₂	Partial pressure Carbon Dioxide
ppm	Parts per million
P/RJ	Pitch//Roll Joint
PRSD	Power Reactant Storage and Distribution System
PRT	Problem Resolution Team
psi	Pounds per square inch
psia	pound per square inch absolute
PTU	Power Transfer Unit
PV&D	Purge, Vent and Drain
PVR	Photovoltaic Radiator
PVRG	Photovoltaic Radiator Grapple Fixture
PWR	Payload water reservoir
QA	Quality Assurance
QD	Quick Disconnect
RAMBO	Ram Burn Observation
RCC	Reinforced Carbon-Carbon
RCS	Reaction Control System
RET	Retractable Equipment Tether
RF	Radio Frequency
RH	Right Hand
RHC	Rotational Hand Controller
RJD	Reaction Jet Driver
RM	Redundancy Management
RPC	Remote Power Controller Modules
RPM	R-Bar Maneuver
RSBPCU	Rudder Speed Brake Power Control Unit
RSD	Range Safety Distribution

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ACRONYMS AND ABBREVIATIONS

Acronym	Explanation
RSRM	Reusable Solid Rocket Motor
RSS	Range Safety System
RTV	Room Temperature Vulcanizing (material)
S&A	Safe and Arm
SASA	S-band Antenna Structural Assembly
SAW	Solar Array Wing
SCS	Solid Rocket Booster Camera System
SDBI	Short Duration BioAstronautics Investigation
SDFS	Smoke Detection and Fire Suppression
SDTO	Shuttle Development Test Objective
SM	Service Module
SLWT	Super Lightweight (ET)
SMRD	Spin Motor Rotation Detector
SM	Service Module
S/N	Serial Number
SPEGIS	Streptococcus Pneumoniae Expressions of Genes in Space
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
SSTS	Short Space Truss Segment
SSV	Sequential Still Video
ST	Star Tracker
STA	Station
STS	Space Transportation System
SWWMS	Supply and Waste Water Management System
SY	Shoulder Yaw (Joint)
TACAN	Tactical Air Navigation System
TCDT	Technical Countdown Demonstration Test
TCS	Thermal Control System/Trajectory Control Sensor
TCTS	Terminal Countdown Test Sequencer
TEA	Torque Equilibrium Attitude
THC	Translational Hand Controller
TI	Terminal Phase Initiation/Transfer Initiation
TIG	Time of Ignition
TPL	Transfer Priority List
TPS	Thermal Protection System
TSM	Tail Service Mast

APPENDIX D

ACRONYMS AND ABBREVIATIONS

Acronym	Explanation
TUFI	Toughened Unipiece Fibrous Insulation
TVC	Thrust Vector Controller
UA	Unexplained Anomaly
USAF	United States Air Force
USMC	United States Marine Corp
V	Volt
VBR	Vibration Boost Regulator
VCR	Video Cassette Recorder
Vdc	Volts direct current
VRCS	Vernier Reaction Control System
WCS	Waste Collection System
WETA	Wireless Video System External Transceiver Assembly
WLE	Wing Leading Edge
WLEIDS	Wing Leading Edge Impact Detection System
WSB	Water Spray Boiler
WVS	Wireless Video System

Symbol/Acronym	Explanation
CO ₂	Carbon Dioxide
deg/sec	degree per second
°F	degrees Fahrenheit
ft	feet
GH ₂	gaseous hydrogen
GN ₂	gaseous nitrogen
GO ₂	gaseous oxygen
kW	Kilowatt
kWh	kilowatt hours
lbm	pound mass
LH ₂	liquid hydrogen
LO ₂	liquid oxygen
Lb	Pound
Mph	miles per hour
nmi	nautical mile
Scch	Standard cubic centimeters per hour
scim	standard cubic inches per minute
min	minute
sec	second
Hr	Hour
in	Inch
mmHg	millimeters Mercury