

STS-114 SPACE SHUTTLE MISSION REPORT

June 2006



**National Aeronautics and
Space Administration**

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

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STS-114

SPACE SHUTTLE MISSION REPORT

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STS-114 SPACE SHUTTLE MISSION REPORT

INTRODUCTION

The Space Transportation System (STS) -114 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 this 114th mission of the Space Shuttle Program. STS-114 was the Return-to-Flight mission for the Space Shuttle Program (SSP). STS-114 was a dual-purpose mission for flight testing Space Shuttle subsystems and delivering supplies to the International Space Station (ISS).

STS-114 was the 89th mission since the return to flight following the STS-51L mission, the 17th to the ISS, and the first mission following the loss of the STS-107 Orbiter and crew. STS-114 was also the 31st flight of the *Discovery* vehicle.

The flight vehicle consisted of the OV-103 Orbiter; the ET, a super lightweight tank (SLWT) designated ET-121; three Block II SSMEs that were designated as serial numbers (S/Ns) 2057, 2054, and 2056 in positions 1, 2, and 3, respectively; and two SRBs that were designated B1-125. The two RSRMs were designated flight set RSRM-92. The individual RSRMs were S/N 360W092A and S/N 360W092B. Launch pad 39B and Mobile Launch Platform (MLP) -3 were used as the platform for launch of the STS-114 mission.

The primary objectives of the STS-114 mission were as follows:

- Demonstrate the capability to inspect all of the Orbiter reinforced carbon-carbon (RCC) panels and Thermal Protection System (TPS) tiles.
- Test new TPS tile-repair method
- Replace Control Moment Gyro 1 (CMG-1) on the International Space Station (ISS)
- Perform three extravehicular activities (EVAs)
- Transfer logistical assets and supplies to the ISS.

Other objectives included the installation of the External Stowage Platform 2 (ESP-2) and transfer of the Multi-Purpose Logistics Module (MPLM) to the ISS. The MPLM contains logistical items for transfer to the ISS and for the transfer of items from the ISS for return to Earth.

STS-114 included significant new capabilities to monitor for released debris during ascent and any subsequent impacts to the Orbiter Thermal Protection System (TPS). These monitoring capabilities included ground-based cameras, External Tank (ET)-based cameras, radar, and wing leading edge (WLE) impact detection instrumentation. This was the first flight of the Orbiter Boom Sensor System (OBSS), which provided the capability to conduct robotic on-orbit inspections of all areas of the Orbiter TPS. In

addition, an R-bar pitch maneuver (RPM) was added to the rendezvous with the ISS so that the ISS crew could photograph the Orbiter.

The STS-114 flight was planned to be a 12-day plus 2-contingency-day flight. An additional docked day was approved during the flight by the Mission Management Team (MMT) because consumables were available. Two contingency days were available for landing weather avoidance or other Orbiter contingencies. One of the contingency days was used because of inclement weather conditions at Kennedy Space Center (KSC). On the landing day, two attempts to land at KSC were waved off, and as a result, the landing site was changed to Edwards Air Force Base (EAFB), CA.

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, ET, and Integration in-flight anomalies (IFA's) 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 and abbreviations and definition as used throughout this report.

The seven crewmembers that were on the STS-114 flight are Eileen Marie Collins, Colonel, U. S. Air Force, Retired, Commander; James M. Kelly, Colonel, U.S. Air Force, Pilot; Soichi Noguchi, Civilian, Mission Specialist 1; Stephen K. Robinson, Ph.D., Civilian, Mission Specialist 2; Andrew S. W. Thomas, Ph.D., Civilian, Mission Specialist 3; Wendy B. Lawrence, Captain, U. S. Navy, Mission Specialist 4; and Charles J. Camarda, Ph.D., Civilian, Mission Specialist 5.

STS-114 was the fourth flight for the Commander, Mission Specialist 3, and Mission Specialist 4, the third space flight for Mission Specialist 2, the second space flight for the Pilot, and the first space flight for Mission Specialist 1 and Mission Specialist 5.

MISSION SUMMARY

STS-114 was originally scheduled to launch on July 13, 2005. During the launch countdown, ET liquid hydrogen (LH₂) engine cutoff (ECO) sensor indication 2 continued to indicate wet when it was commanded dry (IFA STS-114-V-01) during the checkout of the point sensor system. This violation of the Launch Commit Criteria (LCC) MPS-22 resulted in a decision to scrub the launch. An IPR (114V-0446) was taken against this problem. Subsequent troubleshooting under ambient conditions was unable to repeat the failure. A troubleshooting team was formed to investigate this problem. The Orbiter wiring for sensor indications 2 and 4 was swapped to help isolate the source of the failure (Orbiter or ET) should it occur again. The launch was rescheduled for July 26, 2005.

FLIGHT ACTIVITIES

Flight Day 1

During the prelaunch cryogenic tanking and stable replenish, the LH₂ and liquid oxygen (LO₂) ECO sensors performed as expected in response to all simulation commands. No other vehicle issues were identified during prelaunch.

Launch of the STS-114 mission occurred at ignition of the SRB RSRMs at 207/14:39:00.013 GMT, which was 09:39:00.013 Eastern daylight time (EDT) on July 26, 2005. The weather conditions at liftoff were as follows:

1. Winds were from 10 degrees at 4.0 to 5.0 knots;
2. Ambient temperature was 84 °F;
3. Barometric pressure was 30.02 inHg; and
4. Relative humidity was 68 percent.

All Orbiter subsystems performed nominally during ascent.

An Orbital Maneuvering System (OMS) assist maneuver was performed following SRB separation. OMS ignition occurred at 207/14:41:12.076 GMT (00/00:02:12.063 MET), and the OMS assist maneuver was 2 min 12 sec in duration.

Main engine cutoff (MECO) occurred at 207/14:47:26 GMT (00/08:26 MET). The Orbiter separated from the ET 21 sec later at 207/14:47:47 GMT. The LO₂ ECO sensors 1 and 4 flashed dry 6 sec after MECO, and this is a normal phenomenon.

SRB separation and ET separation were clearly visible from the ET camera. Three areas of potential tile damage were seen on ascent video for evaluation by the TPS Damage Assessment Team, and these are discussed later in this summary.

During main engine ignition, the left OMS inboard, upper, Y-web temperature sensor began reading erratically at 207/14:38:57 GMT (IFA STS-114-V-03). After

approximately 2 min of erratic behavior, the transducer recovered for approximately 8 min before resuming the erratic behavior. The sensor experienced its first extended period of off-scale high at 207/15:03:10 GMT (00/00:24:10 MET). This off-scale high indication occurred whenever the heater cycled. The impact of this failure was the loss of direct insight into the left OMS inboard, upper, Y-web heater operation. Indirect insight was still available through the adjacent outboard, upper, Y-web temperature sensor, and it confirmed nominal heater cycling during the mission.

Ascent ground camera imagery showed that two Forward Reaction Control System (FRCS) launch covers (made of Tyvek) were released above the certified vehicle speed of 150 mph (IFA STS-114-V-02). According to the times of the photographs, the thruster F4D cover released at 12.987 sec, and the thruster F3D cover released at 21.548 sec, after launch. These times correspond to estimated airspeeds of approximately 185 and 345 mph, respectively. A preliminary review of launch video data did not indicate that either thruster cover impacted the Orbiter. Although other covers were observed to impact the Orbiter within allowable design speeds, no TPS damage was attributed to Tyvek cover releases. This failure did not affect FRCS thruster performance, as both thrusters fired nominally at ET separation.

The OMS-2 maneuver was performed at 207/15:17:00.076 GMT (00/00:38:00.063 MET) and was 65 sec in duration. The differential velocity (ΔV) was 98.9 ft/sec, and the orbit achieved was 85.2 by 123.6 nmi.

During payload bay door (PLBD) opening, the PLBD right-door-close system 2 indication stayed on for approximately 21 sec longer than the close system 1 indication, after which it changed to the off position (IFA STS-114-V-04). No on-orbit operations were affected by this problem. Both starboard door-open indications transitioned to the open position within the maximum dual-motor run time. This failure did not repeat later in the flight when the PLBDs were reopened following wave-off of the first two landing opportunities on the first planned landing day.

Auxiliary power unit (APU) 1 showed a pressure decay in the drain line that started approximately 1 hr after APU shutdown (IFA STS-114-V-06). The pressure gradually decayed from 15.2 psi to approximately 1.2 psi at end of mission. The drain system showed no evidence of fuel leakage into the drain system during APU operation. This condition was monitored throughout the mission and had no impact on the mission.

Development Test Objective (DTO) 850, Water Spray Boiler (WSB) Cooling with Water/ Propylene Glycol Monomethyl Ether (PGME) Antifreeze, was performed. APU 3 was started at approximately 207/18:05:07 (00/03:26:07 MET). DTO 850 successfully demonstrated the ability to perform a WSB "Hot Re-Start" with PGME/water and the ability to provide APU lubrication oil cooling as soon as 3.5 hr MET. This DTO demonstrated the capability to perform an early return from orbit in the event of a mission contingency.

The port manipulator positioning mechanism (MPM) was deployed at 207/17:34:44 GMT (00/02:55:44 MET) in dual-motor time. The Shuttle Remote Manipulator System (RMS) was subsequently powered up and uncradled. RMS joint drive checkout was successful with no problems noted. The RMS was then positioned in the OBSS pre-grapple position to record video of the Ku-band/OBSS clearance prior to starboard MPM deployment. The RMS was powered down prior to the NC1 maneuver.

The OMS 3 (NC1) rendezvous maneuver was performed just prior to crew sleep at 207/19:42:24.277 GMT (00/05:03:47.264 MET), and cutoff was 80.4 sec later. The orbit achieved was 123.1 by 154.1 nmi.

The starboard MPM was deployed at 207/20:20:22 GMT (00/05:41:22 MET) in dual-motor time.

Initially, intermittent loss of S-band communications was observed from the lower left forward antenna, however, reception improved to nominal conditions for the remainder of the mission.

The crew described the video through the Audio Visual Interface Unit (AVIU) as bad (IFA STS-114-V-13). Because of crew timeline constraints, the unit was swapped out and no troubleshooting was performed during the remainder of the mission.

During crew sleep at 208/01:45 GMT (00/11:06:00 MET), the APU 2 gearbox nitrogen pressure and gas generator bed temperature experienced a step function to 0 (off-scale low) for approximately 2 sec (IFA STS-114-V-09). Data from main bus B aft power controller 5 indicated a drop in current at the same time. There was no mission impact for this momentary dropout, and the problem did not recur.

Flight Day 2

The OMS 4 (NC2) rendezvous maneuver was performed at 208/06:55:31.277 GMT (00/16:16:31.264 MET) and cutoff was 30.2 seconds later. The orbit achieved was 149.6 by 153.6 nautical miles.

The RMS was powered up at 208/06:24 GM (00/15:45 MET) and uncradled. The End Effector checkout was successfully completed, and the RMS was positioned in the OBSS pre-grapple position to view Ku-band/OBSS clearance during antenna deployment. The Ku-band was deployed at 208/08:32 GMT (00/18:02 MET) and successfully used for the remainder of the mission. This antenna was initially driven using single-motor drive to allow detailed imagery analysis of the clearance between it and the OBSS. Once the antenna was clear of the starboard MPM, both motors were used to complete the deployment.

The crew reported that a video tape was stuck in the DSR-20 Video Tape Recorder (VTR), and an error code was observed on the unit (IFA STS-114-V-07). Power cycling the unit caused the tape to eject and the error code to clear, but the tape ejected at an

angle. Several unsuccessful attempts were made to load another tape into the recorder before a tape loaded successfully; however, that tape also became stuck. The tape-loading mechanism of the recorder was declared failed, and the crew replaced the failed unit with the spare unit.

The crew also reported that when a Viper hard-disk-drive card was inserted into the payload general support computer (PGSC), the PGSC would lock up within 10 min (IFA STS-114-V-14). The crew tried three Viper cards with the same result. The crew did not report this same issue with any other PGSC. The portable computer memory card international adapter (PCMCIA) network card worked properly with the PGSC. There were no other mission impacts since there was no subsequent use of the Viper cards.

The Shuttle RMS grappled the OBSS at 208/07:24 GMT (00/16:45 MET) and performed the first flight unberthing of the OBSS from the starboard MPM for the planned flight day 2 surveys of the Orbiter TPS. During the release of the OBSS from the starboard MPM, the aft pedestal manipulator release latch (MRL) system 2 indication did not reflect the release condition until approximately 4 min after the latch was released. The system 1 indication showed the release in about 12 sec, as expected. The delayed system 2 indication was considered an explained condition due to the nominal opening of the MRL using the system 1 motor only.

The two Integrated Sensor Inspection System (ISIS) sensors on the OBSS were activated. OBSS sensor package (SP) 1 was Laser Dynamic Range Imager (LDRI) and OBSS SP 2 was the Laser Camera System (LCS). The RMS/OBSS started the survey of the starboard wing RCC leading edge at 208/09:36 GMT (00/18:57 MET). The nose cap RCC survey commenced at 208/12:12 GMT (00/21:33 MET), and the port WLE RCC survey started at 208/14:04 (00/23:25 MET).

During the OBSS SP 1 checkout, the view was not as expected in the preflight simulations. At pause points during the exterior surveys, the same problem was again observed—the image at the end of the scan was not as expected (IFA STS-114-V-21). The pan-and-tilt unit (PTU) angles appeared to move during the scan. Resetting the PTU angles appeared to produce the correct image. Troubleshooting later in the flight exonerated the flight hardware and attributed the problem to mission-design simulations.

During the OBSS operations, the crew reported that the RMS Sideview Camera (RSC) image appeared to have a smudge on the lens (IFA STS-114-V-05). The center of the image from the RSC was out of focus, but the edges of the image were clear. The crew cycled the camera power with no effect. The premission closeout photograph did not show any evidence of contamination on the lens. The camera was still partially usable for OBSS situational awareness.

The RMS berthed the OBSS into the starboard MPMs at 208/15:44 GMT (01/01:05 MET). No anomalies occurred during the first flight berthing of the OBSS,

and all the ready-to-latch indications and associated hardware in the MPMs operated nominally.

The unloaded RMS was maneuvered to the crew-cabin-survey position, and the starboard survey for TPS damage using the end-effector camera commenced at 208/16:23 GMT (01/01:44 MET). The starboard survey was completed, and the RMS was maneuvered to the port-survey position at 208/16:40 GMT (01/02:01 MET). Upon completion of the port crew-cabin survey at 208/17:27 GMT (01/02:48 MET), the RMS was maneuvered to the pre-cradle position, where it remained until the Orbiter was docked with the ISS.

The Orbiter docking system (ODS) was powered up at 208/13:45:09 GMT (00/23:06:09 MET). The ring extension was completed nominally, the system was powered down at 208/13:49:51 GMT (00/23:10:51 MET), and the ODS was ready for docking operations.

During the Multifunction Electronic Display System (MEDS) multifunction display unit (MDU) Commander (CDR) 2 powerup, the commanding integrated display processor (IDP) 1 reported a CDR 2 built-in-test equipment (BITE) failure (IFA STS-114-V-10). The crew powered off IDP 2 and subsequently repowered the unit using normal planned procedures; the IDP 2 unit indicated normal communications with the CDR 2 unit at all times. The crew did an MDU comprehensive self-test (CST), and the failure reported again. The MDU was power cycled, nominal MDU performance was reported, and the transient error indication cleared. This transient failure of the CDR 2 secondary port had no impact on mission operations. The primary port functioned nominally. The CDR 2 secondary port failed again during de-orbit preparations on flight day 15 with no impact to entry.

Flight Day 3

During the rendezvous to the ISS, the crew performed an RPM to allow the ISS crew to photograph the Orbiter. The findings from these digital pictures are found in the TPS Damage Assessment discussion later in this Summary.

The ODS was powered on at 209/10:43:02 GMT (01/20:04:02 MET). The ISS was captured at 209/11:43:53 GMT (01/21:04:53 MET). Ring retraction occurred as planned, and the 12 hooks closed nominally. Damper 2 was stuck in the on position, and nominal workaround procedures were used to successfully unstick damper 2. Prior to the hooks closing, ring misalignment occurred; however, it realigned. In addition, the capture latch manual release indication came on and should have been off. The crew verified that the capture latch 1 release handle was partially disengaged (1/8 in.), and the crew returned the manual release handle back to the flight configuration (IFA STS-114-V-16). This problem did not impact nominal operations, manual release, or undocking. The ODS was powered off at 209/12:21:28 GMT (01/21:42:28 MET).

Maneuvers required for rendezvous with the ISS are summarized in the table on the following page.

SUMMARY OF ORBITER DOCKING MANEUVERS

Maneuver	Time, GMT/MET	□V, ft/sec	Firing time, sec	Orbit, nmi
NH (OMS 5) (dual OMS)	209/06:28:34 01/15:49:34	61.7	39.6	149.9 by 186.8
NC4 (OMS-6) (dual OMS)	209/07:15:34 01/16:36:34	64.4	41.9	184.0 by 191.2
NCC (multi-axis RCS)	209/07:41:51 01/17:02:50	1.43	6.12	184.3 by 190.9
TI (OMS-7) (left OMS)	209/08:40:04 01/18:11:04	8.2	11.2	185.9 by 192.7
Midcourse correction (MC) 1	209/09:00:03 01/18:21:03	0.35	1.4	186.0 by 192.5
Planar Null (+y-axis RCS)	209/09:16:40 01/18:37:40	-	-	199.7 by 213.1
MC-2 (RCS)	Cancelled			
MC-3 (RCS)	209/09:46:22 01/19:07:22	0.4	1.7	186.2 by 192.6
MC-4 (RCS)	209/09:56:45 01/19:17:45	1.97	8.4	186.5 by 192.9

After successful docking, the Space Station RMS grappled the OBSS and unberthed it from the starboard MPM. Handoff of the OBSS from the Space Station RMS to the Shuttle RMS was completed successfully at 209/15:35 GMT (01/04:35 MET).

Flight Day 4

The Space Station RMS successfully unberthed the multipurpose logistics module (MPLM) from the Orbiter payload bay and berthed it to the ISS.

The Shuttle RMS maneuvered the OBSS to conduct focused inspections of TPS tile areas of interest on the underside of the Orbiter. These are discussed in the TPS Damage Assessment section of this report.

At the Mission Management Team (MMT) meeting, the ISS formally requested the addition of an extra day to the docked duration of the mission. Based on the sufficient forecasted-consumables margin, the MMT approved this request.

The Orbiter resumed attitude control of the Orbiter/ISS stack at 210/16:40.13 GMT (03/02:01:13 MET), with the switch of the digital autopilot set to auto for attitude control during the cabin depressurization activities for the first extravehicular activity (EVA). Attitude control was returned to the ISS at 210/18:29:48 GMT (03/03:50:48 MET) with the digital autopilot returned to the free-drift position.

Flight Day 5

The first of three EVAs was performed. (On all three EVAs, the crew egressed from the Shuttle airlock. Because of preflight uncertainty about the availability of the ISS airlock, the EVA crew was trained to egress from the Shuttle airlock.) The primary purpose of EVA 1 was to perform DTO 848, Orbiter TPS Repair Techniques, and to replace the ISS CMG.

During the hatch closing after EVA 1 egress, the crew reported difficulty latching the external airlock aft hatch. After several cycles of the latch mechanism and lateral movement of the hatch, successful latching was achieved. During the hatch closing at EVA 1 ingress, similar difficulty was encountered. Again, after several latch cycles and hatch lateral movements, the hatch was successfully latched. Prior to EVA 2, recommendations were made to the crew on proper hatch closing techniques. In addition, the crew was requested to take photographs and videotapes during the post-egress hatch closing and latching operation of EVA 2.

The DTO 848 Tile Board survey was removed from EVA 1 because of concern about the out-gassing of repair material on the OBSS sensor lenses.

Downlinked digital imagery from EVA 1 indicated that camera S/N 1015 had reverted from firmware version 3.3.11 (loaded in the primary firmware memory slot) to the previous version, 3.3.10 (loaded in the secondary memory slot). Images from this camera prior to the EVA show the camera was operating with the primary firmware version. The camera functioned nominally on the firmware in the secondary memory slot. The reason that the firmware switched from the primary to the secondary camera firmware is being evaluated. The crew downloaded two sets of the 3.3.11 firmware to the primary and secondary slots prior to EVA 2, and the camera performed nominally throughout the remaining EVA operations indicating that the problem was transient.

In parallel with the EVA, a focused inspection was conducted by the RMS/OBSS to obtain further imagery of port WLE RCC areas of interest. After completion of the survey, the RMS/OBSS was parked at the CMG remove-and-replace position at 211/17:54 GMT (04/03:15 MET).

Flight Day 7

The EVA crew experienced no issues with closing the hatch during the egress to start EVA 2. The crew had been instructed to place the latch actuator handle in the pre-closing position for hatch-closing operations and to use the latch pushrods as a handhold to assist in external-hatch positioning. During troubleshooting for the external airlock hatch-latching difficulty, it was discovered that no handhold is installed on the outside surface of the hatch. Drawing review revealed that the handhold was previously removed for a prior flight, in accordance with a drawing change to eliminate an interference problem in the airlock. Without this handhold, the crew is required to grasp

the hatch in other locations that were not designed for EVA handling. This could have contributed to the difficulty when latching the hatch during EVA 1. The handhold is required only for hatch closure from outside the airlock, which had not been used in any previous flight.

During the second EVA, one of the four port lightweight tool stowage assembly (LWTSA) latches would not open (IFA STS-114-V-18). The EVA 2 crewmember loosened the EVA manual override bolt using the pistol grip tool (PGT), which allowed him to rotate the latch cover and gain access to the hardware in the LWTSA. The EVA 2 crewmember was able to close the door and replace the latch cover, and the EVA bolt was tightened.

During post-EVA 2 activities, the crew was equalizing the pressure in the airlock by opening the starboard equalization valve. The valve was opened, and flow was noted. However, when the airlock reached 10 psid, the crew moved the valve to the emergency position to complete the airlock depressurization (part of nominal operation), and the flow from the valve stopped (IFA STS-114-V-15). The crew activated the port-side equalization valve, and the airlock was depressed satisfactorily. Once inside the airlock, the crew inspected the depressurization valves and reported debris on the port valve screen, but no debris was noted on the starboard valve, which had stopped the depressurization. However, the post-EVA repressurization and leak check was completed nominally. The most probable cause of this anomaly was a cap that was not properly fastened and the cap floated over and positioned itself over the valve. The valve was replaced because of the high detent torque required to operate the valve.

Flight Day 9

DTO 848, Tile Board Survey, was completed using the OBSS, LCS, and LDRI sensors.

The crew conducted EVA 3. During airlock egress, they reported no hatch mechanism or depressurization anomalies. The EVA was completed satisfactorily. An EVA task was added to have one of the EVA crewmembers maneuvered by the Space Station RMS to the underside of the Orbiter in an attempt to remove or adjust the protruding gap fillers. Both gap fillers were easily and successfully removed. During airlock ingress, the crew successfully depressed the airlock using the port equalization valve.

Flight Day 11

To understand the source of the OBSS pointing errors seen on flight day 2, a PTU measurement test was performed. Preliminary results indicated repeatable pan accuracies at lower slew rates and repeatable tilt accuracies at both slow and fast slew rates. The PTU on STS-114 was a first-flight unit. Subsequent testing confirmed that the PTU slippage was not caused by Shuttle RMS motion.

The Space Station RMS unberthed the MPLM from the ISS and reberthed it in the Shuttle payload bay. The Shuttle RMS handed the OBSS back to the Space Station RMS, which successfully berthed it in the starboard MPMs.

Flight Day 12

The hatch between the Orbiter and the ISS was closed, and at 218/07:23:45 GMT (10/16:44:45 MET), the Orbiter successfully undocked from the ISS. A fly-around of the ISS was performed and digital photographs were taken of the ISS. The Shuttle RMS was cradled and the port and starboard MPM pedestals were stowed.

During the stowage of the OBSS, the mid-MPM pedestal system 1 stow indication changed to stow as expected, but system 2 did not change to stow until approximately 20 min later (IFA STS-114-V-22).

TPS DAMAGE ASSESSMENT

TPS Tile

Three areas of potential tile damage were seen on ascent video for evaluation by the TPS Damage Assessment Team. At 66 sec, tile damage was observed on the aft edge of the right outboard corner tile of the nose landing gear door (IFA-STS-114-26). Using radar data, debris was observed at the same time. Suspected tile damage was also seen at the starboard chine and the outboard edge of the right inboard elevon (IFA STS-114-11).

Digital pictures of the flight day 3 RPM taken during the final approach to docking with the ISS were downlinked and showed two Ames gap fillers on the lower forward fuselage protruding from the tile (IFA STS-114-12). A total of 49 areas of interest were identified, which included both upper and lower surfaces.

Based upon reviews of ascent data and RPM imagery, the TPS Damage Assessment Team identified seven areas of interest, including six for which focused inspections were required. The team prioritized all inspections as High, Medium, and Low, and identified corresponding sensor inspection requirements. The three highest priority areas were for the starboard nose landing gear door, the port forward wing trailing edge carrier panel, and the starboard chine area. Two of the areas were for the Ames gap fillers and one was for the ET door. The highest priority items were to be performed during the next inspection on flight day 4. A focused inspection of the window blanket damage was not required.

The focused inspection on flight day 4 was performed using the LCS as maneuvered by the Shuttle RMS/OBSS to the TPS tile areas of interest. Data were obtained for the sites at the nose landing gear door, chine, forward surface of the trailing edge panel, and protruding gap filler. These data were provided to the TPS Damage Assessment Team analysts for the continuing cavity model generation and assessment process.

As a result of this analysis, the TPS Damage Assessment Team cleared for Entry the damaged tiles scanned during the flight-day-4 focused inspection.

The two gap fillers protruding from the TPS tile were also assessed by the TPS and Leading Edge Structural System (LESS) Damage Assessment Team (IFA STS-114-V-12). Aerothermal analysis predicted that the gap fillers would cause an early transition in the boundary layer during entry, resulting in an increased heat load on the Orbiter and negative structural margins on the aft fuselage. In addition, a potential for burn-through of the RCC silicon carbide was also predicted. The results of the assessment were presented to the MMT, which declared that EVA 3 would be modified to include the removal or reduction of the two gap filler protrusions.

The EVA and Robotics groups prepared a procedure to position an EVA crewman on the Shuttle RMS underneath the vehicle while still docked. On EVA 3, the procedure was implemented and the EVA crewman easily and successfully removed both gap fillers with no problems.

TPS Reinforced Carbon Carbon Panels

During ascent, the Wing Leading Edge Impact Detection System (WLEIDS) collected data on possible impacts to the leading edge RCC surfaces. The two regions of interest identified as probable impacts were the port wing panel 6-7 area and the port wing panel 19-20 area. Further data on the health of the RCC panels were collected on flight day 2 using the LDRI.

The LESS RCC Problem Resolution Team assessed both the WLEIDS and LDRI data and identified five areas for which focused inspections were required (a total of 11 areas with TPS tiles was included). The lowest priority area was to obtain an additional view of an RCC panel because the first survey was not acquired at the desired incidence angle for this panel. This condition was the result of the PTU slippage that was noted earlier in the flight. No RCC inspections were completed during the focused inspection on flight day 4.

After additional flight day 2 LDRI data processing was completed, multiple incidents of black spots were identified. RCC focused inspection requirements were modified, and seven specific locations were selected. The RCC focused inspection scanning was performed on flight day 5 using the OBSS Intensified Television Camera (ITVC). The Shuttle RMS completed the planned flight day 5 focused inspections of the RCC.

The LESS RCC Problem Resolution Team assessed the results of the ITVC inspection. Several black spot indications were reviewed, and no silicon carbide (SiC) damage to the substrate was detected. Only one event correlating to ascent was identified. The OBSS inspections confirmed no damage to the WLE.

The results of the TPS Damage Assessment Team (the LESS/RCC Problem Resolution Team) cleared the threats to the WLE RCC, and the MMT approved closeout of this issue.

TPS Blanket

Digital pictures that were taken from the ISS during the Orbiter's final approach to docking showed a damaged blanket just beneath window 1 where the TPS transitions from blanket to tile (IFA STS-114-V-08). The damage appeared to consist of the missing fabric cover with most of the batting still in place.

Upon completion of the gap filler removal task on EVA 3, the Shuttle RMS/OBSS was positioned to provide an ITVC camera view of the damaged blanket beneath window 1.

The TPS Damage Assessment Team presented the results of an analysis which verified that the damaged blanket near window 1 posed no thermal concerns for the local structure during entry. Further assessment of the potential impact should the blanket dislodge during entry was required. A Tiger Team was formed to plan and perform tests to answer the issues. Test articles were developed and flown from KSC to Ames Research Center (ARC) to conduct wind-tunnel testing. The results of the testing verified that the damaged blanket near window 1 would gradually degrade during entry, but posed no concerns for significant size release and subsequent impact on the aft structure of the Orbiter during entry.

ENTRY

Flight Day 13

The Flight Control System (FCS) checkout was successfully completed using APU 3. The APU start command was 219/03:49:05 GMT (11/13/10:05 MET). The APU run time was 4 min 19 sec.

Prior to the RCS hotfire, the chamber pressure (P_c) on Vernier Reaction Control System (VRCS) thruster R5R was low—approximately 50 to 60 psia—(IFA STS-114-V-24). Data review indicates that the heater for this thruster may have been failed on. This failure mode would be a significant contributor to the low P_c . The thruster remained in the Redundancy Management table and continued to be used nominally during deorbit preparations.

The planned hotfire of the RCS primary thrusters was successfully completed at 219/04:53 GMT (11/14:14 MET). All primary thrusters were successfully fired twice.

Flight Day 14

The PLBDs were closed at 220/05:08 GMT (12/14:29 MET) in preparation for the first landing opportunity at KSC on the planned landing day. The operation of the doors was nominal.

Because of forecasted no-go weather conditions, the first landing opportunity was waved off; subsequently, the second landing opportunity was waved off for 24 hrs because of improved but unstable weather conditions. The PLBDs were reopened at 220/09:20 GMT (12/18:41 MET).

The OMS orbit-adjust firing (OMS-8) was performed at 220/12:19:00.GMT (12/21:40:00 MET). The firing was 24.0 sec in duration and imparted a ΔV of 40.8 ft/sec. The resultant orbit was 167.8 by 190.1 nmi.

Flight Day 15

The PLBDs were again closed on orbit 216 at 221/05:23:32 GMT (13/14:44:30 MET). The deorbit firings for the first and second KSC landing opportunities on the first extension day were waved off because of inclement weather. As a result, a decision was made to land at EAFB, CA.

The deorbit firing for the first landing opportunity at EAFB, a dual-engine straight-feed firing, was performed on orbit 219 at 221/11:06:18.277 GMT (13/20:27:18.264 MET). The duration of the deorbit firing was 163.4 sec, and the ΔV was 276.8 ft/sec. The orbit following the deorbit firing was 21.8 by 190.8 nmi.

Entry interface occurred at 221/11:40:18 GMT (13/21:01:18 MET), and entry was completed satisfactorily. The main landing gear touchdown occurred on EAFB concrete runway 22 at 221/12:11:22.494 GMT (13/21:32:22.481 MET) on August 9, 2005. The drag chute was deployed at 221/12:11:31.910 GMT (13/21:32:31.897 MET). The nose gear touchdown occurred at 221/12:11:38.058 GMT (13/21:32:38.058 MET). Wheels stop occurred at 221/12:12:30.565 GMT (13/21:33:30.552 MET). The rollout was normal in all respects. The flight duration was 13 days 21 hr 33 min 30 sec.

The APU parameters were nominal during on-orbit and entry operations, with the exception of APU 3 exhaust gas temperature sensor 1, which became erratic during entry (IFA STS-114-V-25). The exhaust gas temperature sensor 1 data showed values from normal to well below normal. The APUs were shut down approximately 21 min 50 sec after landing. There were no changes to the postlanding switch list.

PAYLOADS AND EXPERIMENTS

FLIGHT OBJECTIVES

The primary Shuttle Program objectives of the mission were to test and evaluate Shuttle Thermal Protection System (TPS) inspection and repair capabilities. In addition, the Logistics Flight 1 (LF1) Flight delivered International Space Station (ISS) Orbital Replacement Units (ORUs) and cargo required to continue assembly and maintenance tasks on the ISS.

Mission success criteria were met by completion of the following primary objectives:

1. Inspect all Orbiter Reinforced Carbon Carbon (RCC) using Orbiter Boom Sensor System (OBSS). Downlink digital photos and wing leading edge (WLE) sensor data.
2. Inspect all Orbiter TPS.
3. Transfer mandatory quantities of water from the Shuttle to the ISS.
4. TPS Detailed Test Objective-848 (Emittance Wash Applicator (EWA), Non-Oxide Adhesive Experiment (NOAX), and tile-board OBSS scan.
5. Restore Joint Airlock Capability [Middeck and Multi-Purpose Logistics Module (MPLM) transfers].
6. Perform removal and replacement of the Control Moment Gyro (CMG) 1 using Space Station Remote Manipulator System (SSRMS) and return failed CMG.
7. Transfer cargo to the ISS that was delivered by the MPLM.
8. Return more cargo from ISS than delivered in the MPLM.
9. Return MPLM to Orbiter Payload Bay.
10. Install External Stowage Platform-2 (ESP-2).
11. Transfer Human Research Facility Rack 2 (HRF2) to ISS.

CREW ACTIVITIES

There were three Shuttle-based EVAs planned for the mission. The first EVA demonstrated repair techniques for the Shuttle's Reinforced Carbon Carbon (RCC) Wing Leading Edge and protective tiles. During the second EVA, the crew replaced a

failed Control Moment Gyroscope (CMG). On the third EVA, an External Stowage Platform, with three ORUs, the Main Bus Switching Unit (MBSU), Utility Transfer Assembly (UTA), Flex Hose Rotary Coupler (FHRC), and four Video Stanchion Support Assemblies (VSSA) was installed on the ISS. During the final EVA, the crew also removed two gap fillers that were protruding beyond the tile surface on the underside of the Orbiter.

The table containing the completion status of the tasks assigned to the three EVAs is found in the Extravehicular Activity section of this report.

The following table summarizes the completion status of the tasks assigned to Flight LF1 in the Mission Integration Plan (MIP) plus real-time processes:

MIP AND REAL-TIME TASK ACCOMPLISHMENT

Source of Tasks	Approved	Completed	Withdrawn	Deferred	Not Complete
MIP Baseline	35	32	1	2	0
Added in Real Time	13	11	1	1	0
Totals	48	43	2	3	0

A. Tasks completed in addition to the MIP requirements: (11)

1. **Tie-down the FHRC multilayer insulation (MLI) using a wire-tie** – The crew tied down the loose FHRC MLI blanket with a wire-tie during EVA 2. Thermal analysis data indicated that the FHRC fluid couplers would exceed the thermal limits during high Beta angles.
2. **Remove 8 Light-Housing-Assemblies (LHAs) and one Baseplate Ballast Assembly (BBA) from the MPLM** – The crew removed 8 LHA's and one BBA from the MPLM and stowed the hardware in the ISS as spares to be used for the failed USOS light assemblies.
3. **Relocate the Articulating Portable Foot Restraint (APFR) ingress-aid** – The crew relocated the APFR from the Crew and Equipment Translation Assembly (CETA) cart to the LAB Worksite Interface Fixture (WIF) no. 9 and documented the activity photographically. This task was performed during EVA3 in preparation for future EVAs.
4. **Transfer additional hardware from the MPLM to the ISS** – The crew performed the following additional hardware transfers from ISS to the MPLM: American Russian Converter Unit, Russian B1 Fan, Pump Package Assembly, moved a second Simplified Aid for EVA Rescue (SAFER) from the middeck to MPLM, and returned 3 additional High Efficiency Particulate Assembly (HEPA) filters.
5. **Transfer of a ISS KURS unit to the MPLM for return to Earth** – The crew stowed a 12th KURS unit for return in the MPLM.

6. **Reconfigure Extravehicular Mobility Unit (EMU) equipment** – The crew reconfigured the EMU and the hardware was retained in the ISS for Expedition 12.
7. **Perform a checkout of the Respiratory Support Pack (RSP)** – The crew performed the required RSP checkout for use on-orbit.
8. **Additional HEPA filter return** – The crew removed, replaced, and transferred three HEPA filters for return.
9. **Remove the second BBA from the MPLM** – The crew removed a second BBA from the MPLM and stowed it in the ISS for use as a spare. A failed unit from the ISS was installed in the MPLM location freed up by the unit stowed in the ISS.
10. **Transfer of additional items from the Orbiter middeck to the ISS** – The crew scavenged items from the Orbiter middeck since the next Orbiter launch was to be delayed due to the foam loss from the External Tank. Some of the items transferred were cameras, a Payload General Support Computer (PGSC), food, batteries, a multimeter, tape, fiberscope, ultrasonic leak detector, etc.)
11. **Transfer of additional Water** – The crew filled and transferred an additional Contingency Water Container (CWC) for a total of 18 CWCs being transferred.

B. Tasks Withdrawn

1. **Transfer of oxygen to the ISS** – The crew did not perform this task as the mission was extended one day and no excess oxygen was available for transfer.
2. **Rotate the MPLM Return Stowage Platform (RSP)** – The crew did not perform this task, which was to evaluate the re-designed RSP drive pins, because of the low priority of this task and the lack of crew-time while docked.

C Tasks Deferred

1. **Install the Video Stanchion Support Assembly (VSSA) and External Television Camera Group (ETVCG) on camera port no. 9** – The crew did not complete this get-ahead task. The camera will be used for viewing the solar-array-wing deployment. This task was deferred when the task to remove the gap-filler material from the tiles on the underside of the Orbiter was added to EVA3.
2. **Install Materials International Space Station Experiment (MISSE) 3 and 4 clamp collar** – The crew did not perform this task due to its low priority and lack of docked crew time.

3. **Remove S1 Thermal Radiator Rotary Joint (TRRJ) motor controller and transfer to the MPLM for return** – The crew did not perform this EVA task because of its low priority and no EVA time was available because of higher-priority tasks.

D. Orbiter consumables transferred to the ISS were:

1. **Water** – A total of 18 CWCs 1739.7 lbm (788.8 L) and 5 PWRs 115.5 lbm (52.4 L) was transferred.
2. **Nitrogen** – A total of 29.0 lbm (13.18 kg) was transferred to Joint Air Lock high pressure tank.
2. **Lithium Hydroxide (LiOH)** – A total of 31 containers was transferred from the Shuttle to the ISS and 32 containers were transferred from the ISS to the Shuttle. The life expectancy had expired on the containers from the ISS that were returned to the ground.

TRANSFER WEIGHT SUMMARY

The weight summary for ISS hardware that was transferred between both vehicles during the mission is shown in the following tables:

Part 1 (Ascent)

Transferred from Shuttle to ISS	Planned, lbm	Actual, lbm
Middeck	1394	1485
MPLM Cargo Element	18166	18166
MPLM Transfers		
Human Research Facility -2 Stowage Rack	1589	
Stowage Transfers	2179	2179
External Stowage Platform -2	6336	6336
External Stowage Platform -2 Cables (Launched in Tool Stowage Assembly)	12	12
Control Moment Gyro	597	597

Part 2 (Return)

Transferred from ISS To Shuttle	Planned, lbm	Actual, lbm
Middeck	1312	1533
MPLM Cargo Element	19576	19776
MPLM Transfers	5094	5269
Zero-gravity Stowage Rack	60	60
Stowage Transfers	5034	5209
External Stowage Platform -2	6336	6336
Control Moment Gyro	599	599
Flight Releasable Grapple Fixture (Returned in Tool Stowage Assembly)	50	50

SIGNIFICANT FIRSTS

The significant firsts that were accomplished during the mission both for the Space Shuttle and Space Station programs are detailed in the following items.

1. **Launch window lighting constraints** – Additional launch constraints were implemented to accommodate new/improved ground imagery sources.
2. **Early External Tank (ET) separation maneuver using Main Propulsion System** – This maneuver allowed for the Space Shuttle crew to photograph the ET at a much closer distance after ET separation.
3. **Thermal Protection System (TPS) inspection** – The Rendezvous Pitch Maneuver (RPM), OBSS, SRMS, and SSRMS are all tools to allow inspection of the Orbiter TPS for any potential damage occurring during ascent.
4. **Wing Leading Edge Sensors (WLE)** – These sensors enabled detection of debris if impact occurred during ascent. Depending on battery life expectancy, the system could be used for detection of Micrometeoroid orbital debris (MMOD) throughout the mission.
5. **ISS –XVV docked attitude for TPS MMOD protection** – Orbiter attitude control of the mated stacked in this attitude resulted in an indirect ISS vehicle reboost of approximately 1.6 nmi in altitude.
6. **MPLM Associated Operations** – Installation of the MPLM on ISS using SSRMS to Node 1 nadir as well as rebirthing of the MPLM and OBSS in the Space Shuttle using the SSRMS.
7. **ISS ingress capability during Shuttle EVA** – This capability enabled the repressurization of the Orbiter airlock to allow the Apace Shuttle crew to ingress the ISS vehicle to perform ISS robotic and MPLM transfer operations.
8. **RCC repair DTO 848** – This DTO demonstrated the capability that repairs can be accomplished.

9. **Contingency Shuttle Crew Support (CSCS) and STS-300 Launch-on-Need (LON) rescue mission** – The definition of this capability enhances the overall conduct of a mission.
10. **Remove and replace the ISS Control Moment Gyro (CMG)** – The demonstration of this capability shows that vital hardware of systems on the ISS can be changed to enhance the useful life of the ISS.
11. **Tile gap filler removal utilizing the SSRMS** – During EVA 3, two gap fillers protruding from forward TPS tile were manually removed by an EVA crewman positioned by the SSRMS.
12. **Non-KSC post-landing cargo bay purge** – The cargo bay temperature was lowered to (85 °F) for STS-114. As a result, no MPLM heater operations were required during the ferry flight.

VEHICLE PERFORMANCE

LAUNCH DELAY

The first launch attempt was scrubbed on July 13, 2005, because of an ET anomaly. During LH₂ replenishment, the LH₂ ECO sensor indicator showed wet conditions, indicating the presence of LH₂ when it had been commanded dry during point sensor checks (IFA STS-114-V-01). This anomaly violated the Operational Maintenance Requirements and Specification Document (OMRSD), which requires that all four of the ECO sensors be operating satisfactorily for launch. In addition, this condition was also a violation of Launch Commit Criteria MPS-22.

The evaluation personnel supported various program-level teams in support of the anomaly investigation, including on-vehicle troubleshooting, design history research, fault-tree development, updates to three of four LCC requirements, and failure history research/probability risk assessment. The team was unable to repeat the anomaly during ambient checkout in the on-vehicle troubleshooting. An interim problem report (IPR) deferral rationale was developed for STS-114 in concert with an updated three of four LCC requirements. The most probable cause of the anomaly was a mechanical/electrical connection in an area that is subjected to temperature extremes associated with cryogenic operations.

During launch attempt 2, additional simulation commands were applied during tanking operations to screen for failure indications down to T - 9 min. No failures occurred. Activities related to improved OMRSD, acceptance test procedures, and design changes were pursued for longer-term support of the program.

SOLID ROCKET BOOSTERS

Data show that the SRBs performed satisfactorily during the ascent and recovery phases. The SRB serial number identification is listed in the Introduction to this report.

STS-114 was the first flight of the following modifications that were made to the SRBs:

1. The SRB/ET forward attachment bolt catcher was modified to correct non-conservative margins in the load capability at SRB separation.
2. The NASA Standard Initiator (NSI) pressure cartridge was modified with a retention device to prevent NSI ejection of the pressure cartridge during firing.
3. The booster separation motor (BSM) igniter was modified to eliminate erratic BSM performance at ignition.

Data indicate that SRB separation was nominal at 121.80 sec (207/14:41:01.813 GMT). Retrieval ships located and secured both SRBs and the frustrums. Both SRBs were towed to Cape Canaveral Air Force Station, where they were inspected in Hanger AF and found to be in excellent condition.

The post-flight inspection of the SRB's revealed six SRB anomalies, which are discussed in the following paragraphs.

Two potential impact sites were noted on the forward face of the right-hand External Tank Attachment Ring (ETAR) foam above the Integrated Electronics Assembly (IEA); one was I-shaped and one was T-shaped (IFA STS-114-B-001). The I-shaped site was 1-in by 1-in by 0.25-in deep, and postflight analysis determined that the site was a post-separation based on forensics. The T-shaped site was smaller and of undetermined depth, and was identified as a pre-existing divot.

A fracture of the RT 255 material was found aft of the Booster Separation Motor (BSM) inboard triple motor (IFA STS-114-B-002). The fracture surface exhibited some darkening, which indicated a possible ascent occurrence, and if this is found to be correct, the debris violates NSTS 60559 "Expected Debris Generation and Impact Tolerance Requirements, Ground Rules and Assumptions".

Hypalon paint was missing from the BTA Thermal Protection System (TPS) closeout around the BSMs (IFA STS-114-B-003). Missing paint areas were located where the aeroheat shield covers contacted the BTA. Evidence has led to the indication that the missing paint was lost during entry.

An area 0.7-in by 0.3-in on the right-hand forward skirt acreage along the -Z axis forward of the Range Safety System antenna was noted to be missing MCC-1 TPS material (IFA STS-114-B-004). The initial indications were that the missing material was caused by a debris hit as a 2-in long streak is located on the adjacent Hypalon paint aft of the area where the foam is missing and the area is darkened. The evaluation team concluded that RSRM slag impacted the forward skirt during the post-separation tumble as evidence of slag was found in the impact divot. The ET separation camera located on the forward skirt shows slag flying toward the forward skirt with the trajectory indicated by the streak trailing from the impact location.

The retaining caps of the left-hand/right-hand forward and aft Tail Service Mast (TSM) NASA Standard Initiator (NSI) pressure cartridge retention devices could be loosened by hand (IFA STS-114-B-005). All pressure cartridges performed satisfactorily. Testing showed that the ascent environment could not cause the failure of the adhesive. The failure of the adhesive was attributed to the small amount of adhesive applied, the shock load at firing, and the impact shock load.

A portion of the aft skirt hold-down shoe sidewall material was missing at post location M7. The shoe remains on the main launch platform (MLP), thus the missing material could be a lift-off debris concern (IFA STS-114-B-006). The approximate dimensions of the half-moon shaped material are 8.05-in by 1.3-in by 0.255-in. Testing thus far has not recreated the anomaly.

REUSABLE SOLID ROCKET MOTORS

The RSRMs performed nominally with no violations of the RSRM LCC. Data indicate that the flight performance of both RSRMs was well within the allowable performance envelopes and typical of the performance observed on previous flights. No anomalies were identified during the analysis of RSRM flight data.

The motor performance parameters were within the Contract End Item Specification limits for this flight. The delivered burn rates at 83 °F propellant mean bulk temperature (PMBT) were nominal. Adaptive guidance throttling (AGT) did not make any corrections that were due to off-nominal thrust.

The ambient temperatures recorded during the 90 hrs prior to launch varied from 74 °F to 95 °F. The data recorded during this time frame were in the -1.0σ range from historical July average hourly temperatures. At the time of launch, the ambient temperature was 84 °F, which is 1 °F below the historical ambient temperature for the time of launch for launch in July.

The field joint heaters operated for 14-hr 38-min during the launch countdown. Power was applied to the heating elements 28 percent of the time, which is average, during the LCC time-frame of the countdown.

RSRM PERFORMANCE PARAMETERS

Parameter	CEI specification limit, 60 °F	Left motor delivered	Right motor delivered
Web time, sec	105.4 – 116.7	109.6	109.6
Action time, sec	115.2 – 131.2	122.3	121.6
Head end pressure, psia	847.9 – 965.7	922.0	921.4
Maximum sea level thrust, Mlbf	2.88 – 3.26	3.09	3.09
Web time average pressure, psia	629.9 – 700.5	671.8	672.1
Web time average vacuum thrust, Mlbf	2.46 – 2.74	2.63	2.63
Web time total impulse, Mlbf sec	285.8 – 291.6	288.3	288.4
Action time impulse, Mlbf sec	293.7 – 299.7	296.6	296.2
ISP average delivered, lbf sec/lbm	266.5 – 270.3	268.6	268.1
Loaded propellant weight, lbm	>1103750	1104778	1105382

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

Reconstructed motor performance parameters adjusted to a 60° F propellant mean bulk temperature (PMBT) are shown in the table on the following page. The calculated PMBT at launch was 80° F. The maximum trace shape variation of pressure vs. time during the 62- to 80-second timeframe was calculated to be 0.369 percent at 71.0-sec

for the left motor and 0.269 percent at 67.0-sec for the right motor. The values were within the 3.2 percent allowable limits.

The predicted and actual propulsion system performances are shown in the following RSRM Propulsion Performance table. The final PMBT calculation was made postflight with reconstructed data and the calculation showed a nominal temperature of 80° F.

RSRM PROPULSION PERFORMANCE

Parameter	Left motor, 72.°F		Right motor, 72.°F	
	Predicted	Actual	Predicted	Actual
Impulse gates				
I-20, 10 ⁶ lbf-sec	65.92	66.63	66.26	66.43
I-60, 10 ⁶ lbf-sec	176.24	177.04	177.02	177.39
I-AT, 10 ⁶ lbf-sec	296.77	296.94	296.93	296.62
Vacuum Isp, lbf-sec/lbm	268.6	268.8	268.6	268.3
Burn rate, in./sec @ 60□F at 625 psia	0.3687	0.3706	0.3697	0.3713
Event times, sec ^a	0.232	N/A	0.232	N/A
Ignition interval	108.3	107.3	107.8	107.3
Web time ^b	118.2	117.2	117.7	117.0
50 psia cue time	120.4	119.8	119.9	119.1
Action time ^b	122.7	121.8	122.7	121.8
Separation command				
PMBT, □F	80	80	80	80
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	3.5	3.1	3.1
Tailoff impulse imbalance differential ^c	Predicted N/A		Actual 410.7	

^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.

The igniter joint heaters operated for 14-hr 29-min during the launch countdown. Power was applied to the heating elements 40 percent of the time, which is average, during the LCC time frame of the countdown.

The aft skirt purge was activated one time during the final countdown for 59 minutes. The total activation time during the recorded 90-hour countdown was 2-hr 33-min. During the LCC time frame, both the left and right motor nozzle/case joint sensor temperatures ranged from 78 °F to 83 °F. The final flex bearing mean bulk temperature (FBMBT) calculated was 80 °F.

All ground environmental instrumentation (GEI) and operational flight instrumentation (OFI) performed within established requirements.

EXTERNAL TANK

Two ET-120 tanking tests were conducted before STS-114, with two significant anomalies identified in the first tanking test:

- First, an anomaly with the LH₂ ECO sensors, which resulted in the replacement of much of the ECO sensor circuitry, including the Orbiter point-sensor box, but no obvious cause was found.
- The second was an anomaly with the LH₂ tank prepressurization cycle count (which was at the LCC limit of 13 cycles). At the time, the only known configuration difference was that the diffuser had a mesh screen that was tighter than normal

The second tanking test was conducted to collect further data to resolve the anomalies from the first tanking test. The LH₂ ECO sensor problem was not repeated. Two pre-pressurization cycles were conducted; on the second, the bipod heaters were turned off. However, the cycle count anomaly recurred both times. After the second tanking test, diffuser testing was conducted; the Ground Support Equipment prepressurization valve timing change was the most probable cause of the pre-pressurization anomaly. The acceptable cycle count limit was lowered from 13 to 11 cycles. Analysis determined that 11 cycles would be acceptable for this flight configuration.

All ET objectives and requirements associated with propellant loading and flight operations were met during the second countdown and the flight. 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 LCC or OMRSD violations occurred during the final countdown.

The pressurization systems functioned properly throughout engine-start and the flight. The minimum LO₂ ullage pressure experienced during the ullage-pressure-slump was 13.9 psid.

The Ice/Frost Red Team reported two cracks on the -Y vertical strut; one was 4- by ¼-in., and the other was 8- by 1/8-in. The team also reported two small ice/frost

accumulations at the feedline to the LH₂ tank interface. Both dissipated after sunrise and were acceptable per NSTS 08303. The final item reported was that LN₂ was dripping from the ground umbilical carrier plate (GUCP) onto the ET/SRB fitting, which resulted in an IPR. This condition did not either degrade the structural capability or the function of the fitting or the strut cover; thus, the condition was declared acceptable for flight.

During launch countdown for the mission, two ET-related conditions were noted. The ET-121 bipod strut-to-yoke flange bolt was torqued beyond the standard yield point. Based on observations of the bolt protrusion, the high design factors of safety, and the robust strain capability, the condition was declared fail safe and acceptable for flight. The second condition involved LN₂ dripping from the GUCP onto the ET/SRB fitting and the ET/SRB upper strut cover as described in a previous paragraph.

ET separation was nominal, and MECO occurred within expected tolerances. Thus, the entry and breakup of the ET was at latitude 36.560 degrees South and longitude 158.714 degrees West, which is 15 nmi up range from the preflight predicted impact point.

SPACE SHUTTLE MAIN ENGINES

On July 26, 2005, all tanking and prelaunch preparations were made. All LCC ignition confirmation limits and main-stage redline margins were satisfactory. All Interface Control Document (ICD) start and shutdown transient requirements were met, and engine performance during start, main stage and shutdown was nominal and as predicted. Cutoff times for Main Engine (ME)-1, ME-2, and ME-3 were 510.834 sec, 510.971 sec, and 511.085 sec, respectively. Based on trajectory data, the specific impulse (I_{sp}) was rated as 453.12 sec. The SSME I_{sp} tag value was 452.12 sec at 104.5 percent power level. Controller and software performance was satisfactory, with no anomalies.

Flight data indicate that SSME performance during mainstage, throttling, shutdown, and propellant dump operations was normal. The high-pressure oxidizer turbopump (HPOTP) and high-pressure fuel turbopump (HPFTP) temperatures appeared to be well within specifications throughout engine operation. No failure identifiers and no significant SSME problems were identified. MECO occurred 504.571 sec after SRB ignition. Commanded Max Q α throttle-down was a one-step throttling to 72 percent.

The SSME Project identified two in-flight anomalies: The first was the Pogo Recirculation Isolation Valve (RIV) on ME-1 indicated 92 percent open post-LO₂ dump, when it should have indicated 100 percent open. The observation has been documented, and the RIV will be removed to support the investigation. The second was that ablative material was noted during postflight inspection to be missing from the nozzle on ME2 and ME-3 postflight. This was not a safety-of-flight condition for STS-114 but, rather, is a concern for reuse of the nozzle if Braycote was also present.

SHUTTLE RANGE SAFETY SYSTEM

Shuttle Range Safety System (SRSS) closed-loop testing was completed as scheduled during the launch countdown. 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 sated, and SRB system power was turned off prior to SRB separation.

ORBITER SYSTEMS

Main Propulsion System

One Main Propulsion System (MPS) in-flight anomaly [IFA STS-114-01 (LH₂ ECO Sensor no. 2) occurred during the first countdown and this anomaly resulted in rescheduling the flight for a later date. During the STS-114 mission, the MPS operated satisfactorily with no in-flight anomalies identified and no LCC or other OMRSD violations noted.

The maximum hydrogen concentration level in the Orbiter aft compartment (with the normally elevated system back pressure used for fast fill) was 88 ppm. [Hazard Gas Detection System (HGDS) B was used to determine the maximum concentration.] This compares favorably with previous data for this vehicle. Preliminary data indicate that the LO₂ system performed as planned. The LH₂ prepressurization cycle count was 11 cycles, which is the LCC limit. (The maximum acceptable cycle count was lowered from 13 to 11 cycles for this flight only.) Engine inlet net-positive-suction pressure requirements were met throughout the flight.

Postflight reviews of STS-114 data disclosed a number of conditions that are discussed in the following paragraphs.

A momentary violation of the ± 0.8 psi requirement was observed during throttleup coming out of the throttle bucket. Dynamic transient parameters, such as SSME outlet temperature and ET nose-cap pressures, lagged behind other parameters used in the reconstruction, causing mass-flow calculations to be in error. After the transients passed, these errors diminished and the model correlated well with flight data. The steady-state model data indicate that the gaseous oxygen (GO₂) pressurization system performed nominally, verifying that the flow-control valve orifice was free from both blockage and erosion. This requirement will be reviewed to evaluate whether to modify either the criteria for transients or the time period that they are in effect.

The 15 standard cubic inches per minute (scim), plus an established maximum leakage requirement for decay of the gaseous hydrogen (GH₂) pressure system, was violated (IFA STS-114-V-32). Based on known leakage values, the allowable leakage for OV-103 is 15.75 scim; thus, the calculated leakage value of 22.4 scim for STS-114 violates this requirement. The GH₂ decay check will be performed again on the ground. If

decay check fails on the ground, further checkouts will be performed to determine what leakage values have changed since the leakage values were last taken.

It was determined that the LO₂ engine-inlet pressure exceeded the LO₂ manifold pressure by more than 50 psi (main engine cutoff to dump start). STS-114 data indicate that the relief valve functioned as designed, since the manifold and engine inlet pressures converged approximately 35 sec after the LO₂ pre-valves were closed. An evaluation of the excessive pressure will be made.

The results of an analysis of MPS/SSME GH₂ data, showed that the 3.88 psi/min decay (including known solenoid valve leakages) requirement for the MPS/SSME low-pressure helium-decay check was violated (IFA STS-114-V-33). The actual calculated value for STS-114 was 4.42 psi/min, which is in violation of the File IX requirement. As a result, the MPS pneumatic helium low-pressure decay check was performed during postflight operations and no out-of-tolerance leaks were found. All hazardous gas concentrations during loading 1 and loading 2 were nominal, as noted in the following table.

HAZARDOUS GAS CONCENTRATIONS

Gas	Loading 1 peak, ppm	Loading 2 peak, ppm
Helium	8,000	7,560
Hydrogen	88	71
Oxygen	10	12
Load 54/55	0/0	N/A

The overall GH₂ system in-flight performance was nominal, with all three flow-control valves operating nominally. The engine 1 cycle count was 6 cycles; the engine 2 cycle count was 14 cycles; and the engine-3 cycle-count was 7 cycles.

Gas Sample Analysis

The measured sample bottle pressures indicated the redesigned Orbiter aft fuselage Gas Sampler System collected four out of six samples that were within previously established pressure limits—Right Hand 1 (RH1), Left Hand 2 (LH2), LH3, and RH3. It was the third flight for RH1, LH1, RH2, LH2, and RH3 and the second flight for LH3. The table on the following page reflects the analysis of the contents of the bottles.

AFT FUSELAGE GAS ANALYSIS

S/N	Position	Actual pressure, torr	Ar, %	Air from Ar, %	He, %	CO ₂ , %	CH ₄ , %	CO ₂ , %	O ₂ from air, %	O ₂ found %	H ₂ , %	H ₂ pyro-corrected, %
1077 FLT-3	RH1	164	0.04	4.71	0.82	<0.01	<0.01	<0.01	0.99	1.20	0.05	0.05
1084 FLT-3	LH1	760	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1078 FLT-3	RH2	61.8	0.04	4.07	0.69	<0.01	<0.01	<0.01	0.85	1.38	0.02	0.02
1085 FLT-3	LH2	36.2	0.05	5.14	0.72	<0.01	<0.01	<0.01	1.08	2.08	0.02	0.02
1081 FLT-3	RH3	2.3	0.04	4.35	4.07	<0.01	<0.01	0.011	0.91	7.11	0.56	0.56
1093 FLT-2	LH3	8.0	0.03	3.00	1.09	<0.01	<0.01	<0.01	0.63	9.32	0.21	0.21

Note: All values are given in percentages by volume, and the balance is nitrogen.

The pressure in bottle LH1 was 14.7 psia. Because the sample was contaminated from the atmosphere leaking in, no mass spectrometer data were taken (STS-114-V-37).

The second bottle that was considered invalid had a pressure below the minimum allowable. Bottle RH2 had a pressure of 61.80 torr, the minimum allowable being 64.83 torr. Pressure is used as a screen mainly to determine if a sample bottle was contaminated by air leaking into the bottle after re-entering the atmosphere. Atmospheric contamination postflight would result in elevated pressures, not reduced pressures. During the postflight inspection, it was found that bottle RH2 acquired its sample 1-2 sec late and this explains the lower-than-expected bottle pressure. Since the sample pressure was very close to the allowable pressure, contamination due to air intrusion was not anticipated, and an H₂ system leak rate was calculated.

Oxygen concentrations for the first three bottles were well below the flammability limit. However, the concentrations increased with each of the first three samples, and the concentrations in the last two bottles (RH3 and LH3) were extremely high (STS-114-V-36). As shown in the following table, the helium concentrations were within the expected ranges and appeared nominal when compared to previous flights of OV-103.

A summary of bottle pressures and gas concentrations for STS-114 is given in the table on the following page.

SUMMARY OF BOTTLE PRESSURES AND GAS CONCENTRATIONS

Number	Position	Pressure, psia	Helium, %	Measured oxygen, %	Hydrogen, %
1	RH1	3.17	0.82	1.20	0.05
2	LH1	14.7	N/A	N/A	N/A
3	RH2	1.20	0.69	1.38	0.02
4	LH2	0.70	0.72	2.08	0.02
5	LH3	0.15	1.09	9.32	0.21
6	RH3	0.04	4.07	7.11	0.56

The ascent hazard analysis indicates the maximum hydrogen firing leak rate for STS-114, the 31st flight of OV-103, was 2275 scim. The maximum allowable firing leak rate on ascent is 57,000 scim. The estimated firing leak rates for all sample bottle data from this flight are summarized in the following table.

ESTIMATED FIRING LEAK RATES FOR SAMPLE BOTTLE DATA

Number	Position	Hydrogen firing leak rate, scim
1	RH1	2275
2	LH1	N/A
3	RH2	435
4	LH2	295
5	LH3	850
6	RH3	710

Purge, Vent, and Drain System

The Purge, Vent, and Drain (PV&D) System performed nominally throughout the mission, with no anomalies noted in the review of the prelaunch and postlanding data.

The PV&D System is not active during the mission. Postlanding purge of the PV&D System was initiated 71 min after touchdown and 30 min after the Upper Level Safety Assessment was completed. A Data Trend Notice (DTN) was generated for exceeding the 45-min-after-touchdown requirement. No problems were noted as a result of the delay.

Reaction Control System

The Reaction Control System (RCS) performed nominally with no noted in-flight anomalies. The RCS window-protect maneuver was initiated at 207/14:41:00 GMT

(00/00:00:02:xx MET) for 2.08 sec. This maneuver fired the F1U, F2U, and F3U thrusters. The intent of the window-protect maneuver is to deflect the exhaust from the SRB separation motors away from the windows during SRB separation. The ET separation maneuver was performed at 207/14:47:45 GMT (00/00:08:45 MET) and was a 3 sec, 10-thruster translation. The ET photo maneuver was performed at 207/14:47:54 GMT (00/00:08:54 MET).

The RCS preflight propellant load was 4395.6 lb of oxidizer and 2749.3 lb of fuel, for a total of 7144.9 lb of propellant loaded for the mission. The residual propellants, as calculated by the Primary Avionics Software System (PASS), were 1873.9 lb. The propellant used was 5271.0 lb, which included 515.8 lb used from the OMS during RCS interconnect operations.

Ground camera imagery showed that two FRCS Tyvek launch covers (on thrusters F3D and F4D) released at above the certified vehicle speed of 150 mph (IFA STS-114-V-02). According to the photo times, F4D released 12.987 sec, and F3D released 21.548 sec, after launch. These correspond to estimated airspeeds of approximately 185 and 345 mph, respectively. There was no reported damage as a result of the late release.

The Pc of vernier thruster R5R was lower than expected, reaching only 63 psia, at a firing at 218/15:33:12 GMT (11/00:45:27 MET), as recorded in IFA STS-114-V-24. Prior to this time, the Pc of this thruster was mainly nominal. Similar signatures were noted on previous flights and attributed to hot propellant causing a temporary mixture ratio shift. A subsequent review of STS-114 mission-long data concluded that the vernier thruster heater had failed-on halfway through the mission and was the cause of the hot propellant. Overall, there was little impact from the hot propellant other than off-nominal Pc. In fact, after some firing, the hot propellant was replaced by propellant at nominal temperature and the chamber pressure returned to nominal. Although the low Pc was intermittent, it was never low enough to trip the redundancy management (RM) limit for a failed-off thruster (26 psia).

RCS firings, times initiated, ΔV s, and firing times are listed in the table on the following page.

RCS MANEUVERS AND FIRING DATA

Firing	Time of ignition, GMT	ΔV , ft/sec	Length, sec
RCS window protect	207/14:41:00	N/A	2.08
ET separation	207/14:47:45	N/A	3.0
ET photo maneuver, +X	207/14:47:54	N/A	9.92
NC3	Cancelled		
NCC	209/07:41:51	1.43	6.12
MC1	209/09:00:03	0.35	1.4
MC2	Cancelled		
Out-of-plane null	209/09:16:40	N/A	N/A
MC3	209/09:46:22	0.4	1.7
MC4	209/09:56:45	1.97	8.4
ISS flyaround			
Separation 1	218/08:36:24		4.66
Final separation	218/08:36:24	2.8	12.7
RCS hotfire	219/04:47:05	N/A	All thrusters had at least one 0.320-sec pulse

All forward thrusters were deselected for the EVA 2 gap filler removal procedure and were reselected after gap filler removal when configuring attitude control for ingress at 215/14:00:17 GMT (07/07:07:41 MET).

As part of the undocking preparations, thrusters F1U, F2U, and F3U were reselected at 218/06:38:46 GMT (10/15:59:46 MET). Undocking was initiated with a +Z pulse at 218/07:23:55 GMT (10/16:44:55 MET). ISS undocking was nominal. The flyaround and separation from the ISS were accomplished nominally. The final separation ΔV was 2.8 ft/sec, and the resulting orbit was 186.9 x 193.7 nmi.

The RCS hotfire was completed satisfactorily, and all thrusters were fired at least once for at least 0.320 sec on each pulse. No fail-off or fail-leak problems were detected during hotfire.

The RCS pressurization and propellant isolation valves were configured for entry at 220/07:08:24 GMT (12/15:29:24 MET). After the planned landing waveoff, the RCS pressurization and propellant isolation valves were reconfigured for on-orbit operation.

The RCS pressurization and propellant isolation valves were again configured for entry. The FRCS dump (four thrusters) was satisfactory and lasted 44.2 sec.

The postflight Redundant Circuit Verification Test was completed, and there were no anomalies. All valves and switches were exercised, as required.

The primary thrusters were fired 3331 times, for a total firing time of 1005 sec. The vernier thrusters were fired 14,566 times, with a firing time of 21,030.24 sec.

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

CONTROL RESPONSIBILITIES BETWEEN ISS AND SHUTTLE

Control responsibility	Control start, GMT	Control end, GMT	Elapsed time, hr:min:sec	Comments
ISS	209/11:17:19	209/11:42:07		Docking
Shuttle	209/11:42:07	209/11:50:04		
ISS	209/11:50:04	209/11:50:12		
Shuttle	209/11:50:12	209/12:27:00		
ISS	209/12:27:00	209/12:28:38		
Shuttle	209/12:28:38	209/12:43:56		
ISS	209/12:43:56	210/16:40:13		
Shuttle	210/16:40:13	210/18:29:48	00/01:49:35	Cabin depressurization
ISS	210/18:29:48	211/05:26:24	00/10:56:36	
Shuttle	211/05:26:24	211/09:21:42	00/03:55:18	
ISS	211/09:21:42	211/09:23:08	00/00:01:26	EVA 1 start
Shuttle	211/09:23:08	211/10:36:33	00/01:13:25	
ISS	211/10:36:33	211/10:38:09	00/00:01:36	
Shuttle	211/10:38:09	211/15:51:22	00/05:13:13	
ISS	211/15:51:22	211/15:52:26	00/00:01:04	EVA 1 end
Shuttle	211/15:52:26	211/15:56:34	00/00:04:08	
ISS	211/15:56:34	211/16:01:35	00/00:05:01	
Shuttle	211/16:01:35	211/17:04:12	00/01:02:37	
ISS	211/17:04:12	211/17:06:10	00/00:01:01	
Shuttle	211/17:05:13	212/05:37:00	00/12:31:47	
ISS	212/05:37:00	212/05:37:25	00/00:00:25	
Shuttle	212/05:37:25	212/09:06:46	00/03:29:21	Waste water dump
ISS	212/09:06:46	212/16:10:43	00/07:03:57	
Shuttle	212/16:10:43	212/17:10:28	00/00:59:45	
ISS	212/17:10:28	213/08:26:07	00/15:15:39	
Shuttle	213/08:26:07	213/09:29:18	00/01:03:11	
ISS	213/09:29:18	213/15:06:37	00/05:37:19	EVA 2
Shuttle	213/15:06:37	213/16:22:34	00/01:15:57	
ISS	213/16:22:34	214/05:38:51	00/13:16:17	
Shuttle	214/05:38:51	214/08:43:59	00/03:05:08	Waste water dump

CONTROL RESPONSIBILITIES BETWEEN ISS AND SHUTTLE (CONCLUDED)

Control responsibility	Control start, GMT	Control end, GMT	Elapsed time, hr:min:sec	Comments
ISS	214/08:43:59	214/16:24:11	00/07:40:12	
Shuttle	214/16:24:11	214/16:57:54	00/00:33:43	Cabin depressurization
ISS	214/16:57:54	215/08:29:08	00/15:31:14	
Shuttle	215/08:29:08	215/09:12:31	00/00:43:23	
ISS	215/09:12:31	215/14:05:00	00/04:52:29	EVA 3 gap filler repair
Shuttle	215/14:05:00	215/15:24:03	00/01:19:03	
ISS	215/15:24:03	217/05:30:27	01/14:06:24	
Shuttle	217/05:30:27	217/08:33:44	00/03:03:17	Waste water dump
ISS	217/08:33:44	217/12:10:07	00/03:36:23	
Shuttle	217/12:10:07	217/12:11:47	00/00:01:40	
ISS	217/12:11:47	217/12:27:49	00/00:16:02	
Shuttle	217/12:27:49	217/12:33:46	00/00:05:57	ISS CMGs could not sustain desired attitude during MPLM relocation
ISS	217/12:33:46	217/12:40:34	00/00:06:48	
Shuttle	217/12:40:34	217/12:44:02	00/00:03:28	
ISS	217/12:44:02	217/13:12:22	00/00:28:20	
Shuttle	217/13:12:22	217/13:50:25	00/00:38:03	
ISS	217/13:50:25	217/14:08:14	00/00:17:49	
Shuttle	217/14:08:14	217/14:18:16	00/00:10:02	
ISS	217/14:18:16	217/14:35:32	00/00:17:16	
Shuttle	217/14:35:32	217/15:19:15	00/00:43:43	ISS CMGs saturated during MPLM operations
ISS	217/15:19:15	218/06:13:20	00/14:54:05	
Shuttle	218/06:13:20	218/07:04:49	00/00:51:29	
ISS	218/07:04:49	218/07:07:07	00/00:02:18	
Shuttle	218/07:07:07	218/07:21:03	00/00:13:56	Undock phase
ISS	218/07:21:03	218/07:23:55	00/00:02:52	Undock phase
Shuttle	218/07:23:55	EOM	N/A	Undock
Total attitude control time		ISS Shuttle	05/18:32:33 01/20:11:09	

Orbital Maneuvering System

The OMS functioned satisfactorily, with one anomaly noted, which is related in this section. The standard OMS configuration is provided in the table on the following page.

OMS CONFIGURATION

Vehicle/equipment	Flight	Orbital Maneuvering Engine (OME)	Ancillary data
OV-103	31 st		
Left Pod (LP) 01	34 th	L-OME S/N 115	1 st rebuilt flight, 16 th flight
Right Pod (RP) 03	32 nd	R-OME S/N 106	5 th rebuilt flight, 29 th flight

Pressure/temperature data during coast periods indicated no detectable leakage. Helium usage during the mission was very close to preflight predicted values.

Following the first launch attempt, the Orbiter was powered down. Upon restoration of power, the OMS totalizer outputs took on random values; this is a known feature of the totalizers. The left OMS oxidizer quantity indicated 3.8 percent, and the right OMS oxidizer quantity indicated 0.0 percent. Because these values were below the 5-percent low-level alert threshold, there was an alarm upon transition to Operational Sequence (OPS) 1 mode. This was an expected condition. Fourteen seconds into the OMS assist maneuver, the totalizers updated from the probes, as expected, and output the correct values.

Imaging reported that a red-orange illumination was viewed from the ET camera at approximately the same time as the OMS assist ignition. The OMS/RCS identified this as an oxidizer cloud either from an aft thruster valve bounce or one that occurred during OMS assist pre-ignition. With a nominal OMS engine firing, oxidizer enters the thrust chamber before the fuel and, therefore, would escape and produce a large orange cloud. Additionally, the injector temperatures of some aft right thrusters dropped at about the same time, indicating leakage which could produce a small cloud. However, because of the camera angle and the lack of experience with visual data on oxidizer clouds at high altitude, the exact cause of the cloud was not identified. However, it was concluded to be oxidizer and, most likely, it was from the OMS assist ignition. There was no impact to hardware for either possible cause.

The OMS firings and interconnect operations are given in the following table.

OMS MANEUVERS

Maneuver designation	Configuration	Time of ignition, GMT	Firing time, sec	ΔV , ft/sec or interconnect usage, %
Assist	Dual OME	207/14:41:12	137.3	N/A
OMS-2	Dual OME	207/15:17:00	65.0	98.9
OMS-3	Dual OME	207/19:42:24	80.4	123.7
OMS-4	Dual OME	208/06:55:31	30.2	46.3
OMS-5	Dual OME	209/06:28:34	39.6	61.7
OMS-6	Dual OME	209/07:15:35	41.9	64.4
OMS-7	Left OME	209/08:40:04	11.2	8.2
OMS-8	Dual OME	220/12:19:00	24.0	40.8
DOB	Dual OME	221/11:06:18	163.4	276.8
Left interconnect				1.208 %
Right interconnect				2.775 %

Official propellant residuals should be taken from the following table.

PROPELLANT DATA

Parameters	Left OMS pod		Right OMS pod	
	Oxidizer	Fuel	Oxidizer	Fuel
Loaded, lbm	7702	4689	7702	4685
Residual, lbm (aft gage)	483	275	435	313
Residual, lbm (burn time integration)	439	214	466	317
Residual, lbm (Engineering estimate)	N/A	N/A	N/A	N/A
Residual, lbm (SODB flow rate)	501	305	469	325

The engine inlet pressure, chamber pressure, and regeneration jacket temperatures for both engines were as expected. OMS firing times and propellant consumption were consistent with predictions and verified proper performance.

The left upper Y-web structural temperature went erratic at SRB ignition (IFA STS-114-V-03). Heater performance was monitored with a redundant measurement. Throughout the flight, the measurement went off-scale high during time frames coincident when the

heaters were powered, and the measurement reverted following removal of heater power. After undocking, the measurement remained consistently off-scale high until entry, where it began tracking the redundant measurement. At the time of this report, the cause of the inconsistency was still under investigation.

Power Reactant Storage and Distribution System

The OV-103 Power Reactant Storage and Distribution (PRSD) system performance was nominal during STS-114. No in-flight anomalies occurred, and all OMRSD File IX requirements were satisfied for the PRSD. The five PRSD tank sets were loaded on July 24, 2005. The tanks also had been loaded on July 11, 2005, to support the earlier launch attempt on July 13. The tank quantities at the end of loading, launch, and landing are listed in the following table.

PRSD TANK QUANTITIES

Oxygen	Tank 1, %	Tank 2, %	Tank 3, %	Tank 4, %	Tank 5, %	Total Mass, lbm
Loaded	101.8	101.8	100.5	100.9	101.9	3958
Launch	100.9	100.9	100.1	100.5	100.9	3931
Landing	22.1	22.6	20.8	5.5	6.4	604
Hydrogen	Tank 1, %	Tank 2, %	Tank 3, %	Tank 4, %	Tank 5, %	Total Mass, lbm
Loaded	102.3	102.3	102.8	102.3	103.2	472
Launch	100.1	99.7	100.6	100.6	101.5	462
Landing	24.5	26.7	26.7	1.1	2.4	75

The PRSD system supplied the fuel cells with 3076 lbm of oxygen and 387 lbm of hydrogen for the production of 4526 kWh of electrical energy. The average power level for the 333.55-hr mission was 13.6 kW. A 36-hour mission extension was possible at the average power level with the reactants remaining at touchdown. Oxygen and hydrogen tank sets 4 and 5 were depleted to residual quantities.

The Environmental Control and Life Support System (ECLSS) was supplied with 250 lbm of oxygen. The O₂/H₂ manifold isolation valves were cycled for the crew sleep periods, which satisfied the OMRSD File IX In-flight Checkout requirement. At Orbiter wheels stop at EAFB, the PRSD residuals were 604 lbm of oxygen and 75 lbm of hydrogen after a 1-day mission extension due to weather.

Three PRSD cryogenic storage tank annulus vacuum measurements indicated zero on July 20, 2005 (IPR 114-V-0460 for hydrogen tanks 3 and 5 and oxygen tank 5). These

measurement readings were verified good when checked out in the Orbiter Processing Facility (OPF). The boiloff rates for each of the tanks were nominal during the STS-114 launch scrub, verifying a good vacuum in all of the tanks.

During the cabin repressurization at 208:08:10 GMT (00/17:31 MET), the PRSD O₂ manifold 1 and 2 pressures increased to 900 psia. This occurred while O₂ tank 4, at 93 percent, was controlling the manifold pressures. When the high flow to the cabin ceased, the cold, dense fluid warmed and expanded to increase the manifold pressure to slightly above the nominal upper pressure range of 875 psia. The manifold pressure remained well below the manifold relief valve cracking pressure of 975 psia. This is a typical occurrence during cabin depressurization or repressurization procedures, particularly with the oxygen tanks at high quantity.

Destratification and pressure collapse occurred in O₂ tank 4 after the cabin depressurization to 10.2 psia, which started at 210:17:40 GMT (03/03:40 MET). The O₂ tank 4 pressure decayed to 595 psia; however, pressures recovered quickly to the nominal pressure control range when the tank heaters were energized.

Fuel Cell System

The overall performance of the OV-103 Fuel Cell System was nominal, and there were no fuel cell anomalies during STS-114. The average electrical power level and load was 13.6 kW and 438 A. The fuel cells produced 3463 lb_m of potable water and 4526 kWh of electrical energy from 3076 lb_m of oxygen and 387 lb_m of hydrogen. The OV-103 fuel cells were operated as backup power for Tanking Tests I and II.

Fuel cell startup was initiated on July 25, 2005, at 206:23:10:01 GMT and was completed on July 26 at 207:01:08:47 GMT. Startup and prelaunch operations were nominal. Fuel cell operating times, which are the times accumulated for prelaunch, on-orbit, and postlanding, were 368:21:37 for fuel cell 1, 368:23:05 for fuel cell 2, and 367:24:34 for fuel cell 3. The end-of-mission accumulated operating times for these fuel cells are 1078, 422, and 418 hr, respectively.

Five purges of the fuel cells were performed, occurring at approximately 38, 118, 206, 299, and 322 hr MET. The actual fuel cell voltages at the end of the mission were 0.15 V above that predicted for fuel cell 1 and 0.00 V above that predicted for fuel cells 2 and 3. The voltage margins above the minimum performance curves at 200 A at the end of the mission were 1.10 V above the minimum for fuel cell 1, 1.20 V above the minimum for fuel cell 2, and 1.10 V above the minimum for fuel cell 3.

The overall thermal performance of the fuel cell water relief, water line, and reactant purge heater systems was nominal. All of the water system heaters were cycled to satisfy the File IX checkout requirements, except for the fuel-cell-1, water-relief-valve-B heater. The fuel cell alternate water line temperatures were erratic and high during intervals, indicating leakage past the alternate water check valves. The leakage corresponded to the condition that occurs when potable water tanks A and B are full or

isolated, which causes the pressure upstream of the check valve to increase above the downstream pressure. When the pressure is great enough, the check valve cracks and the leakage of the 140 °F product water affects the nominal heater cycles of the line heaters. This was observed in the temperatures of all three fuel cell alternate water lines. It was more pronounced on fuel cell 3, less pronounced on 2, and even less pronounced on fuel cell 1.

The Fuel Cell Monitoring System (FCMS) was used to monitor individual cell voltages during prelaunch, on orbit, and postlanding. Full-rate on-orbit data were recorded for 13 min beginning at 213:05:49:06 GMT. All cell voltages were nominal. Because of an OV-103 vehicle-specific FCMS instrumentation bias, fuel cell 1, cell 59, was biased 12 mV high; and fuel cell 2, cell 25, was biased 12 mV low. Each of these fuel cells has soldered voltage pin connections.

Auxiliary Power Unit System

The APU System performance was nominal throughout the STS-114 mission. Three in-flight anomalies were recorded against the APU System, and these are discussed later in this section.

The run times and fuel consumption for the APUs, including the S/N of each, during STS-114 are summarized in the following tables.

APU RUN TIMES

APU (S/N)	Ascent, hr:min:sec	DTO, hr:min:sec	FCS checkout, hr:min:sec	Entry, hr:min:sec	Total time, hr:min:sec
1 (306)	00:20:42	00:00:00	00:00:00	1:02:17	1:22:59
2 (403)	00:20:55	00:00:00	00:00:00	1:28:10	1:49:05
3 (208)	00:21:03	00:06:01	00:04:19	1:02:31	1:33:54

APU FUEL CONSUMPTION

APU (S/N)	Ascent, lb	DTO, lb	FCS checkout, lb	Entry, lb	Total , lb
1 (306)	51	0	0	118	169
2 (403)	55	0	0	159	214
3 (208)	58	14	16	141	229

The following APU in-flight anomalies occurred during STS-114.

The APU 1 drain system pressure began to decay from approximately 15.2 psi at 207/16:00 GMT (001/01:21:00 MET), down to 6.8-7.4 psia approximately 21 hr 46 sec later. It continued to decay down to approximately 0.8 psia (IFA STS-114-V-06). The decay began on orbit approximately 1 hr after APU post-ascent shutdown. Because no fuel leakage into the drain system was seen during APU operation or after shutdown, it was believed to be an external leak of gaseous nitrogen (GN₂) into the aft fuselage. Subsequent external fuel leakage into the drain system would not be expected because of the low pressure (lack of driving force) in the system and the small leak path.

APU 2 had a momentary loss of pressure and temperature indications, when it took a step function of approximately 20 psi and 365 to 415 °F, respectively, to 0 (off-scale low) for approximately 2 sec. Data from main bus B aft power controller 5 current indicated a drop in current at the same time the data were lost (IFA STS-114-V-09). There were no immediate impacts to the vehicle/mission and no immediate crew response or procedure changes due to this problem.

The APU 3 exhaust gas temperature sensor operated erratically during entry with an erratic output signature (IFA STS-114-V-25). This data value was for display only, and no action was required by the crew and this anomaly had no impact on the flight.

Hydraulics/Water Spray Boiler System

Overall, the performance of the Hydraulics and Water Spray Boiler (WSB) System during STS-114 was nominal. One in-flight anomaly was identified and it occurred at landing with no impact on the system operation or flight operations.

During prelaunch operations, the hydraulics bootstrap accumulators were charged when circulation pumps 1, 2, and 3 were activated. Approximately 10 min after start of circulation pump operations, the brake isolation valves were cycled open to perform the final landing gear fill and then were closed. Nominal circulation pump and accumulator signatures were noted throughout the prelaunch period. There were no additional bootstrap accumulator recharges.

All WSB systems exhibited several steam-vent heater cycles during the prelaunch phase. A WSB ready indication was confirmed on all three systems shortly after the initial opening of the GN₂ isolation valves. The valves were then cycled closed. A WSB ready indication was reconfirmed on all three WSB systems shortly after the WSB GN₂ isolation valves were opened prior to launch.

During ascent, there were no unexpected decreases in reservoir quantity, which indicated there were no gross leaks of the hydraulic system. Priority valve cracks at APU activation were all less than the 1-sec specification limit. Priority valve reseats on all three systems at APU shutdown were also within specification (≥ 2675 psia).

APU lubrication oil temperatures at WSB spray start were well below the limit of 275 °F. Likewise, coolant usage for each of the three WSB systems was well below the maximum specification of 8 lb.

On-orbit, in preparation for DTO-850, APU Re-Start, WSB 3 Controller Power A was turned "ON" at 207/16:41:58 GMT (00/02:02:58 MET), activating the steam vent heaters. Vent temperatures rose above 122 °F approximately 2 hr post-APU shutdown. Soon after heater activation, all three systems demonstrated nominal heater cycling performance. Vent heaters on systems 1 and 2 were left on approximately 3 hr for post-ascent bakeout. The WSB 3 vent heater was not reactivated following DTO 850.

In preparation for FCS checkout, all three WSB System "B" vent heaters performed nominally. WSB vent heaters rose above 122 °F (off-scale low) approximately 1 hr prior to APU start.

APU/Hydraulic system 3 was selected for FCS checkout. Due to the APU 1 drain system pressure anomaly, the team recommended APU 1 should not be used for FCS checkout and time of ignition (TIG) for entry should be delayed to Entry Interface (EI) minus 13 min.

Hydraulic and WSB performance on system 3 was nominal. Reservoir quantity and priority valve crack and reseal pressures were within specification. The APU ran for 4 min 19 sec. Due to the short run time, APU lubrication oil spray cooling was not required. The lubrication oil return temperature at APU shutdown was well below the nominal operating level.

Hydraulic System performance during entry was nominal. APU 2 was activated first for entry at TIG - 5 min, followed by APU 1 and APU 3 at EI minus 13 min, and shortly thereafter, all three systems were taken to normal pressurization. Priority valve cracks during startup for entry and postlanding reseats at shutdown were nominal.

At landing, the WSB 3 corrected GN₂ regulator outlet pressure was calculated to be 23.97 psig, which was below the 24.5 psig [system pressure (37.5 psia minus atmospheric pressure (13.53 psia)] allowable (IFA STS-114-V-34). Regulator pressure on all three systems was within the proper range during entry prior to entering the atmosphere and the increased atmospheric pressure. The requirement is to verify that the GN₂ pressure is being regulated properly. The range in which the regulator should begin regulating is 24.5 to 26.0 psig. Loss of GN₂ regulator function to provide proper regulated GN₂ flow from the high-pressure GN₂ tank would result in the eventual loss of WSB spray cooling of the APU lubrication oil resulting in the loss of hydraulic system upon APU shutdown. The occurrence of this condition was attributed to instrumentation bias.

Hydraulics heat exchanger mode was achieved on all three systems. WSB 1 achieved heat exchanger mode during entry, followed by WSB 3 and WSB 2, respectively, after wheels stop.

WSB coolant usages during entry for the three systems were as follows: 13.4 lb for WSB 1, 22.7 lb for WSB 2, and 18.2 lb for WSB 3. The usage for each system was well below the maximum usage limit of 45 lb per system.

Electrical Power Distribution and Control System

The Electrical Power Distribution and Control (EPDC) System performed nominally during all mission phases of STS-114, and no anomalies were identified in the EPDC System. In addition, all File IX requirements were met. The data review and analysis of all available EPDC parameters have been completed, and no abnormal conditions were identified.

As a minimum, the following EPDC parameters were analyzed for this mission:

- a. Fuel cell voltages and currents
- b. Essential bus voltages
- c. Control bus voltages
- d. Forward Power Control Assemblies voltages and currents
- e. Mid-Power Control Assemblies voltages and currents
- f. Aft Power Control Assemblies voltages and currents
- g. Alternating current (ac) bus voltages and currents
- h. Ac bus monitor/auto switch status and overload/overvoltage alarm
- i. Main-bus-to-control-bus Remote Power Controller (RPC) status
- j. Forward, mid-, and aft Motor Control Assemblies operational status
- k. Fuel-cell-to-essential bus switch status
- l. Main-bus-to-essential-bus RPC and switch status
- m. Drag-chute pyrotechnic controller functions

In addition, the evaluation of the data enabled the satisfaction of EPDC File IX in-flight checkout requirements.

Orbiter Docking System

The STS-114 ODS was powered up at 208:13:45:09 GMT (00/23:06:09 MET). The ring extension was completed nominally, and the system was powered down at 208:13:50:21 GMT (00/23:11:21 MET). In this configuration, the ODS was ready for rendezvous and docking operations.

The ODS was powered on at 209:10:43:02 GMT (01:20:04:02 MET). The ISS was captured at 209:11:43:53 GMT (01:21:04:53 MET). The ring retracted and the 12 hooks closed nominally. Damper 2 was stuck on, and nominal workaround procedures were used successfully to unstick damper 2. During the closing of the hooks, ring misalignment occurred (IFA STS-114-V-30); however, it realigned. The capture latch manual release indication came on and should have remained off (IFA STS-114-V-16). After docking was completed, the crew verified that the manual capture latch 1 release handle was partially disengaged (~1/8 in.), and the crew returned the manual

release handle back to the flight configuration. The anomaly did not impact nominal operations, manual release (the backup to opening capture latches electrically), or undocking. The anomaly is currently under analysis to determine the cause. The ODS was powered off at 209:12:21:28 GMT (01:21:42:28 MET).

The ODS was powered on at GMT 218/06:58:36 GMT (10/16:19:36 MET). All three capture-latch talkbacks indicated closed, as expected. The hooks drove open nominally at dual-motor speed and undocking was completed at 281:07:23:45 GMT. Powerdown occurred at 218:07:45:14 GMT (10/16:44:45 MET).

Atmospheric Revitalization Pressure Control System

The Atmospheric Revitalization and Pressure Control System (ARPCS) performed nominally throughout the mission. All of the scheduled in-flight checkout requirements were satisfied, except for the automatic switchover function of the N₂/O₂ control panel. As a result of the crew's time schedule, joint ISS Pressure Control System (PCS) operations, and the three EVAs performed for the Orbiter airlock, a complete System 1 and System 2 ARPCS checkout could not be performed. This checkout will be performed during postflight testing at KSC.

Three Orbiter-based EVAs were supported by the ARPCS. These include 10.2-psi operations and repressurization of both the Orbiter and the airlock. The Orbiter ARPCS supported ISS PCS operations with four ISS stack repressurizations, O₂ transfers via the Orbiter payload O₂ valves and manual operation of the control panel, and an N₂ transfer to the ISS of about 22 lb.

Atmospheric Revitalization System

The Atmospheric Revitalization System (ARS) performed satisfactorily and no anomalies were noted in the evaluation of the data. An in-flight anomaly was reported by the crew at the post-mission crew debriefing. The crew observed a crack in the lithium hydroxide (LiOH) canister (IFA STS-114-V-35). This was the 13th flight for this canister, and there was no previous history to indicate when the crack occurred. The crack, which was on the screen mesh of the canister, caused no impact to the mission. Subsequently, the laboratory at KSC reported another cracked LiOH canister returned from the mission.

Active Thermal Control System

All Active Thermal Control System (ATCS) parameters showed nominal hardware performance during the STS-114 mission. All File IX requirements were met satisfactorily.

Airlock System

The Airlock System performed nominally with one exception. At the end of EVA 2, the aft hatch starboard equalization valve failed to depressurize the airlock for EVA crew ingress hatch opening (IFA STS-114-V-15). The discrepant valve was placed in the closed position, and the port valve was used to properly depressurize the airlock. The suspect valve was not used for the remainder of the mission, and postflight troubleshooting attributed the anomaly to the cap blocking the vent port as the most probable cause.

All of the in-flight checkouts were performed with the exception of two. The airlock functional valve verification was not completed because of the in-flight anomaly. The in-flight checkout of the vestibule heater controls was not met. As a result of the crew's time lines, ISS operations, and the three EVAs performed using the Orbiter airlock, a verification of the vestibule heater-control was done with only Main A-bus power and showed nominal temperature signatures. The heater verification using Main B-bus power was not performed. The checkout using Main B-bus power will be performed at KSC during postflight testing.

The Airlock System supported all ISS operations, including three EVAs. These EVAs included depressurization of the airlock for EVA crew egress, repressurization during the EVA (so the remaining Orbiter crew could resume ISS operations), another airlock depressurization for the EVA crew to ingress into the airlock, and then one last repressurization of the airlock to equalize with the Orbiter each time. A nominal N₂ transfer of about 22 lb was performed by connecting the GN₂ transfer line and configuring the airlock transfer panel and manned maneuvering unit (MMU) isolation valves. All structural heater strings were monitored and verified for proper functioning during the entire mission.

Supply and Waste Water System

The Supply and Waste Water Management System (SWWMS) performed nominally throughout the mission, and all of the scheduled in-flight checkout requirements were satisfied except for the supply-water dump line. A supply-water overboard dump was not scheduled for this mission because of the high volume of water transferred to the ISS; thus, the File IX in-flight checkout requirement was not satisfied. Postflight testing will be performed at KSC. Supply water was managed through the use of the Flash Evaporator System and water transfer to ISS. The line heater maintained the supply water dump line temperature between 75 and 94 °F throughout the mission.

Five waste water nozzle dumps from the waste tank were made at an average rate of 1.94 percent/min (3.2 lb/min). During this mission, three contingency water containers (CWCs) containing ISS water (two ISS condensate and one CWC extravehicular mobility unit (EMU) water), four payload water reservoirs (PWRs), one leaking CWC (Fill 16, S/N 1012, IFA STS-114-V-19) containing supply water, and two CWCs containing

Shuttle condensate were nominally dumped through the Orbiter dump nozzle. All CWC dumps were performed satisfactorily.

The waste water dump line temperature was maintained between 59 and 95 °F throughout the mission.

Nineteen CWCs were filled with supply water, and eighteen were transferred to the ISS, for a total of 1739.7 lb. Because of leakage, CWC (Fill16, S/N 1012) did not contribute to the total quantity of supply water transferred and was dumped through the waste dump line nozzle (IFA STS-114-V-19). Six of the transferred CWCs contained potable water, and twelve contained technical water. In addition, five PWRs were filled and transferred to the ISS.

The vacuum vent line temperature was maintained between 59.8 and 79 °F.

Waste Collection System

The Waste Collection System (WCS) operated satisfactorily, and no in-flight anomalies were reported by the crew.

Smoke Detection and Fire Suppression Systems

The Smoke Detection System showed no indications of smoke generation during the entire duration of the flight. Use of the Fire Suppression System was not required.

Flight Data Processing System

The Data Processing System (DPS) performed satisfactorily with no anomalies identified in the data. During postlanding operations, 10 GPC errors were enunciated by the PASS redundant set. The errors were explained in PASS program notes.

Flight Control System

The FCS hardware/effector systems performed nominally during ascent through APU shutdown. At all times, the SRB thrust vector controller (TVC), MPS TVC, and aerosurface actuators were positioned exactly 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 Station rate gyro assemblies (SRGAs) tracked one another normally, and there were no spin motor rotation detector (SMRD) dropouts. The outputs of the four accelerometer assemblies (AAs) also tracked one another normally. 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 OMS TVC File IX requirements were met, and OMS TVC actuator rates were normal. Flight control actuator temperatures were also normal. The Rudder/Speed Brake Power Drive Unit (RSB PDU) motor backdrive did not occur during hydraulic system shutdown.

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

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

Air Data Transducer Assembly

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, which were performed shortly after power-on, were nominal. There is 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 207/18:00:11 GMT (00/03:21:11 MET). All ADTA mode/status words were nominal.

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

Entry performance was nominal from de-orbit through wheels-stop. All 16 transducers tracked during the pre-probe deployment phase of entry. Air data probes were deployed at approximately Mach 4.7, and deployment timing was within specification at less than 15 sec. ADTA data were incorporated into Guidance, Navigation, and Control (GN&C) and altitude at about Mach 2.6. No ADTA dilemmas or RM failures occurred during deployment through wheels-stop. The ADTAs were powered down at 221/13:13:35 GMT (13/10:44:35 MET). Entry data were retrieved and reviewed, and no anomalies were observed.

Flight Software

Performance of all flight software, which includes the Primary Avionics Software System (PASS), the Backup Flight System (BFS), the Multifunction Electronic Display

Subsystem (MEDS), and the Miniature Airborne Global Positioning System Receiver (MAGRS) was nominal throughout the STS-114 mission. No unexpected PASS or BFS GPC errors or input/output (I/O) errors were encountered. The postflight review of MEDS and MAGRS fault logs confirmed the nominal performance observed through telemetry data. No issues or anomalies related to the STS-114 mission were identified.

Displays and Controls System

The Displays and Controls (D&C) System, including lighting, performed nominally during all phases of the STS-114 mission. Some observations were made, and are discussed in the following paragraphs.

During OV-103 postflight inspection and checkout, it was found that an incorrect nose-wheel steering (NWS) switch guard was installed on panel L2A1. The entire panel L2 was designated for shipment to the NASA Shuttle Logistics Depot (NSLD) for repair and replacement of the incorrect NWS switch guard.

Forward starboard payload bay floodlight 2 appeared to have a crack across the lens from 11 o'clock to 5 o'clock. Floodlight 2 was designated for repair and sent to NSLD.

The ODS forward-truss docking light was off and should have been on, resulting in removal and replacement of the bulb.

Communications and Tracking System and Navigation Aids

The Communications and Tracking (C&T) System performed nominally during the mission with one anomaly noted.

An intermittent loss of S-band communications through the lower left antenna was experienced early in the mission. The communications improved to nominal; later in the mission, the S-band system 1 was in operation for approximately 24 hr, which satisfied the File IX requirement of 24 ± 4 hr; and the anomaly was closed as an explained condition.

Navigation Aid (NAVAID) data analysts successfully completed the required audit, which showed nominal performance; and all File IX requirements were satisfied

Operational Instrumentation/Modular Auxiliary Data System

The Operational Instrumentation/Modular Auxiliary Data System (OI/MADS) performed satisfactorily. Two data system anomalies occurred during the mission, neither of which caused a significant impact on the mission. These are discussed in the following paragraphs.

The measurement for the left OMS upper Y web temperature was erratic during ascent (STS-114-V-03). A backup measurement provided the necessary data during the mission.

The APU exhaust gas temperature operated erratically (STS-114-V-25). This problem has been experienced on numerous missions because of the environment in which the measurement operates. The sensor will be removed and replaced prior to the next mission.

Numerous master frame dropouts were noted on payload data interleaver 1 (PDI 1) decommutator 1 during two different periods of the mission. Since PDI 1 decommutator 1 was used extensively during the mission with no problem, this problem is believed to be most likely payload related.

Two times during the mission, deorbit checkout and initial part of entry, the right landing gear outboard brake puck pressure no. 2 was full-scale high and noisy for approximately 9 minutes.

Structures and Mechanical System

The Structures and Mechanical Systems performed satisfactorily. The operation of the Payload Bay doors was nominal for opening and closing. The main landing gear touchdown occurred on EAFB concrete runway 22 and drag chute deployment and rollout was normal in all respects.

The following table presents the pertinent data on the landing of the Orbiter.

LANDING PARAMETERS

Parameter	From threshold, ft	Speed, keas ^a	Sink rate, ft/sec	Pitch rate, deg/sec
Main landing gear touchdown	1385.9	221.5	6.04	N/A
Nose landing gear touchdown	6515.4	155.9	N/A	-5.503
Brake initiation speed		88.3 keas		
Brake-on time		33.33 sec		
Rollout distance		12736.7 ft		
Rollout time		68.08 sec		
Runway		22 (concrete) EAFB		
Orbiter weight at landing		226,199.0 lb		

Parameter	Max Brake Pressure, psia	Total Brake Energy, M Ft-lb
Left inboard	818.6	15.17
Left outboard	794.1	14.39
Right inboard	857.8	14.20
Right outboard	803.9	10.35

^aKnots estimated air speed.

The landing gear tires were reported to be in good condition. There was no ply undercutting on the main landing gear tires.

Integrated Aerodynamics, Heating, and Thermal Interfaces

The post-flight inspections indicate that the overall Orbiter TPS looked normal with no signs of excessive local heating. The following table shows the maximum temperatures and maximum temperature rise during entry.

The lower structural temperature data indicated normal entry heating. The recorded temperatures are within the flight experience of OV-103 with the exception of the lower fuselage forward center maximum temperature rise that was a new record (134.8 °F). The RCC chin-panel-to-nose-cap gap at the time of access was 0.20-in at the centerline. Possible damage to the chin panel angle seal corner was noted on the left-hand side. The RCC nose-cap windward side showed serious discoloration. The NLGD thermal barriers looked normal. No external damage was observed as a result of the damaged blanket below the no. 1 window. The table on the following page 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	150.6	134.8 ^a
Lower fuselage forward left-hand	195.3	179.4
Lower fuselage forward mid left-hand	169.6	170.9
Lower fuselage mid center	160.1	159.5
Lower fuselage mid aft center	182.9	174.7
Lower fuselage aft center	182.9	151.9
Left-wing center	111.9	138.9
Right wing center	122.0	136.5
Port side FRCS forward	158.7	142.3
Port side fuselage forward center	98.6	100.0

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

Port side fuselage forward mid center	89.6	93.5
Port side fuselage mid aft center	57.1	76.8
Port side fuselage aft center	72.6	64.2
Starboard side FRCS forward)	166.5	137.3
Starboard side fuselage forward center	138.0	128.1
Starboard side fuselage forward mid center	108.8	85.4
Starboard side fuselage mid-aft center	67.5	56.5
Starboard side fuselage aft center	90.7	69.5
Left-hand OMS pod side forward	72.6	64.2
Right-hand OMS pod side forward	67.5	41.1
Lower body flap center	116.8	92.9
Right-hand OMS-pod side forward	67.5	41.1
Left-hand OMS-pod side forward	72.6	64.2
Right-hand PLBD forward	59.6	89.3
Left-hand PLBD forward	59.6	106.8
Right-hand PLBD aft	75.3	97.0
Left-hand PLBD aft	70.1	107.3
Right wing upper center	85.5	107.7
Left wing upper center	80.4	112.4
FRCS forward center	80.4	66.8
Forward fuselage upper center	67.6	92.0

^a New OV-103 Record

Aerothermodynamics

The Boundary Layer Transition (BLT) onset time occurred 1257 seconds after entry interface at Mach 7.3 as indicated by four thermal sensors on the windward side. This is based on transition times from MADS data and the STS-114 best estimated trajectory (BET).

Wing transition based on the surface thermal sensor indicated BLT occurred on the outboard LH wing near the trailing edge at 1226 sec after entry interface, corresponding to Mach 8.0. There is no sensor at the corresponding RH wing location. Final review of the aileron deflection data and yaw jet firings indicated symmetrical BLT.

Data indicate that the acreage heating was normal during entry. The lower structural temperature data is within the range expected for this Orbiter weight and orbital inclination. The recorded temperatures are within the flight experience of OV-103 with the exception of the forward windward structure maximum temperature rise with a new record of 134.8 °F. However, the maximum temperature at touchdown was only 151 °F.

At the same area, on the OV-103 previous flight, STS-60, the maximum temperature rise was 121 °F with a maximum temperature of 168 °F at touchdown.

Local heating was also normal. The postflight inspection of the Orbiter lower surface following did not reveal any notable (beyond normal) degradation resulting from boundary layer disturbances. The damages on the aft NLGD edges and downstream of the protruding gap fillers were specifically inspected for degradation on the runway as well as various other damage sites discovered following landing.

Thermal Control System

The Orbiter passive Thermal Control System (TCS) maintained all subsystem temperatures within acceptable limits. The low beta angles and planned local vertical, local horizontal (LVLH) attitudes during the docked phase resulted in a benign thermal environment. Mission highlights included three EVAs during the 9 days that the Orbiter was docked to the ISS. No significant thermal issues occurred during the mission, with following the exceptions.

Immediately prior to liftoff, the port-OMS-pod, upper-Y-web sensor displayed an erratic signal that continued intermittently throughout the flight (IFA STS-114-V-03). Also, the R5R thruster heater failed on at approximately 207/17:52:26 GMT (00/03:13:28 MET) and remained on through the remainder of the mission. These two anomalies are discussed in the RCS and OMS sections of this report.

The TCS requested the end-of-mission (EOM) thermal conditioning attitude be changed to top-Earth, starboard wing, on velocity vector (-ZLV + YVV) attitude for the nominal EOM and extension days. This attitude provided a better margin for the lower limit of the main landing gear tire and eliminated the need for bottom Sun attitude.

The EMU checkout was performed on velocity vector (-ZLV + YVV) attitude. Three EVAs were performed nominally in the torque equilibrium attitude (TEA) from the Orbiter external airlock. EVA 1 was biased for the DTO involving non-oxide adhesive tile repair.

Thermal Protection System and Windows

The Orbiter TPS performed satisfactorily throughout the mission. A discussion of the specific TPS Tile and RCC anomalies that were addressed real-time during the mission is presented in the Mission Summary section of this report. Additional information is provided below.

Pad cameras identified a piece of orange shim stock falling after main engine start (IFA STS-114-K-109). Previous flight history had identified several occurrences of shim-stock releases. A change will be made to all shim-stock installations that protrude to make them visible for removal.

Additional TPS Tile & RCC Anomalies

Problems were noted during post-landing walk-down inspection on the runway. The upper and lower nose cap expansion seals were noted to be damaged (IFA STS-114-V-27). A second anomaly was that approximately five TPS tiles that had putty repairs missing were noted (IFA STS-114-V-31).

The post-flight inspections also revealed a partially debonded, low-temperature, reusable surface insulation (LRSI) tile near windows 5 and 6 (IFA STS-114-V-28). The tile is being evaluated to determine whether the tile will be rebonded or replaced.

Wing Leading Edge System and TPS Reinforced Carbon Carbon Assessment

The Wing Leading Edge System Detection System (WLEIDS) comprises accelerometers and temperature sensors mounted behind the Wing Leading Edge (WLE) spar at the attach fittings for RCC panels 1-19 and in the chine area. The WLE sensors are used to detect and generally locate accelerations that indicate debris impacts. The sensors connect to 22 battery-powered sensor units per wing and are mounted in two groups in either the wing glove area or in the wing cavity. They are powered by four sets of batteries on the mid-forward and mid-aft sidewalls. Four of the sensors did not generate processed data because of a firmware configuration issue (IFA STS-114-V-17). The firmware has been updated by the vendor for incorporation during the KSC flow process for the next flight of this vehicle.

Temperature predictions were provided for the batteries and updated them in real time as flight data from the Micro Tau temperature sensors (which are installed near the batteries) were downlinked. In the standard (-ZLV - XVV) attitude, the set of batteries not located on the Sun side got cold. The preferable attitude would be (-ZLV \pm YVV) to allow the Sun to shine on both sides of the wings.

The ATCS provided several updates to the Micro Tau WLES sensor battery temperature predictions during the flight. The final biased predictions were plotted in real time against the flight data to allow the WLES sensor monitoring group to adjust their plans to download data and optimize battery voltages.

Overall Tile Discussion and Postflight Damage Assessment

The vehicle sustained 176 hits, of which 29 had a major dimension of 1 in. or larger. This total does not include the numerous hits on the base heat shield attributed to SSME vibration/acoustics and exhaust plume recirculation. The following table lists the STS-114 Orbiter damage hits by area:

ORBITER DEBRIS DAMAGE

Orbiter Surface	Hits > 1 in.	Total hits
Lower surface	21	152
Upper surface	0	0
Window area	3	12
Right side	0	1
Left side	0	2
Right OMS pod	4	7
Left OMS pod	1	2
Totals	29	176

The Orbiter lower surface sustained 152 total hits, of which 21 had a major dimension of 1 in. or larger. Approximately 26 damage sites (with two larger than 1 in. in a major dimension, one of which was the largest on the lower surface) were located in the area forward of the right main landing gear door on the wing glove. The source of these impact damage sites is to be determined.

Numerous damage sites around the ET/Orbiter umbilical represent the largest concentration of Orbiter lower surface hits and were most likely caused by pieces of the umbilical purge barrier flapping in the airstream and contacting tiles before pulling loose and falling aft.

The tile damage to the nose landing gear door aft perimeter observed during on-orbit operations showed signs of entry heating. Additional damage on adjacent tiles was observed and is thought to be the result of landing gear deployment.

Postlanding debris damage maps of the lower surface were compared to on-orbit imagery, and results showed agreement for the quantities, locations, and apparent sizes of the larger damage sites.

The mapping process included the use of e-maps, which correlate the damage site locations to specific tiles. The e-maps will be posted at the KSC Orbiter TPS website.

Three protruding gap fillers (6 in. long by 0.125 in. high, 6 in. long by 0.125 in. high, and 6 in. long by 0.25 in. high) were observed between the umbilical and main landing gear doors. All showed no signs of entry heating.

A comparison of lower surface damage sites for the previous 10 flights is shown in the following table.

**COMPARISON OF LOWER SURFACE DAMAGE SITE DATA
FROM PREVIOUS 10 FLIGHTS**

Parameter	STS- 100	STS - 104	STS - 105	STS- 108	STS - 109	STS - 110	STS - 111	STS - 112	STS - 113	STS- 114
Lower surface, total hits	42	108	108	81	63	70	47	81	68	152
Lower surface, hits > 1 in.	4	24	15	17	14	18	21	22	14	21
Longest damage site, in.	2.5	4.5	5	8	3.5	3.5	3.0	3.5	7.0	3.0
Deepest damage site, in.	0.12	0.25	0.06	0.37	0.12	0.62	0.50	0.25	0.59	0.2

There were two damage sites on the vertical tail and one protruding, frayed, Ames gap filler on the left side of the vertical tail leading edge near the OMS pod.

The white streak observed on the upper surface of RCC panel 4 on the right wing reported during prelaunch countdown operations had not changed in appearance. No adverse effects were observed due to the presence of this streak.

Window hazing appeared to be less than normal. Streaks were observed on forward-facing window 3 and may have been from the RCS cover adhesive. A total of three impact damage sites on the window perimeter tiles were observed. This tile damage is presumed to be the result of using the new Tyvek forward RCS cover. Although damage was identified, it was a magnitude less than during past flights with the butcher paper.

A triangular white tile between and below windows 5 and 6 was protruding approximately 0.75-in above the outer mold line (IFA STS-114-V-28). There were no signs of entry heating on this tile step. The TPS analyst's evaluation of this item concluded that the tile had partial debonding present.

The damaged Advanced Flexible Reusable Surface Insulation (AFRSI) TPS blanket that was observed below window 1 while on orbit appeared to be unchanged from the effects of entry. Further inspection in the mate/demate device (MDD) indicated an opening in the leading edge of the blanket that allowed a flow of gas to enter the blanket pocket. A breach in the AFRSI material near the aft end of the blanket segment allowed

this gas to exit (IFA STS-114-V-08). Local signs of heating and discoloration were observed on the adjacent AFRSI blanket near this breach. Further details will be provided after closer observation of the area.

No ordnance fragments were reported on the runway beneath the umbilicals. A small piece of foam was found on the runway beneath the area between the umbilical doors. The source of this foam is not known, however, the sample will be submitted for laboratory identification analysis and testing.

Tile damage on the base heat shield was typical. The SSME Dome Heat Shield closeout blankets were in excellent condition, except for the SSME 1 closeout blanket, which was torn at the 7 o'clock position.

A postlanding walk-down of the runway was performed. No unexpected flight hardware was found. All components of the drag chute were recovered; however, the Debris Assessment Team personnel recovered the mortar cover on August 10. The drag-chute hardware and components appeared to have functioned normally. Both reefing and line-cutter pyrotechnic devices were expended.

In summary, both the total number of Orbiter TPS debris hits (176) and the number of hits 1 in. and larger (29) was slightly greater than the established family average of 31 greater than 1 in and 156 total debris hits. Potential identification of debris damage sources for mission STS-114 will be based on the laboratory analysis of Orbiter postlanding microchemical samples, inspection of the recovered SRB components, film analysis, and aerodynamic debris particle trajectory analysis. The results of these analyses will be documented in the STS-114 Debris/Ice/TPS assessment and the Integrated Photographic Analysis Report.

EXTRAVEHICULAR ACTIVITY

EXTRAVEHICULAR ACTIVITY EQUIPMENT EVALUATION

The Extravehicular Mobility Unit (EMU) checkout was performed at 208/14:21 GMT (00/23:42 MET).

The higher, set-point, C heaters were used to ensure the cold-flowing liquid cooling garment (LCG) lines were heated following liquid cooling and ventilation garment (LCVG) flow stoppages. The LCG loop signatures were affected during flow by the orbital variation of the Freon loops. This was caused by the FES being disabled during most of the docked phase. The signature is usually not seen except in the event the 6-min water coolant loop (WCL) 1 cycle occurs during LCG flow, since the Flash Evaporator System (FES) controls Freon temperatures well, resulting in steady LCG temperatures. The port loop was in full flow, and Freon temperatures were above 45 °F resulted on the WCL and LCG loops. There was no impact to the EVA crewmembers, except for some cooling level changes determined from the LCG pressure measurement and stimulus identifications.

FIRST EXTRAVEHICULAR ACTIVITY

Space Shuttle Mission Specialists Soichi Noguchi (EV1) and Stephen Robinson (EV2) completed the first of three scheduled EVAs on flight day 5. The activities began with the TPS DTO 848 RCC panel repair demonstration. The crew used a caulk gun to dispense Non-Oxide Adhesive Experimental (NOAX) material onto the pre-damaged RCC panels. Four cracks and two gouges were filled. Next, the crew demonstrated the emittance wash-repair technique on a damaged tile sample using the Emittance Wash Applicator (EWA) to apply a mixture of silicon carbide granules and vulcanizing material to the exposed substrate. All activities were completed nominally. The samples remained stowed in the DTO box in the payload bay and were returned to the ground for further analysis. Following the DTO activities, the crew removed the External Stowage Platform Attachment Device (ESPAD) from the payload bay and installed it onto the ISS airlock trunions. The ESPAD provides a structural connection for ESP-2 that was installed during EVA 3. Upon installation of the ESPAD, crewman EV1 successfully removed and replaced a Global Positioning System (GPS) antenna while EV2 restored power to CMG 2 by completing the Patch Panel Reconfiguration activity. The crew also routed power cables in preparation for ESP-2 installation. As a get-ahead task, the crew retrieved Material International Space Station Experiment (MISSE) 1 and 2 payload samples from the outside of the ISS airlock and took digital images of the Orbiter front port-window blanket. Total EVA time was approximately 6 hr 50 min.

SECOND EXTRAVEHICULAR ACTIVITY

The crewmembers EV1 and EV2 successfully removed and replaced CMG 1 on EVA 2. They began the EVA by exiting the Orbiter airlock and translating to the Z1 truss to remove the failed CMG. The crew peeled back the thermal shroud and released CMG

1 by unfastening six bolts. The Space Station Remote Manipulator System (SSRMS) was used to maneuver EV1, carrying the failed CMG, from Z1 to the payload bay where he temporarily stowed the unit with assistance from EV2. The new CMG was removed from the flight support equipment and temporarily stowed while the crew secured the failed CMG for landing. EV1 used the SSRMS to move the new CMG to the Z1 truss. Installation was performed nominally, all connectors were mated, and the thermal shroud was reattached. The EVA crew completed several get-ahead tasks including the Flex Hose Rotary Cover (FHRC) Multilayer Insulation (MLI) redress, return of the Payload Retention Devices to the Airlock external EVA Tool Stowage Device (ETSD), retrieval of expired ISS tethers, retrieval of the Articulating Portable Foot Restraint (APFR) ingress aid, retrieval of the round scoop from the port ETSD for the Rotary Joint Motor Controller (RJMC) task on EVA 3, and retrieval of the pry-bar/forceps caddy for the gap-filler removal task. Total EVA time was 7 hr and 14 min.

During EVA 2, one of the four port LWTSA latches would not open (IFA STS-114-V-18). The EVA 2 crewmember loosened the EVA manual override bolt using the PGT, which allowed him to rotate the latch cover and gain access to the hardware in the LWTSA. EV2 was able to remove the hardware that was needed from the LWTSA. The EVA 2 crewmember was able to close the door and replace the latch cover, and the EVA bolt was tightened. The anomaly could not be recreated during postflight testing of the LWTSA. Troubleshooting indicated that latch 3 may not have been centered in the latch receiver; the latch was able to rotate to the open position, but with a little more resistance than the remaining latches.

The table showing the tasks completion status for the second EVA is found at the end of this section.

THIRD EXTRAVEHICULAR ACTIVITY

The Shuttle EVA crewmembers completed a successful EVA 3 in just over 6 hr. With robotic assistance, the crew installed the ESP-2 to the ESPAD on the ISS Airlock. Cables were then mated to provide power to the platform. EV2 removed the ESP-2 Flight Releasable Grapple Fixture (FRGF) and stowed it in the starboard Tool Stowage Assembly (TSA) for return. EV1 successfully installed MISSE Payload Experiment Carrier (PEC) 5 on P6. The payload was opened to expose the samples and later powered. EV1 also performed photo documentation get-ahead tasks while at the P6 worksite. Photographs were taken of the Floating Potential Probe (FPP) and the Beta Gimbal Assembly (BGA) 4-bar linkage for ground analysis. As an additional get-ahead for future flights, the crew installed a Worksite Interface Fixture (WIF) extender onto ESP-2. The final EVA task was completed successfully when EV2 removed two pieces of Orbiter gap filler material that was protruding from the Orbiter tiles. After the gap filler task, the crew was directed to defer the RJMC task and come in early to protect for the possibility of an additional EVA to address the window billowing thermal blanket. EVA 4 was later determined not to be required.

The table showing the task completion status for the three EVA's follows.

TASK ACCOMPLISHED DURING THE THREE EXTRAVEHICULAR ACTIVITES

EVA	Hours, Planned/actual, hr:min	Type	Crew Members	Tasks, Preflight Planned	Tasks, As Performed
1	6:30/6:50	Assembly	Shuttle Robinson/Noguchi	TPS DTO Emittance Wash Demonstration NOAX Demonstration ESP2 Primary Power Cable Routing ESP2 Secondary Power Cable Routing ESPAD removal from ESP2 and installation on ISS Airlock GPS Antenna Removal and Replacement CMG Get-Ahead Install GAP Spanner on Node Handrail Patch Panel Reconfiguration Remove Node Light Stanchion and stow	TPS DTO Emittance Wash Demonstration NOAX Demonstration ESP2 Primary Power Cable Routing ESP2 Secondary Power Cable Routing ESPAD removal from ESP2 and Installation on ISS Airlock GPS Antenna Removal and Replacement CMG Get-Ahead Install GAP Spanner on Node Handrail Patch Panel Reconfiguration Remove Node Light Stanchion and stow MISSE PEC no. 1 retrieve – EVA3 Task CMG Removal and Replacement FHRC MLI Re-dress – EVA3 Task Return PRDs to Airlock Tool Box – Get-Ahead Task Retrieve and Return Expired Life Safety Tethers – Get Ahead Task Retrieve and Return APFR Ingress Aid – Get Ahead Task
2	6:30/7:14	Assembly	Shuttle Robinson/Noguchi	CMG Removal and Replacement	CMG Removal and Replacement FHRC MLI Re-dress – EVA3 Task Return PRDs to Airlock Tool Box – Get-Ahead Task Retrieve and Return Expired Life Safety Tethers – Get Ahead Task Retrieve and Return APFR Ingress Aid – Get Ahead Task

TASK ACCOMPLISHED DURING THE THREE EXTRAVEHICULAR ACTIVITES

3	6:00/6:01	Assembly	Shuttle Robinson.	ESP2 Installation Camera installation on Camera Port 9 MISSE PEC no.5 installation MISSE PEC nos. 1 and 2 Retrieve ESP2 FRGF removal FHRC MLI Re-dress Node Light Stanchion Reinstallation	ESP2 Installation Camera installed on Camera Port 9 – Not Accomplished because of addition of Orbiter Gap Filler removal task MISSE PEC no. 5 installation ESP2 FRGF Removal Node Light Stanchion reinstallation S1TRRJ RJMC Removal – Not Performed. – This task was added to EVA3 during the flight. Orbiter Gap Filler Removal –This task was added during the flight. Installation of Worksite Interface Fixture Extender onto ESP2 – Get-Ahead task OBSS Survey of DTO 848 Samples – Get-ahead task Photo Documentation of FPP – get- ahead task Photo Documentation of P6 BGA 4-Bar Get-Ahead task
Total	19:00/20:05				

REMOTE MANIPULATOR SYSTEM AND ORBITER BOOM SENSOR SYSTEM

REMOTE MANIPULATOR SYSTEM

STS-114 was the 70th flight of the Shuttle Remote Manipulator System (SRMS), the 23rd flight of arm 301, and the first flight of Orbiter Boom Sensor System (OBSS) 201. The SRMS operated satisfactorily throughout the mission.

The SRMS was powered up for checkout at 207/17:29 GMT (00/02:50 MET) on FD 1. The End Effector (EE) checkout was postponed until FD 2 because of time constraints. The RMS was then positioned in the OBSS pre-grapple position to record video of the Ku-band/OBSS clearance prior to starboard MPM deployment. The RMS was cradled and powered down at 207/20:13 GMT (00/05:34 MET).

The RMS was powered up for EE checkout at 208/06:19 GMT (00/15:40 MET) on FD 2. Following the successful checkout, the SRMS then grappled the OBSS and unberthed it. During the release of the OBSS from the starboard MPMs, the aft manipulator retention latch system-2 release-indication did not reflect the release until approximately 4 minutes after the latch was released, but this was considered an explained condition due to the nominal opening of the MRL using the system 1 motor only. The SRMS/OBSS then completed the planned surveys of the starboard wing leading edge RCC, nose cap and port wing leading edge RCC. The SRMS berthed the OBSS at 208/15:44 GMT (01/01:05 MET) and performed the EE crew cabin survey. The SRMS was then maneuvered to the pre-cradle position, where it remained during docking with the ISS on FD 3. After docking on FD 3, the Space Station Remote Manipulator System (SSRMS) grappled and unberthed the OBSS and handed it off to the SRMS at 209/15:35 GMT (02/00:56 MET). The SRMS/OBSS was then maneuvered to the CMG remove-and-replace (R&R) viewing position.

On FD 4, the SRMS/OBSS was maneuvered to the MPLM Viewing Position at 210/05:26 GMT (02/14:47 MET) to provide camera views of the SSRMS installing the MPLM. The SRMS/OBSS began focused inspections of six suspected damage sites on the Orbiter at 210/12:43 GMT (02/22:04 MET). Following the inspection, the SRMS/OBSS was returned to the CMG R&R position at 210/15:21 GMT (03/00:52 MET).

On FD 5, the SRMS/OBSS began surveys of six further areas of interest on the port wing leading edge RCC at 211/14:41 GMT (04/00:02 MET) and this was performed in parallel with EVA 1. The SRMS was returned to the CMG R&R position at 211/17:54 GMT (04/03:15 MET). On FD 7, the SRMS/OBSS provided camera views during EVA 2 from the CMG R&R position.

On FD 9, the SRMS/OBSS maneuvered to the first DTO-848 Tile Board Survey position at 215/07:14 GMT (07/16:35 MET). Following the tile board survey, the

SRMS provided camera views of the gap filler removal during EVA 3, and inspected a torn blanket on Discovery's crew cabin.

On FD 11, a PTU test was performed to help understand the source of the pointing errors on FD 2. The test confirmed that the PTU slippage was not caused by SRMS motion. The SRMS provided camera views as the SSRMS unberthed the MPLM and installed it in the payload bay. The SRMS then handed the OBSS off to the SSRMS for berthing and maneuvered to the pre-cradle position.

The SRMS was powered down and stowed on FD 12, as no more SRMS activities were planned for the mission.

ORBITER BOOM SENSOR SYSTEM

The OBSS performed all functions required during the mission; however, two anomalies were noted during flight operations.

The OBSS was installed on the starboard side of the Orbiter payload bay, on top of the sill longeron. It was the first flight of this hardware, which was used to inspect the Orbiter TPS and RCC panels on orbit. The OBSS is intended for use with both the SRMS and the SSRMS. The heaters on several components of the OBSS are powered ON during stowing and deployment and are powered OFF during handoff between the SRMS and the SSRMS. The sensors can be downlinked only when the OBSS is stowed on the MPM on the starboard longeron.

For STS-114, all components were maintained within limits while berthed with the MPM. The data indicated the OBSS was within limits while deployed on the SRMS for flight day 2 and throughout the docked phase.

At 216/17:13 GMT (09/02:34 MET), the MCC noted the loss of video from the OBSS ITVC during a sensor package status check in preparation for overnight survey operations (IFA STS-114-V-20). The MCC commanded a workaround procedure that recovered the use of the camera, and the camera performed satisfactorily for the remainder of the mission.

The starboard MPM mid-system 2 indication was slow in transition from off to on. Approximately 20 min elapsed before the stow indication did occur (IFA STS-114-V-22). No mission operations were affected by this anomaly. Corrective action will be taken prior to the next flight of this vehicle.

GOVERNMENT-FURNISHED EQUIPMENT/FLIGHT CREW EQUIPMENT

During rendezvous operations, the Trajectory Control Sensor exhibited out-of-family performance when compared with other Trajectory Control Sensor units (IFA STS-114-V-23). The out-of-family performance was observed between the ranges of 975 ft to 400 ft. Performance was nominal from 400 to 0 ft. The overall performance was within the Trajectory Control Sensor performance specification. The Trajectory Control Sensor had 31 data losses, each one lasting between 3 and 11 sec. Similar behavior was exhibited by this unit on the previous two missions on which it was flown, but not to the extent observed on this mission. Corrective action is being developed for this unit in preparation for the next mission.

During post-flight inspection, KSC ground operations personnel noticed that a NASA Standard Initiator (NSI) in one of two of the forward ET attachment shear bolt pressure cartridges was no longer in place (IFA STS-114-V-29). Evidence indicated that a missing O-ring in the NSI pressure cartridge interface was the failure root cause. As a result, the on-hand NSIs at KSC were returned to JSC for inspection and a new lot of NSIs will be provided to KSC.

POST-LAUNCH PAD INSPECTION

Postlaunch inspection of Pad B disclosed debris and/or damaged items, most of which are located on the flight service structure (FSS).

No flight hardware was found. Orbiter liftoff lateral acceleration data did not indicate any stud hang-ups. Inspection was performed, and the south holddown studs were visually assessed and verified as having no indication of hangup. Erosion was typical for both the north and south posts. North holddown postlaunch blast covers and T - 0 umbilical covers exhibited nominal exhaust plume damage. Both SRB aft skirt GN₂ purge lines were intact and slightly bent. The protective tape layering was completely eroded, and the two lines exhibited frayed braiding.

The LO₂ and LH₂ tail service masts appeared undamaged, with both bonnets observed to have closed properly. The MLP deck was generally in excellent shape.

The GH₂ vent line latched on the eighth (and last) tooth on the latch mechanism. The vent line was located slightly left of center in the latch mechanism. The ET GUCP 7-in., GH₂, quick-disconnect probe was accessible for inspection and appeared to be undamaged. The probe sealing surface was in good condition. The deceleration cable was in nominal configuration, and the vent-line blanket was partially torn away and had indications of soot.

The Orbiter access arm appeared to be intact, with no evidence of plume impingement. All slide-wire baskets were secured, with no evidence of damage.

The GO₂ vent arm, ducts, and structure appeared to be in nominal condition. The GO₂ vent seals were not inspected because of access limitations.

Although many items of debris were found, the deck of the MLP facility was in excellent condition from a debris/damage standpoint when compared to previous launches.

Visual inspections of the Pad B north flame trench and east infield perimeter areas were performed, and no flight hardware was found. Numerous pieces of concrete were found along the fencing of the north perimeter road. The impact of concrete and rock debris on the upper portion of the fencing was also evident. Several pieces of SRB throat plug material were also found along the north perimeter roadway and fence line. Some pieces were embedded in the fence. These findings were typical when compared with previous launches.

DEVELOPMENT TEST OBJECTIVES

DTO 848, TILE BOARD SURVEY (ORBITER TPS TILE AND RCC PANEL REPAIR TECHNIQUES)

One of the primary purposes of the STS-114 mission was to perform DTO 848, Orbiter Tile Board Survey and TPS and RCC Panel Repair Techniques. This included inspection of all of the Orbiter RCC panels and the TPS tiles and testing new repair methods. This activity was scheduled for EVA 1 on flight day 5.

Activities began with the RCC panel repair demonstration. The crew used a caulk gun to dispense Non-Oxide Adhesive Experiment (NOAX) material onto the pre-damaged RCC panels. Four cracks and two gouges were filled. Next, the crew demonstrated the emittance wash-repair (EWA) technique on a damaged tile sample using the EWA to apply a mixture of silicon carbide granules and vulcanizing material to the exposed substrate. All activities were completed nominally. The samples were stowed in the DTO box in the payload bay for the return to Earth and further analysis.

The Tile Board Survey portion of DTO 848 was removed from EVA 1 because of concern about the out-gassing of repair material on the OBSS sensor lenses. On flight day 9, the Tile Board Survey was completed using the OBSS, LCS, and LDRI sensors.

DTO 850, WATER SPRAY BOILER HOT RESTART

DTO 850 successfully demonstrated the capability to perform a WSB hot restart with PGME/water and the capability to provide APU lubrication oil cooling as soon as 3.5 hr MET. This demonstrates the capability to perform an early return from orbit in the event of a mission contingency.

The WSB-3 GN₂ isolation valve was opened at 207/18:03:19 GMT (00/03:24:19 MET) to get a WSB READY indication on WSB 3. APU-3 was started at approximately 207/18:05:07 (00/03:26:07 MET) with APU-3 injector temperature at 396 °F (below the 401 °F required to perform APU restart). APU-3 ran for 6 min 1 sec. WSB spray cooling with PGME/water was successfully initiated at an APU lubrication oil return temperature of 264 °F. Steady-state cooling of the lubrication oil was maintained at 256 °F. Spray cooling was maintained for 3 min, 5 sec, until WSB-3 power off, approximately 8 sec prior to APU-3 shutdown. During spray cooling, the WSB-3 core temperature increased from approximately 58 to 74 °F. The telemetry measurements associated with WSB boiler tank quantities were not downlisted during the DTO, so no quantity is indicated for PGME/water usage.

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-114 vehicle. In general, less than typical facility debris entered the field of view of the MLP and Flight Service Structure cameras. Numerous normal as well as other observations were made, and these are presented in the following list.

1. One camera showed an orange shim stock that appeared during the SSME start sequence (IFA STS-114K-109). The origin of the shim stock is now known; however, it appeared to be from the upper side of the body flap.
2. Two cameras showed vapors emanating from the +Y ET/SRB cable tray vent hole.
3. One camera showed free-burning GH_2 that was visible below the LH_2 T-minus-0 interconnect.
4. One camera showed several small tile-coating losses emanating from stinger.
5. The camera showed numerous debris particles, most likely facility rust and/or scale, were observed falling from the LH_2 tail service mast (TSM) during the SSME start sequence. None of these particles made contact with the vehicle. All particles appeared to be less than the maximum allowable debris mass.
6. No stud hang-ups were noted on the launch platform.
7. The launch platform North hold-down, postlaunch blast shields closed nominally.
8. Five cameras showed the SRB throat plugs ejected from the SRB exhaust hole after T-minus-0. No material contacted the vehicle.
9. Two cameras showed the LO_2 and LH_2 T-minus-0 umbilicals retracted properly.
10. Two cameras showed the TSM bonnets (doors) rebounded slightly, and the body flap movement was typical during SSME ignition.
11. Three cameras showed an aft-skirt foam particle that was ejected from the right SRB exhaust hole at T-minus-0. The trajectory was toward the LO_2 TSM. No contact with the vehicle was observed.
12. Ice/frost was observed falling from the mid/aft LO_2 feedline bellows.
13. One camera showed the GH_2 retracted nominally.
14. Ice particles were noted falling from the LH_2/LO_2 TSM T-minus-0 disconnects.
15. Residual vapors were present from the LH_2 and LO_2 T-minus-0 disconnects at T-minus-0.
16. Mach diamond formations occurred simultaneously on SSME 1 and 2.
17. One camera showed a thin wire/cord vibrated out from the gap between the MLP deck and the raised deck near the SSME exhaust hole.

APPENDIX A
STS-114 MISSION EVENTS

Event	Description	Actual, GMT
ASCENT		
APU activation	APU-1 GG chamber pressure APU-2 GG chamber pressure APU-3 GG chamber pressure	207:14:34:10.152 207:14:34:11.519 207:14:34:13.090
*SRB HPU activation	Left HPU System A start command Left HPU System B start command Right HPU System A start command Right HPU System B start command	207:14:38:31.983 207:14:38:32.143 207:14:38:32.303 207:14:38:32.463
*MPS Main Engine (ME) start	ME-3 Start command accepted ME-2 Start command accepted ME-1 Start command accepted	207:14:38:53.469 207:14:38:53.580 207:14:38:53.709
*SRB ignition command (liftoff)	SRB Ignition command	207:14:39:00.013
Throttle to 72%	Command throttle	207:14:39:33
Max Q	Derived ascent dynamic pressure	207:14:39:50
*Throttle to 104.5%	ME-1 command accepted ME-2 command accepted ME-3 command accepted	207:14:39:03.826 207:14:39:03.836 207:24:39:03.845
*Throttle to 72%	ME-1 command accepted ME-2 command accepted ME-3 command accepted	207:14:39:32.466 207:14:39:32.477 207:14:39:32.485
*Throttle to 104.5%	ME-1 command accepted ME-2 command accepted ME-3 command accepted	207:14:39:53.267 207:14:39:53.277 207:14:39:53.285
RCS window protect	Ignition command	207/14:41:00
*Both RSRMs chamber pressure < 50 psi	Left RSRM chamber pressure Right RSRM chamber pressure	207:14:40:57.213 207:14:41:01.453
*End RSRM action time	Left RSRM chamber pressure Right RSRM chamber pressure	207:14:40:59.113 207:14:40:59.713
*SRB physical separation	Left APU B turbine speed – LOS	207:14:41:01.813
OMS assist ignition	Left engine bi-prop valve position Right engine bi-prop valve position	207:14:41:12.1 207/14:41:12.2
OMS assist cutoff	Left engine bi-prop valve position Right engine bi-prop valve position	207/14:43:29.4 207/14:43:29.6
Throttle down for 3G	ME-1 command accepted ME-2 command accepted ME-3 command accepted	207:14:46:24.638 207:14:46:24.646 207:14:46:24.650
3g acceleration	Total load factor (g)	207:14:46:55.3
Throttle down to 67% for cutoff	ME-1 command accepted ME-2 command accepted ME-3 command accepted	207:14:47:18.399 207:14:47:18.407 207:14:47:18.411
SSME shutdown	ME-1 command accepted ME-2 command accepted ME-3 command accepted	207:14:47:24.559 207:14:47:24.567 207:14:47:24.571

APPENDIX A (Continued)

Event	Description	Actual, GMT
ASCENT (Concluded)		
MECO	MECO command flag MECO confirmed flag	207:14:47:25 207:14:47:26
ET separation	ET separation command flag	207:14:47:47
APU deactivation	APU-1 GG chamber pressure APU-2 GG chamber pressure APU-3 GG chamber pressure	207:14:54:49.692 207:14:55:02.927 207:14:55:13.460
OMS-1 ignition	Left engine bi-prop valve position Right engine bi-prop valve position	Not required
OMS-1 cutoff	Left engine bi-prop valve position Right engine bi-prop valve position	Not required
OMS-2 ignition	Right engine bi-prop valve position Left engine bi-prop valve position	207:15:17:00.1 207:15:17:00.2
OMS-2 cutoff	Left engine bi-prop valve position Right engine bi-prop valve position	207:15:18:05.4 207:15:18:05.5
PLBD open	Right PLBD open 1 Left PLBD open 1	207:16:14:45 207:16:16:05
ON ORBIT		
OMS-3 ignition	Left engine bi-prop valve position Right engine bi-prop valve position	207:19:42:24.2 207:19:42:24.3
OMS-3 cutoff	Left engine bi-prop valve position Right engine bi-prop valve position	207:19:43:44.8 207:19:43:44.9
OMS-4 ignition	Left engine bi-prop valve position Right engine bi-prop valve position	208:06:55:31.0 208:06:55:31.1
OMS-4 cutoff	Right engine bi-prop valve position Left engine bi-prop valve position	208:06:56:01.3 208:06:56:01.4
OMS-5 ignition	Left engine bi-prop valve position Right engine bi-prop valve position	209:06:28:34.2 209:06:28:34.2
OMS-5 cutoff	Right engine bi-prop valve position Left engine bi-prop valve position	209:06:29:14.1 209:06:29:14.2
OMS-6 ignition	Left engine bi-prop valve position Right engine bi-prop valve position	209:07:15:35.6 209:07:15:35.6
OMS-6 cutoff	Left engine bi-prop valve position Right engine bi-prop valve position	209:07:16:16.6 209:07:16:16.7
OMS-7 ignition	Left engine bi-prop valve position Right engine bi-prop valve position	209:08:40:04.2 N/A
OMS-7 cutoff	Left engine bi-prop valve position Right engine bi-prop valve position	209:08:40:15.6 N/A
Docking	Capture	209:11:34:13
Undocking	Undocking complete	218:07:45:13
FCS cutoff, APU start	APU-3 GG chamber pressure	219:03:49:04.241
APU stop	APU-3 GG chamber pressure	219:03:53:20.680

APPENDIX A (Concluded)

Event	Description	Actual, GMT
ON ORBIT (Concluded)		
PLBD close	Left PLBD close 1 Right PLBD close 1	220:05:07:37 220:05:04:22
PLBD reopen	Right PLBD open 1 Left PLBD open 1	220:09:19:53 220:09:21:15
OMS-8 ignition	Left engine bi-prop valve position Right engine bi-prop valve position	220:12:19:00.2 220:12:19:00.2
OMS-8 cutoff	Left engine bi-prop valve position Right engine bi-prop valve position	220:12:19:25.2 220:12:19:25.2
ENTRY		
PLBD close 2	Left PLBD close Right PLBD close	221:05:20:41 221:05:22:33
APU activation	APU-2 GG chamber pressure APU-1 GG chamber pressure APU-3 GG chamber pressure	221:11:01:18.367 221:11:27:01.144 221:11:27:03.211
Deorbit burn	Left engine bi-prop valve position Right engine bi-prop valve position	221:11:06:18.3 221:11:06:18.3
Deorbit burn cutoff	Left engine bi-prop valve position Right engine bi-prop valve position	221:11:09:01.9 221:11:09:01.9
Entry interface	Orbiter alternate/reference ellipsoid	221:11:40:02
Blackout end	Data locked (high signal rate)	No blackout
TAEM	Major mode code (305)	221:12:05:23
Main landing gear (MLG) contact	MLG left tire press 2 MLG right tire press 1	221:12:11:23 221:12:11:23
MLG weight on wheels	MLG left weight on wheels MLG right weight on wheels	221:12:11:23 221:12:11:23
Drag chute deploy	Drag chute deploy No. 1 CP Volts	221:12:11:31.9
Nose landing gear (NLG) contact	NLG left tire press 2	221:12:11:38
NLG weight on wheels	NLG weight on wheels	221:12:11:39
Drag chute jettison	Drag chute jettison No. 2 CP Volts	221:12:12:08.7
Wheels stop	Velocity WRT runway (F/S)	221:12:12:31
APU deactivation	APU-1 GG chamber pressure APU-2 GG chamber pressure APU-3 GG chamber pressure	221:12:29:16.183 221:12:29:25.868 221:12:29:33.721

APPENDIX B

STS-114 FLIGHT ANOMALIES

Introduction

This appendix contains listings and discussions of each of the flight anomalies that were recorded during the STS-114 mission.

1. Orbiter In-Flight Anomalies
2. Solid Rocket Booster In-Flight Anomalies
3. Reusable Solid Rocket Motor In-Flight Anomalies
4. External Tank In-Flight Anomalies
5. Systems Engineering and Integration In-Flight Anomalies
6. Flight Operations and Integration (Payload) In-Flight Anomalies

STS-114 was the first flight for the Systems Engineering and Integration In-Flight Anomalies to be in the Mission Report, as this area was not in existence as a separate office. Likewise, the Payload In-Flight Anomalies are appearing in the Mission Report for the first time.

No Main Engine In-flight Anomalies occurred during the STS-114 Mission.

APPENDIX B
ORBITER IN-FLIGHT ANOMALIES

IFA Number	Title	Comments
STS-114-V-01	LH ₂ ECO Sensor 2 Stayed Wet When Commanded Dry	<p>During the prelaunch countdown for the first launch attempt, LH₂ ECO sensor 2 continued to indicate WET when it was commanded DRY during the checkout of the point sensor system. This condition violated the LCC and OMRS requirements, thus resulting in a launch scrub. Additional system testing was conducted after the launch scrub but prior to draining the ET, in an effort to better characterize the problem. This troubleshooting included a power cycle of the point sensor system and various combinations of commands. After the external tank was drained and all commands had been removed (normal point sensor operational configuration), the sensor continued to indicate wet while all other ECO sensors appropriately indicated dry. Approximately 5 hr after the ET was drained, the sensor transitioned to DRY without a command or other immediate cause. Troubleshooting was unable to repeat the anomaly during the ambient checkout of the system and vehicle wiring. An LH₂ ECO 2 and 4-pin swap was implemented to help isolate the source of the indication if it happened again. During cryogenic loading for the 2nd STS-114 launch attempt, the failure signature did not repeat in response to continuous commands. No anomalies were seen during the STS-114 launch and ascent. For STS-121, the PSB and pin swap will be kept in the current configuration.</p>
STS-114-V-02	Tyvek Cover Late Release (Thrusters F3D, F4D)	<p>Ground camera imagery showed that two FRCS Tyvek launch covers (on thrusters F3D and F4D) released at above the certified vehicle speed (150 mph). Based on times of the photographs, the F4D cover released 12.987 sec and the F3D cover released 21.548 sec after launch. These times correspond to estimated airspeeds of approximately 185 and 345 mph, respectively. Tyvek covers as a debris source could cause window, LESS, or TPS damage. Review of launch video data showed neither thruster cover impacted the Orbiter. No TPS damage has been attributed to Tyvek cover releases in previous missions. A preliminary review of the ground-based launch videos showed that the pockets on both F4D and F3D did not open until covers on thrusters F2D and F1D, respectively, had been shed approximately 7 sec after liftoff. At that point, the F4D/F3D pockets immediately inflated and burst. For F4D, the remaining streamer of pocket material did pull off the cover at 13 sec (approximately 185 mph). This was consistent with Tyvek cover developmental testing with covers that failed in this manner. During development, these failures were attributed to rough edges made by hand cutting the covers from the Tyvek sheet; production covers are laser cut. This failure mode did not repeat during qualification/certification wind tunnel testing. In the case of F3D, at ~14 sec postlaunch, the streamer remains of the burst pocket tore off completely. Without a pocket to pull the cover off, the remaining (flat) cover was retained until 21.5 sec after liftoff.</p>

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IFA Number	Title	Comments
STS-114-V-02 (Continued)	Tyvek Cover Late Release (Thrusters F3D, F4D)	This failure did not affect FRCS thruster performance. Both thrusters fired nominally at ET separation. FRCS thruster performance was nominal during the mission. No immediate postflight testing is required by KSC.
STS-114-V-03	Left OMS Upper Y-Web Inboard Temperature Erratic	The Left OMS upper Y-Web temperature sensor began reading erratically at 207/14:38:57 GMT (3 sec prior to liftoff). After approximately 2 min of erratic behavior, the transducer recovered for approximately 8 min before resuming erratic behavior 1 min after MECO. The sensor had its first extended period of off-scale-high (OSH) at 207/15:03:10 GMT. The impact of this failure was loss of direct insight into left OMS Y-web upper inboard heater operation. Indirect insight was still available. No vehicle, mission, or crew responses occurred. Two heater cycles were observed. The signature was seen as crosstalk on the redundant measurement. Postflight trouble shooting confirmed DSC nominal operation. Sensor wire was found pulled loose from the sensor. New sensor and wire were installed and tested.
STS-114-V-04	STBD PLBD Close Indication Stayed On 21 Sec After Door Motion	During PLBD opening, the PLBD right Close 2 indication stayed ON for approximately 21 sec before the indication transferred to the OFF position. Both starboard doors were fully open and the indications occurred within maximum dual motor run time. No on-orbit operations are affected by this anomaly. Both doors opened fully, and the open indications occurred within the maximum dual motor run time. The switch assembly was removed and repaired NSLD. The assembly was reinstalled on the vehicle and rigging was completed satisfactorily.
STS-114-V-05	RMS Sideview Camera (RSC) Lens Smudge	During the OBSS operations, the crew reported that the RMS Sideview Camera (RSC) image appeared to have a smudge on lens. The center of the image from the RSC was out of focus. The edges of the image were clear. The crew power-cycled the camera with no effect. The pre-mission closeout photographs do not show any evidence of contamination on the lens. The camera was still partially usable for OBSS situational awareness. The camera was removed prior to payload removal. Tests were conducted on this and several other video inspection cameras used or slated to be used for the RSC and Keel cameras for STS-114 and STS-121. All four had condensation inside the sealed housing. The investigation is continuing to develop better controls to ensure that the dry nitrogen with which the cameras are purged is indeed dry.

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IFA Number	Title	Comments
STS-114-V-06	APU 1 Drain System Pressure Decay	APU 1 drain system pressure began to decay from approximately 15.2 psi down to 6.8-7.4 psia in 20 hr and continued to decay. The decay began approximately 1 hr after APU post-ascent shutdown. No fuel leakage into the drain system was seen during APU operation or after shutdown, so the drain system decay is believed to an external leak of GN ₂ into the aft fuselage. Subsequent fuel leakage into the drain system would not be expected to leak externally due to the low pressure (lack of driving force) in the system and the small leak path. There were no immediate impacts to the vehicle/mission due to this problem. Postflight, APU 1 was found to be leaking internally, and the vendor replaced an elbow on the reference line. Helium decay checks were successfully completed with no leakage identified.
STS-114-V-07	DTV DSR-20 Tape Loading Failure	The crew reported that a tape was stuck in the DSR-20 Video Tape Recorder (VTR) and an error code was observed on the unit. Power cycling the unit caused the tape to eject and the error code to clear, but the tape was ejected at an angle. Subsequently, several unsuccessful attempts were made to load another tape into the recorder before a tape was loaded successfully. That tape also became stuck. The tape loading mechanism of the recorder was declared failed, and the crew replaced the failed unit with the spare unit. Postflight testing is in progress.
STS-114-V-08	TPS Blanket Damage Near Window 1	The digital still pictures from the ISS show a damaged blanket just beneath window 1 at the line where the TPS transitions from blanket to tile. The damage appeared to consist of a missing fabric cover with most of the batting still in place. An assessment was performed on the windows and the Window Problem Resolution Team (PRT) concluded that any threat to the windows would be at low Mach numbers when the TPS function was complete. The thermal assessment shows that there is no thermal impact, even with damage. Wind tunnel testing at Ames Research Center with test articles indicated that the blanket would not degrade nor dislodge as a total structure during entry. The Mission Management Team (MMT) members approved the OPO recommendation to not perform an additional EVA and return with the blanket in the as-is condition. The blanket was replaced during the postflight operations.

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IFA Number	Title	Comments
STS-114-V-09	APU 2 Momentary Loss of Pressure and Temperature Indication	APU 2 gearbox nitrogen pressure and gas generator bed temperature data took a step function of approximately 20 psi and 365-415° F, respectively, to 0 (off-scale low) for approximately 2 sec. The current data from main bus B aft power controller 5 indicated a drop in the current level at the same time the data were lost. There were no impacts to the vehicle or mission, and no immediate crew response or procedural changes due to this problem. The problem did not recur. If the problem had recurred and remained, heater operation could have been regained by switching to system B. This condition is a constraint to STS-114. A check of load control assembly (LCA) 2, connectors, wiring, and switch is in progress. The APU controller replacement is complete. The vendor found no anomalies in the APU. The connectors and wiring were inspected and tested with no anomalies found. LCA 2 has been replaced.
STS-114-V-10	MEDS MDU CDR2 1553B Error	At MDU CDR2 power-up, commanding IDP (IDP1) reported a CDR2 built-in test equipment (BITE) failure. The crew powered off IDP2 and subsequently powered up per normal planned procedures, with IDP2 reporting normal communications with CDR2 at all times. The crew performed MDU CST, and the failure was reported again. The MDU was power cycled; and nominal MDU performance was reported (transient BITE error indication cleared with MDU power cycle. Trouble shooting has recreated the anomaly 5 times in 127 tries. MDU CDR2 was removed and installed in a laboratory where it has not failed. A new unit will be installed in OV-103 and tested.
STS-114-V-11	TPS Tile Damage (Debris Induced)	<p>The TPS Damage Assessment was summarized at the MMT with photographs and diagrams of the following identified areas:</p> <ol style="list-style-type: none"> 1. Right-hand NLGD tile damage – primary thermal barrier is still intact; 2. Left wing tile damage – data show 1.7-in. depth, flagged for inspection, right wing chine tile damage – preliminary data shows depth at 0.27in.; 3. Left hand inboard elevon tile damage – imagery indicates damage is very shallow; 4. A protruding blanket on vertical tail.
STS-114-V-12	TPS Gap Filler Protuberances	<p>Based on focused inspection, all sites were cleared for entry.</p> <p>Two protruding gap fillers were discovered on the lower forward fuselage during the RPM with the photography of the bottom of the vehicle. Review of paper associated with the location indicate the protruding part was a gap filler. The gap filler interfaces with tiles V070-391061-081, 088, and -082. The V070-391061-088 tile was removed and replaced prior to flight 31 (STS-114). The final step and gap measurements were found to be out of tolerance. Both out-of-tolerance gap conditions were filled with single installation of ceramic AMES gap fillers per the standard process. The gaps were filled to nominal (2 to 3 layers).</p>

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IFA Number	Title	Comments
STS-114-V-12 (Continued)	TPS Gap Filler Protuberances	Protruding material was also discovered on the side forward fuselage during the RPM with the photography of the bottom of the vehicle. The material interfaces with tiles V070-391015-184/-183. The material possibly could be filler bar. The TPS damage assessment of the effects of leaving the gap fillers protruding, however, the potential aerothermal risks associated with the tripping of the boundary layer prior to Mach 19 prompted the decision to remove both gap fillers during EVA 3, and both gap fillers were successfully removed.
STS-114-V-13	AVIU Failed to Function	The crew described the video through the AVIU as bad. Due to crew time constraints, the unit was swapped out with no troubleshooting. The AVIU has three prime functions: 1. Unbalanced to balanced video conversion, which failed in this use; 2. Balanced to unbalanced video conversion; and 3. Power video equipment. Loss of any of those capabilities may allow the unit to be moved to another location and continue to be used for the flight in another configuration. A good possibility is that the Hi-Z switch was set to the Hi-Z position instead of the nominal 75-ohm setting. That would create high-amplitude video and would be bad. Another possible cause is the video/power cable, which was also swapped out. During postflight operations, no failures were found in the AVIU, cable, or cameras. Potential causes could have been a switch in the wrong position or an interface connection not properly mated.
STS-114-V-14	Lockup of STS3 PGSC when Viper PCMCIA Card Inserted	The crew reported that on the STS3 PGSC whenever a Viper hard disk drive card was inserted, the PGSC would lock up within 10 min. The crew tried three Viper cards with the same result. The crew did not report this same issue with any other PGSC. The PCMCIA network card worked properly with the PGSC. The Viper PCMCIA card is used to update the PGSC internal hard disk drives with late information available just prior to launch. There were no potential mission impacts since there were no plans to use the Viper cards for the rest of STS-114. The anomaly could not be reproduced during postflight testing. The team suspects a Windows 98 software issue. No further testing is currently planned, and the anomaly is planned to be closed as a unexplained anomaly.

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IFA Number	Title	Comments
STS-114-V-15	Airlock Depressurization was Off-Nominal	<p>At the end of EVA2, the crew had to depressurize the external airlock using the equalization valve to ingress the airlock. The procedure calls out to put one of the two equalization valves in the NORM position until the airlock is depressurized to 10 psid and then to emergency position to complete airlock depressurization. After the airlock reached 10 psid in the normal position, the equalization valve was taken to the emergency position and there was no flow indication for about a minute. The EVA crew member cycled the valve between emergency and normal with no depressurization observed. The crew switched to the port-side equalization valve and completed the airlock depressurization. The crew was requested to inspect the valves from the airlock side and reported that there was some debris on the port-side valve screen, but nothing on the starboard valve. The post-EVA repressurizations and leak checks were nominal. There was no impact to the mission. The crew switched to the redundant equalization valve on the port side and a nominal flow rate was observed. Review of the EVA video downlink showed the crewmember properly dialing the valve position. The crew inspected both valves on FD8 by removing caps and reported that they appeared normal. For EVA 3, the starboard equalization valve remained closed and capped. The port valve was used successfully to vent the airlock. The anomaly was not recreated on the ground. The starboard valve was replaced because of another anomaly related to torque.</p>
STS-114-V-16	ODS Capture Latch Manual Release Talkback Showed "Open"	<p>The Capture Latch Manual Release indicated ON prior to hooks drive, it should be OFF. There was no constraint to operations. Docking operations were complete, and there were no impacts to mated operations or undocking. The manual release is a backup to opening the capture latches electrically. There is one manual release lever per latch; one of three will give the sensor indication. The manual release lever on petal 1 was verified partially open (1/8 in.) by the crew. The manual release handle was re-engaged and placed back into flight configuration. There have been no previous occurrences of this problem. The OMRSD was modified pre-STS-114 to verify proper manual release configuration prior to closeout. The crew inspected the latch for undocking and redocking contingencies. The inspection showed the latch configuration to be nominal.</p>

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IFA Number	Title	Comments
STS-114-V-17	Four of the WLE IDS: Sensor Units Did Not Generate Process Data	<p>After WLES activation, the data from the launch event were expected to be downloaded. Four sensor units 1009, 1019, 1046 and 1051 did not download their GRMS summary data files. The same four units had only 4 out of 8 expected network card files available. Data from sensor units 1049 and 1043 also appeared not to be available initially, but this was later found to be due to difficulty in communication with the units. Data were obtained from sensor unit 1049 after a repeat request was initiated (same relay path). For sensor unit 1043, data were obtained after switching from one sensor unit side relay unit to another. According to the vendor, this is a known issue with firmware version 1.1 (OV-103 specific). An error can occur within a pre-programmed sequence of events in which one event fails to transition to the next. The launch is a pre-programmed sequence of events, and the sequence stopped after collecting ascent data, but before the peak summary file processing event. The summary file processing is followed by the stop network card event (which creates a network card file). The next event in the nominal sequence restarts the network card at a lower data rate and creates another network card file, and this was the file missing for units 1009, 1019, 1046 and 1051. No postflight trouble shooting on the vehicle is planned, as this problem was identified and planned to be corrected by the vendor in the next version of the firmware. This updated version is installed on the OV-104 sensors and is part of a planned postflight upgrade for OV-103. Further evaluation of the new firmware will be performed by the vendor to verify that the problem is fixed.</p>
STS-114-V-18	Port Lightweight Tool Stowage Assembly Latch Would Not Open	<p>During the FD 7 EVA 2, one of the four port Lightweight Tool Stowage Assembly (LWTSA) latches would not turn. EV2 loosened the manual override EVA bolt on the latch assembly with the Pistol Grip Tool (PGT), and this allowed the latch to be rotated and the LWTSA cover opened. The LWTSA door was closed, the latch cover was replaced, and the EVA bolt was tightened with the PGT. There were no further planned mission usage (contingency only) and no significant impacts to the vehicle or the mission. The vehicle was safe to return with a minimum of 3 of the 4 latches secured. The only concern was that the EVA bolt was over-torqued (potential bolt foreign object damage). The EVA bolt was torqued to 16 ft-lb; the torque should be 4 ft-lb. No further actions or trouble shooting are required. The anomaly was not recreated during postflight testing. Trouble shooting indicated that latch 3 may not have been centered in the latch receiver. Postflight, latch 3 was rotated to the open position, but with a little more resistance than the remaining latches. Tolerance buildup between the latch and receiver along with deflection caused during flight could be a factor. Recommended action to MOD and the EVA Project Office is to review torque settings and crew training procedures.</p>

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IFA Number	Title	Comments
STS-114-V-19	Leaking Contingency Water Container (CWC)	<p>The crew reported that CWC SN 1012 (filled 16 times) was leaking so badly that it could not be transported to ISS for stowage and repair. The crew reported that one of the fittings on the CWC was disconnecting from the bag. The CWC was temporarily enclosed in a Russian water bag (waterproof trash bag), and later vented (post undocking) to empty. The CWC redesign is progressing well. Hardware delivery to KSC is targeted for January.</p>
STS-114-V-20	OBSS ITVC Video Loss	<p>Approximately 1 hr prior to crew sleep, the loss of video from the OBSS ITVC was noted in the MCC during the OBSS Sensor Package 1 (SP1) status check in preparation for the overnight ISS Survey Operations. The following trouble shooting steps were performed;</p> <ol style="list-style-type: none"> 1. MCC commanded the camera to LDRI mode 2 (ITVC w/illuminators) to confirm mode and no video was present. 2. MCC commanded the SP1 pan-and-tilt unit (PTU) and confirmed commands were reaching the assembly. 3. MCC then commanded the camera to LDRI mode 3 (LDRI) and video was seen on the ground. <p>The crew cycled the ITVC ENABLE switch on R12. Video from the OBSS ITVC was recovered.</p> <p>The OBSS ITVC has since been used during PTU testing and performed nominally. Exhaustive testing has been performed on the STS-114 ITVC/LDRI in an attempt to recreate the reported problem, with no success. It has been concluded that this was a one-time logic hang up that was reset when the crew cycled the camera power. There have been no further occurrences either during the rest of the mission or during postflight testing.</p>
STS-114-V-21	OBSS Pointing Inaccuracies	<p>During the SP1 checkout, the view was not as expected based on the preflight simulations. At pause points during the scan, the same problem was observed. The image at the end of the scan was not as expected. The PTU angles appeared to move during the scan. Resetting the PTU angles appeared to produce the correct image. The PTU measurement test was successfully initiated and was completed early on FD 10. Preliminary results indicated repeatable pan accuracies at lower slew rates and repeatable tilt accuracies at both slow and fast slew rates. The PTUs on STS-114 are first-flight units. Additional tests to characterize PTU performance using single-joint RMS operations were conducted. The pointing inaccuracies resulted in additional time and effort during the scans. There was a potential for missing RCC locations, but this was cleared by ground analysis. Because the most probable cause cannot be identified, however, the leading candidates are a better</p>

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IFA Number	Title	Comments
STS-114-V-21 (Continued)	OBSS Pointing Inaccuracies	understanding of PTU hard-stop location and the accuracy of the models used to define the scans and crew procedures. Work continues to correlate the planning model to flight performance.
STS-114-V-22	STBD MPM Mid System 2 Stow Indication Slow	During OBSS manipulator positioning mechanism (MPM) stow operations, the stow position indication for the mid-MPM was slow to transition from off to on. Approximately 20 min after the first indication, the stow indication for the mid-MPM did occur. No mission operations or objectives were affected by this anomaly. The OBSS was stowed and not deployed again on STS-114. This limit switch is an indication for only the mid-pedestal. The OBSS deploy/stow limit switches are located on the shoulder. A stowed indication is displayed to the crew as long as one of two stow limit switches indicate stowed position. Switch rerigging has been completed.
STS-114-V-23	Trajectory Control Sensor (TCS) Repeated Loss Of Track	During rendezvous, the TCS (S/N 1010) exhibited out-of-family performance as compared to other TCS units. This anomalous performance was observed between the range from 975 to 400 ft. Performance was nominal for 400 to 0 ft. The entire performance was within the TCS performance specification. The TCS had a total of 31 data-loss occurrences, each one lasting between 3 and 11 sec. Similar behavior was exhibited by this unit on STS-111 and 113, but not to the extent of this mission. Some of the losses were attributed to the normal transition from the long-range to short-range laser. Some of the losses occurred during the performance of internal calibrations. Other losses occurred during adjustments of signal strength to maintain reflective signal strength within acceptable limits. All three types of losses contributed to the anomalous performance. The most probable causes are pulse/CW coalignment, galvanometer response, beam size settings, and Orbiter correction firings. The flight data from STS-114 and STS-113 will be reviewed; for TCS S/N 1010 and for TCS S/N 1004, which is supporting STS-121 potential STS-121 impact. Two TCS units (S/N 1008 and S/N 1009) are available as replacement units, if required. The TCS unit S/N 1010 was removed from OV-103, and TCS unit S/N 1008 was installed. The removed unit will be shipped to JSC for testing.
STS-114-V-24	VRCS Thruster R5R had Low Chamber Pressure (Pc)	The chamber pressure of VRCS thruster R5R was lower than expected, reaching only 63 psia. Prior to this time, the Pc of the thruster was mainly normal. Similar signatures have been noted on previous flights. There are three possible causes of this type of Pc signature: <ol style="list-style-type: none"> 1. Hot propellant causing a temporary mixture ratio shift, 2. A partially blocked Pc tube, or 3. Trim orifice contamination.

APPENDIX B
ORBITER IN-FLIGHT ANOMALIES

IFA Number	Title	Comments
STS-114-V-24 (Continued)	VRCS Thruster R5R Had Low Chamber Pressure (Pc)	The thruster will continue to be used until the RCS hot fire to gain additional data. During the preparations for entry, a longer firing of thruster R5R Pc occurred, and the Pc came back to normal and stayed normal during subsequent firings. It was noted that R5R heater had not been off for a significant period and it was suspected to be failed-on, which could be the cause of the low Pc. Thruster replacement will be performed on the vehicle prior to right-hand pod removal for attach-point inspection.
STS-114-V-25	APU-3 Exhaust Gas Temperature (EGT) Erratic During Entry	APU 3 System 1 EGT sensor failed during entry with an erratic output signature. After landing, the APU 3 System 2 EGT sensor output signal was reading low and was determined to be failed. The EGT sensor was replaced, and the retest showed satisfactory performance.
STS-114-V-26	TPS Tile Damage (Nose Landing Gear Door)	During the postflight activities, a repair of tile around the landing gear door was made using standard procedures. In addition, the design requirements/historical gap were evaluated; modification of gap requirements is under review.
STS-114-V-27	Upper and Lower Nose Cap Expansion Seal Port-Side Damage	Installation documentation and repair history are being evaluated.
STS-114-V-28	Partially Debonded LRSI Tile Near Windows 5, 6	Installation documentation and design load data were evaluated. Repairs are in work.
STS-114-V-29	Forward ET Attach Shear Bolt NSI Release	Inspection of NSI found O-ring missing. JSC inspection of fired NSIs found some missing O-rings. The current stock at KSC was returned to JSC for inspection. KSC will receive a new lot of NSIs. Structure damage repair is in work. A fault-tree as well as an evaluation of the structures as well as an evaluation of the structures were completed. A test program may be necessary to determine the cause.
STS-114-V-30	Late Loss of ODS Ring Alignment Indication	During docking, the Ring Align light went off, as structural hooks were driving closed. This condition previously occurred on OV-103 during the STS-105 mission. The Ring Align light was lost just prior to hook drive. In both cases, the Androgynous Peripheral Assembly System (APAS) alignment pins were engaging, the structural hooks were beginning to drive closed, and no loss of function occurred. No impact to remaining capture ring functions occurred on either mission. No occurrences were noted on the other two vehicles. Potential cause is rubbing between capture ring and body latch during retraction. Inspections were made to note any wear marks. The APAS operated properly during a passive docking test and a functional test. Telemetry data from the test are under review.

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IFA Number	Title	Comments
STS-114-V-31	Missing TPS Putty Repairs	Approximately five tiles that had missing putty repairs were noted on the runway. Final assessment and evaluation of the installation documentation were made upon return to KSC. Repairs are in work.
STS-114-V-32	GH ₂ Pressure System Leakage	An evaluation of the STS-114 data determined that the 15 scim (plus known leakages) requirement for the GH ₂ pressure system decay was violated. Based on known leakage values, the allowable leakage for OV-103 is 15.75 scim. The actual calculated value for STS-114 was 22.4 scim, which is in violation of a File IX requirement. The GH ₂ pressure system decay check will be performed on the ground. If the decay check fails on the ground, then further checkouts will be performed to determine the source of additional leakage.
STS-114-V-33	MPS/SSME Low Pressure Helium Decay Rate Exceeded	After review of the STS-114 data, it was determined that the 3.88-psi/min. decay (includes known solenoid valve leakages) requirement for the MPS/SSME low-pressure Helium decay check was violated. The actual calculated value for STS-114 was 4.42 psi/min, which is in violation of the File IX requirement. The MPS pneumatic helium low- pressure decay check will be performed on the ground. If the decay check fails on the ground, then further checkouts will be performed to determine the source of additional leakage. KSC completed the File III requirements and found no leaks out of tolerance.
STS-114-V-34	WSB GN ₂ Regulator Outlet Pressure Low	At touchdown, the HYD WSB System 3 corrected regulator outlet pressure (37.5 psia + 13.53 psia = 23.97 psig) was below the 24.5 psig allowable. The EAFB Dry Lake ambient atmospheric pressure (approximately 2300-ft elevation) at landing was verified to be 13.53 psia. The WSB System 3 regulator outlet pressure toggled between 23.97 and 24.27 psig. Per this requirement, all three WSB GN ₂ regulators are to maintain an outlet pressure between 24.5 and 26.0 psig for EAFB Dry Lake at 13.53 psia ambient. Regulator pressure on all three systems was within the proper range during entry and prior to entering the atmosphere and increased ambient pressure. The requirement is intended to verify that the GN ₂ regulator is performing properly. The range in which the regulator should begin operating is 24.5 to 26.0 psig. Failure to regulate GN ₂ from the high-pressure GN ₂ tank would result in eventual loss of WSB spray cooling of the APU lubrication oil, resulting in subsequent loss of the hydraulic system upon APU shutdown. In this case, the event occurred after the vehicle landed. During OV-103 turnaround processing, tests were performed to verify System 3 WSB GN ₂ regulator operation and the accuracy of the GN ₂ low-pressure transducer. The regulator performance was satisfactory, and the checkout was repeated five times with all results good. This sensor appears biased low. The plan is to close the PR as equipment operating as designed.

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ORBITER IN-FLIGHT ANOMALIES

IFA Number	Title	Comments
STS-114-V-35	LiOH Cartridge Found Cracked During Destowing of Vehicle	The LiOH cartridge shell is made of Aluminum 6061 series material. An inner liner of Nomex material acts as a second or redundant barrier to contain the LiOH even though the outer shell may be split. The cartridges contain LiOH, an expendable material rated for 48 man-hours. Once the material is expended, the cartridge is changed out and a fresh cartridge is installed in the atmospheric revitalization system (ARS) cabin air loop. Postflight, the LiOH cartridges are returned to the LiOH facility, where spent LiOH cartridges are refurbished and packed with new LiOH. For the split can, there was no impact to the vehicle or mission. Crew persons are trained on handling techniques for LiOH cartridges. The LiOH cartridge shell has no limited life on the number of repack cycles and is considered a fly-until-failure item. At this time, there is no trouble shooting/analysis planned or required. Cartridge shell failures of this type have occurred in the past and a prior-failure-history investigation is conclusive. No corrective action or analysis is required as the failure mode is known and some failures are expected. The cartridge was scrapped. The KSC Malfunction laboratory is nearing completion of the analysis report on the work performed to determine the potential cause for the tear on the metal mesh grading material.
STS-114-V-36	Aft Fuselage Sample Bottles R3 and L3 Indicate High Oxygen Concentrations	Aft fuselage sample bottles 3 R (right) and 3L (left) were analyzed postflight. The results show that 3R had a 18.48-percent oxygen concentration and No. 3L and a 13.58-percent oxygen concentration. The first four bottles showed normal oxygen levels.
STS-114-V-37	Aft Fuselage Sample Bottle L1 Failure to Contain Sample	The concentrations in the last two bottles (RH3 and LH3) were extremely high.

APPENDIX B
SOLID ROCKET BOOSTER ANOMALIES

IFA Number	Title	Comments
STS-114-B-001	Potential Impact Sites on ETA Ring Foam	Two potential impact sites were identified on the forward face of the right-hand ETAR foam above the IEA. One site was "I" shaped and was 1 in by 1 in by 0.25 in deep. The second site was "T" shaped and smaller in size from the first site and of undetermined depth. Samples were obtained and requirements for evaluation were established. The "I" shaped site was determined to be a post-separation event based on forensics, and a closeout report was submitted. The "T" shaped site was identified as a pre-existing divot. Report submitted and the IFA was closed.
STS-114-B-002	RT455 TPS missing aft of the BSM onboard triple motor	A 1.25 in by 5.5 in by 0.9 in piece of RT455 TPA material was missing aft of the inboard triple motor. The RT455 fracture surface exhibited some darkening that indicated possible a possible ascent condition. A possibility of performing a Debris Transport Analysis (DTA) was discussed. Samples were obtained and evaluation requirements established. If this occurrence is ascent related, the debris violates the established limits found in NSTS 60559. Panel testing in the hot-gas facility was scheduled to begin on 12/5/05. A new design configuration was evaluated. Since the new design will not be available for the next flight, an assessment of this debris was made for the next flight. Re-evaluation of the aerodynamic loads shows no loads on aft face of BSM triple motor mount. This implies that even though the aft face is the hottest location during ascent and degrades the bondline adhesion capability, there is no forcing function during ascent to liberate the RT455 from the aft face. The temperatures on the forward face don't begin to reach degradation levels until 100 seconds into the flight. Initial analysis of the aerodynamic loading on the forward face past 100 seconds indicated that the loading is negligible due to the lack of levels until 100 seconds into the flight. Initial analysis of the aerodynamic loading on the forward face past 100 seconds indicated that the loading is negligible due to the lack of atmosphere at that altitude. The analysis should show that there are no ascent-related concerns for this issue. Completion of the hot-gas testing should validate the lack of an ascent-related concern. The stress analysis has been completed and initial indications show entry loads.

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SOLID ROCKET BOOSTER ANOMALIES

IFA Number	Title	Comments
STS-114-B-003	Frustum Hypalon paint missing with darkened BTA	<p>Hypalon paint was noted to be missing from the BTA TPS closeout around the BSMs. Areas were located where the aerodynamic heat shield covers contacted the BTA. The visible BTA substrate was darkened. Samples were obtained and analysis and test requirements were established. If this occurrence is ascent related, the debris violates the established limits (0.0018 lbm vs. 0.0002 lbm requirement) found in NSTS 60559. DTA performed on the paint during the return-to-flight (RTF) effort. Testing to prove that the Hypalon paint came off during entry was established. If the paint did not come off during entry, the alternate corrective action was to remove the paint from the impact locations. Testing was performed on 5 of the 12 panels with the Hypalon paint removed. BSM firing impact testing was completed and the preliminary results suggest that the painted configuration should be used. Evidence supports that the missing paint occurred during entry.</p>
STS-114-B-004	Forward Skirt Missing MCC-1 TPS Material	<p>A 0.7 in by 0.3 in piece of MCC-1 TPS material was missing from the right-hand forward skirt acreage along the -Z axis forward of the RSS antenna. An inspection of the site appears to show that the loss was caused by debris as a 2-in long streak is located on the adjacent Hypalon paint aft of the area. The MCC-1 fracture surfaces are darkened. Samples were obtained for testing and a Fault Tree was developed and all items were closures were evaluated. Evidence of slag was found in the impact divot. Also, the ET observation camera located on the forward skirt shows slag flying toward the forward skirt with the trajectory indicated by the streaks trailing from the impact location. The team has concluded that the damage was caused by SRM slag impacting the forward skirt during post-separation tumble. No corrective action is required as the post-separation loss of TPS in that area is acceptable.</p>

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SOLID ROCKET BOOSTER ANOMALIES

IFA Number	Title	Comments
STS-114-B-005	NSI Pressure Cartridge NRD Retaining Caps Can Be Loosened	<p>The observed retaining caps of the left-hand/right-hand forward and aft and TSM separation bolts associated with the NSI pressure cartridge NSI retention devices could be loosened by hand. All NSI pressure cartridges performed as expected. Six retention devices could be loosened by hand, but not easily, and appeared to have not backed off. Testing showed that the ascent environment could not cause failure of the adhesive. The failure was attributed to the small amount of adhesive applied, shock load at firing, and impact shock load. Potential debris release was also assessed with no concern noted. The SRB Project will go forward with recommendation to fly as-is. Units for the next several flights have been built, but future units will have adequate adhesive.</p>
STS-114-B-006	Missing Aft Skirt Shoe Sidewall Material (Post location 7)	<p>A portion of the aft skirt hold-down shoe sidewall material was missing at post location M7. The shoe remains on the MLP, thus the missing material could be a lift-off debris concern. The approximate dimensions were 8.05 in by 1.3 in by 0.25 in. Four blast shield impact tests were performed and all demonstrated that the blast shield skid plate contacted the protruding material on the inboard leg of the shoe. The material was broken to a small degree where the skid plate contacted the protruding portion, but remained adhered to the shoe and did not fracture. The tests did not duplicate the failure that was seen on the post 7 shoe from STS-114. The small pieces of material that fractured were bagged for assessment. Two additional tests were made with shoes that the protruding material had been trimmed flush with the shoe inboard surface. As a result of the tests, the SRB Project has determined that the protruding material measured above the shoe inboard leg was a contributor to the missing material. Trimming for all future boosters including STS-121 will be performed.</p>

APPENDIX B
REUSABLE SOLID ROCKET MOTOR ANOMALIES

IFA Number	Title	Comments
STS-114-M-01	Numerous Acrymax paint/ RT455 pop-outs/pop-ups on GEI runs and filed Joint closeouts	Circular shapes of the Acrymax paint and TPS were missing (IFA STS-114-I-036). High concentrations of these conditions exist in the high heat-affected areas. In some areas, as many as 20 sites occurred in each square inch. The missing shapes vary in size from approximately 0.1-in diameter to approximately 1.25-in diameter; however, the majority of the sites were approximately 0.25-in diameter. Many of the smaller sites were pop-ups where paint remained mostly intact and retained the TPS. Maximum depth of the missing pop outs was approximately 0.2-in.
STS-114-M-02	Spalling of cork in the center aft and aft GEI cork runs and aft face of the inactive stiffener stub	Circular shapes of missing cork were found in the aft-center and aft- segment ground environment instrumentation (GEI) cork runs and on the aft face of the inactive stiffener stub (IFA STS-114-I-037). Missing shapes vary from approximately 0.5-in diameter to 1.0-in diameter, and the maximum depth was approximately 0.5-in. Acrymax paint was missing from the areas exhibiting cork loss.
STS-114-M-03	Impact marks on the forward nose ring (FNR) and aft inlet ring (AIR) interface	Depth and appearance appeared abnormal. Slight erosion of the edges and bottom of each impact; indicates late in burn occurrence. Impact marks are typical and are caused by inhibitor or slag during motor operation.
STS-114-M-04	Discoloration on the RH center field joint j-joint insulation	Shallow indentations (10 mils max depth) on the J-leg inboard tip. Joint pressure sensitive adhesive (PSA) remaining in area of discoloration/pitting.

APPENDIX B
EXTERNAL TANK IN-FLIGHT ANOMALIES

IFA Number	Title	Comments
STS-114-T-001	Liquid Hydrogen (LH ₂) Intertank Flange Foam Loss	<p>The losses occurred in the LH₂ Tank flange closeout.</p> <ul style="list-style-type: none"> - Debris loss no. 1 (7.5 in by 7.5" by 2.0" diameter) at Xt-1119. The size is under review by the Image Analysis Team. - Debris loss no. 2 (4.5" by 4.5" by 1.0" diameter) at Xt-1119. The size is under review by the Image Analysis Team. <p>Release time is not applicable as the events occurred after SRB separation.</p>
STS-114-T-002	Minus Y Bipod Spindle Closeout Foam Loss	<p>The debris loss was noted at the Bipod fitting closeout.</p> <ul style="list-style-type: none"> - The debris loss (8.4" by 7.3" by 1.5" diameter) was observed on the forward outboard portion of the -Y bipod closeout at Xt-1124. The release time of the debris was 148.1 sec Mission Elapsed Time (MET).
STS-114-T-003	LH ₂ Acreage Foam Loss	<p>The debris loss was noted in the LH₂ tank acreage.</p> <ul style="list-style-type: none"> - The debris loss (4.8" by 3.3" by 1.0" diameter) is located at Xt-1163 approximately 2 ft below the -Y bipod fitting. The debris loss occurred 135. sec MET. - A shallow debris loss (approximately 10.3" by 7.8" by 0.7" diameter) was located in the LH₂ acreage between the LO₂ feedline and pressure lines at Xt-1839. The release time of the debris is not applicable in the particular loss.
STS-114-T-004	LH ₂ Ice/Frost Ramp Foam Loss	<p>The debris loss occurred in the LH₂ Ice/Frost ramps at three different locations.</p> <ul style="list-style-type: none"> - Debris loss no. 1 (5.6" by 3.5" by 2.9" diameter) was noted in the LH₂ Ice/Frost ramp at Xt-1262 where exposed Conathane adhesive was noted. The event occurred at 154.8 MET. - Debris loss no. 2 (7.3" by 1.9" by 2.5" diameter) was noted in the LH₂ ice/frost ramp at Xt-1525 where exposed Conathane adhesive was noted. The release time of the debris is not applicable in the particular loss. - Debris loss no. 3 (4.0" by 2.6" by 0.3" diameter) occurred in the LH₂ Ice/Frost ramp at Xt-1841. The release time of the debris is not applicable in the particular loss.
STS-114-T-005	LH ₂ PAL Ramp Foam Loss	<p>The debris loss (36.3" by 110" by 6.7" diameter) occurred in the LH₂ PAL ramp foam at Xt-1281. The release time of the debris was 127.1 sec MET.</p>
STS-114-T-006	Plus Y Thrust Strut Flange (Secondary Debris Impact)	<p>The debris loss of thermal protection system material (11.7" by 3.8" by 2.2" diameter) on the +Y thrust strut flange occurred at Xt-1916. The release time of the debris is not applicable in the particular loss.</p>

APPENDIX B
SPACE SHUTTLE MAIN ENGINE ANOMALIES

IFA Number	Title	Comments
STS-114-E-01	SSME-1 POGO Recirculation Isolation Valve (RIV) showed 92-percent open post engine propellant dump (typically open 100%)	The recirculation isolation valve (RIV) on ME-1 did not return to 100-percent open after MECO and the propellant dump (opened to 92-percent, see page 4). (IFA STS-114-I-43). While this is out of family, the SSME criteria for this valve to open to a minimum of 80-percent during start and mainstage operation. No specific criteria for post LOX dump (criticality 3 – no effect in this phase).
STS-114-E-02	Missing SSME Nozzle Aft Manifold Ablative	Post flight inspections revealed areas of missing Nozzle Aft Manifold Ablative on SSME-2. (IFA STS-114-I-35).

APPENDIX B
SYSTEMS ENGINEERING AND INTEGRATION IN-FLIGHT ANOMALIES

IFA Number	Title	Comments
STS-114-I-01	Debris at 127.1 seconds -- External Tank (ET) Protuberance Air Load (PAL) ramp foam loss.	Reference STS-114-T-05
STS-114-I-02	135.8 seconds -- LH2 acreage debris below -Y bipod (PDL repair)	Reference STS-114-T-03
STS-114-I-03	148.1 seconds -- Debris coming from -Y bipod.	Reference STS-114-T-02
STS-114-I-04	Debris from LH2 Intertank flange at -83 degree locations. Time unknown	Reference STS-114-T-01
STS-114-I-05	Debris from LH2 Intertank flange at -90 degree locations. Time unknown	Reference STS-114-T-01
STS-114-I-06	Debris from aft LH2 tank acreage between LO2 feedline and pressure line. Time unknown.	Reference STS-114-T-03
STS-114-I-07	154.8 seconds -- Debris from LH2 ice/frost ramp at X _T -1262.	Reference STS-114-T-04
STS-114-I-08	Debris from LH2 ice/frost ramp at X _T -1525, unknown time.	Reference STS-114-T-04
STS-114-I-09	Vapor from ET LH2 Vent during ascent	Imagery captured vapors trailing aft from the vicinity of the ET ground umbilical carrier plate (GUCP) during ascent. The vapor source could cause a H ₂ leak. A large enough H ₂ can create a flammability hazard with the ET foam. A H ₂ leak can also cause the vehicle to run out of propellant prior to the MECO target. The observation of GUCP vapors were reviewed and have been determined that the most likely contributors were airflow over the ET carrier plate or airflow over the vehicle structure. The thermal, aerodynamic or environmental conditions are conducive to vapor production, but that condition is difficult to prove.
STS-114-I-10	Free-flying debris observed 18 minutes after ET separation	Crew photographs at ET separation plus 18 minutes showed free-flying debris. The Imagery Integration Team determined that this was likely umbilical ice, and this condition has been documented on previous missions. Detailed post-flight Orbiter TPS inspections did not identify any missing TPS that could be the source of the object in the photograph.

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SYSTEMS ENGINEERING AND INTEGRATION IN-FLIGHT ANOMALIES

STS-114-I-11	Payload General Support Computer (PGSC) STS-2 would not boot up on initial try	At 208/13:00 GMT, the PGSC WINDECOM STS2/760XD signature was three beeps (one long, two short) and then the unit did not boot up. Its function is to connect to the Orbiter pulse code modulation master unit (PCMMU) and then pass data to other PGSC's. STS2 was replaced with a spare and the spare performed nominally. The STS2 760XD worked properly after it was undocked. The STS2 expansion unit is suspect. A test procedure has been developed to visually inspect the pins/connectors on the expansion unit and to verify bootup with the GSE laptop docked. The STS2 laptop was transferred to ISS. The post-flight flight crew equipment removal documentation shows that the STS2 expansion did not return to JSC after STS-114 landing. The expansion unit was most likely transferred to the ISS along with the STS2 laptop PGSC.
STS-114-I-12	Lock-Up of STS3 PGSC/760XD when Viper PCMCIA Card Inserted	Reference STS-114-V-14
STS-114-I-13	Bird strike on ET during ascent	The ground cameras showed a bird strike to the ET following liftoff of STS-114. The bird (vulture) contacted the ET approximately on the north eastern side of the ET as the vehicle was leaving the launch pad. The bird is believed to have been vaporized by the SRB plume, thus no remains were found. As a result of this event, a new procedure has been implemented to assess the bird activity near the vehicle during the launch countdown and make a decision during the final minute to either hold or continue the countdown to launch. This new procedure serves to reduce the risk of striking a bird during launch. In addition, the IFA team investigated a series of potential mitigation methods and several of the proposed methods were selected for further investigation and possible implementation.
STS-114-I-14	LN2 dripped from ET vent line ice suppression shroud	Reference STS-114-K-001
STS-114-I-15	Debris walkdown identified several FOD/debris weighing more than a U.S. quarter (0.014 lb)	Reference STS-114-K-66 thru 90, -110, -113, -118
STS-114-I-16	NSI firing lines pulled out of the HDP post prior to breaking loose	Reference STS-114-K-114
STS-114-I-17	66 seconds -- Right nose landing gear door tile material loss. Across two tiles.	Reference STS-114-V-26
STS-114-I-18	Liquid Hydrogen (LH2) Engine Cutoff (ECO) #2 Sensor Failed Wet During	Reference STS-114-V-01

APPENDIX B
SYSTEMS ENGINEERING AND INTEGRATION IN-FLIGHT ANOMALIES

	Test	
STS-114-I-19	Orbiter experienced several instances of TPS tile damage	Reference STS-114-V-11
STS-114-I-20	Late release of Tyvec cover on jets F3D and F4D	Reference STS-114-V-02
STS-114-I-21	TPS blanket damage near Window 1	Reference STS-114-V-08
STS-114-I-22	Protruding gap fillers	Reference STS-114-V-12
STS-114-I-23	APU 1 drain system pressure decay	Reference STS-114-V-06
STS-114-I-24	Both SRB aft skirt gaseous nitrogen (GN2) purge lines were intact and slightly bent. The protective tape layering was completely eroded. The two lines exhibited frayed braiding.	Reference STS-114-B-05
STS-114-I-25	Potential ascent impact site to RH SRB ET attach ring foam.	Reference STS-114-B-001
STS-114-I-26	RT455 missing aft of inboard RH Booster Separation Motor (BSM) triple motor housing.	Reference STS-114-B-002
STS-114-I-27	Hypalon debris generated from BSM Aero Heat Shield impact	Reference STS-114-B-003
STS-114-I-28	Potential ascent impact site to RH forward skirt on acreage along -Z axis Forward of Range Safety System (RSS) Antenna	Reference STS-114-B-004
STS-114-I-29	Forward ET attach bolt pyro NASA Standard Initiator (NSI) ejection	Reference STS-114-V-29
STS-114-I-30	Shim stock fell from Orbiter TPS during ascent	Reference STS-114-K-109
STS-114-I-31	ET experienced several instances of impact damage	During imagery review, white streaks were observed on the ET LH ₂ barrel acreage. The white streaks are indicative of a scrape-like impact, as the substrate NCFI foam is white. No impacts or responsible debris sources were observed in the imagery. Root cause is unknown. Research of the timeline continues.

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SYSTEMS ENGINEERING AND INTEGRATION IN-FLIGHT ANOMALIES

STS-114-I-32	A31P Laptop Timing Problems	A31P laptop timing problems were affecting wing leading edge sensor (WLES) operations. The problem was initially identified at 208/20:00 GMT. To resolve this condition, the WLES will not use laptops to synchronize clocks during flight, unless a specific ground request is made. This prevents the sensors from being set to an unexpected time. A time-vector server will be installed on the A31P load and used to synchronize the laptop clock to GMT prior to a WLES sensor time synchronization. This will allow the automatic setting of laptop clocks to the Orbiter GMT, thus avoiding manual inputs in the unlikely event a time synchronization is required.
STS-114-I-33	Orbiter experienced several putty repair losses	Reference STS-114-V-31
STS-114-I-34	Missing Aft Skirt Shoe Sidewall Material (Post Location 7)	Reference STS-114-B-006
STS-114-I-35	SSME Nozzle Aft Manifold Ablative	Reference STS-114-E-02
STS-114-I-36	Numerous Acrymax paint/ RT455 pop-outs/pop-ups on GEI runs and filed Joint closeouts	Reference STS-114-M-01
STS-114-I-37	Spalling of cork in the center aft and aft GEI cork runs and aft face of the inactive stiffener stub	Reference STS-114-M-02
STS-114-I-38	+ Y Thrust Strut Flange Foam Loss	Reference STS-114-T-06
STS-114-I-39	GH2 PRESS System Leakage	Reference STS-114-V-32
STS-114-I-40	GH2 Umbilical - Quick Disconnect, STEM has raised metal, 7" QD Transition area has raised metal	During post-launch testing of the 7-inch GH ₂ quick disconnect (QD) in preparation for refurbishment (SN -007QD), areas of raised metal were found on the poppet, QD body and later the poppet spring. Initial disposition involved removing the raised metal and applying Iridite per normal procedures, and the poppet spring was replaced because of the raised metal. However, the QD is only partially assembled with the damaged area obscured from view with a PR now against the spring. The most likely cause was that the poppet spring was caught on the shoulder of the poppet guide during retraction. The action of poppet retraction during assembly or installation forced the spring out of the gap, causing the raised metal on the spring and smeared/chamfered the shoulder. The marking on the poppet was likely and indentation of the base of the spring.

APPENDIX B
SYSTEMS ENGINEERING AND INTEGRATION IN-FLIGHT ANOMALIES

STS-114-I-41	High MPLM Pressure During Environment Check #1	Reference STS-114-P-01
STS-114-I-42	MLP3 - UPS-40/40A plug backed out of receptacle	Reference STS-114-K-048
STS-114-I-43	SSME 1 Recirculation Isolation Valve (RIV) Did Not Return to 100% Open after Propellant Dump	Reference STS-114-E-01
STS-114-I-44	High O ₂ Concentrations in Aft Compartment during Ascent	<p>Post-flight evaluation of the aft compartment sample bottles L3 and R3 indicated high oxygen (O₂) concentrations. Also, bottle L3 evaluation showed that the bottle was above the flammability limit.</p> <p>The investigation found no evidence of an O₂ system leak. The investigation identified that this flight was the first flight to use a new system for analyzing the sample bottle contents. A calibration error was identified with the new sample bottle analysis hardware procedures. When the error was corrected, the L3 and R3 O₂ concentrations were lowered by approximately half and the L3 concentration was now below the flammability limit. However, the revised concentrations were still out-of-family high. Comparisons between the old and new analysis hardware were made, and the results did not identify differences of a magnitude to entirely account for the out-of-family differences. The Investigation team recommended the IFA be closed as a unexplained anomaly (UA) because no definitive cause of the out-of-family O₂ concentrations was identified. The investigation team could not completely rule out measurement errors due to differences between the old and new sample bottle measurement devices and procedures used. The investigation team could also not completely rule out an O₂ system leak due to limitations associated with the aft compartment instrumentation and system leak checks.</p>

APPENDIX B
FLIGHT OPERATIONS AND INTEGRATION (PAYLOAD) IN-FLIGHT ANOMALIES

IFA Number	Title	Comments
STS-114-P-01	High MPLM Pressure During Environment Check #1	<p>At the first MPLM environment check, approximately 3 hours after liftoff, the Multi-purpose Logistics Module (MPLM) pressure was higher than expected and violated the flight rule limit of 14.95 psia. The average pressure inside the module was 15.07 psia (779.34 mmHg). The temperature reading was 73.7 °F (23.2 °C). The as-tested cracking pressure for all three positive pressure relief actuator (PPRA) valves on this module was 15.08 psia. The lowest as-tested re-seat pressure for the three valves on this module was 14.98 psia. The average pressure is calculated from the 3 pressure sensors inside the MPLM. The individual readings for the sensors were 15.022, 15.110, and 15.071 psia. The accuracy of the individual sensors is ± 0.23 psia. Based on the fact that the module pressure was higher than the re-seat pressure, it is believed that the PPRA valves did not crack. No further action was taken during the mission.</p> <p>Based on the post-flight investigation into this issue, two causes have been identified. The first is a bias in the MPLM pressure sensors. The second is inadequate prelaunch purge requirements. The pressure sensor bias was noticed during the mission relative to the Laboratory pneumatic control assembly (PCA) pressure reading. The MPLM average pressure consistently indicated 0.08-0.09 psi higher than the Laboratory. Previous MPLM mission data for Flight Module (FM) 2 showed an identical bias for the two missions prior to LF-1. Now that the sensor bias is known, a computation will be applied to MCC displays for more accurate MPLM pressure readings. The second part of the solution is to adjust the prelaunch ground-purge requirements. MPLM Operations and Maintenance Requirements and Specification Document (OMRSD) requirements for prelaunch ground purge have been updated.</p>
STS-114-P-02	Unable to Install ZSR in MPLM P3 Location	<p>Due to interference from the stowage fences on the adjacent Resupply Stowage Platforms (RSPs), the Zero-g Stowage Rack (ZSR) could not be installed on the front of the Resupply Stowage Rack (RSR) at the preflight-planned MPLM P3 location. The ZSR was instead installed at the MPLM S3 location, which met verification loads analysis (VLA) requirements and constraints.</p> <p>Post mission investigation recommended the implementation of a new preflight process to perform clearance verification on the internal stowage configuration of the MPLM using computer models.</p>

APPENDIX B
FLIGHT OPERATIONS AND INTEGRATION (PAYLOAD) IN-FLIGHT ANOMALIES

STS-114-P-03	Crew Difficulty in Opening MPLM Hatch	<p>While attempting to ingress the MPLM, Mission Specialist (MS) 4 reported that the MPLM hatch could not be opened. No difficulty was reported with the hatch mechanism. There was some discussion on whether or not the hatch MPEV was open at her first call, but when the manual pressure equalization valve (MPEV) was verified open, air flow was felt through the valve, but the hatch still could not be opened. MS4 also verified the MPLM hatch launch restraint pip pin had been removed. A few minutes after the call with the problem, MS4 reported that working together with the International Space Station (ISS) Commander (CDR) and Flight Engineer (FE) the MPLM hatch was pushed open. It is suspected that the MPLM had a higher pressure than the Node. This differential pressure would have made it difficult to open the hatch.</p> <p>Post mission, one possible cause of a pressure differential was identified. If a small leak had existed in the inter-module ventilation (IMV) inlet jumper, it could cause a slight pressure differential between the MPLM and the Node. To mitigate this risk on future missions, the NASA MPLM Element Manager has coordinated with Mission Operations Directorate (MOD)/Environmental Control personnel to develop a simple contingency procedure to be implemented in the event that the crew experiences difficulty in opening the hatch. The MPLM inlet isolation valve will be cycled closed and this would allow the pressure to be very quickly equalized.</p>
STS-114-P-04	Loss of CMG Attitude Control During MPLM Uninstall	<p>During MPLM uninstall on 217:12:01:50 GMT, the Control Moment Gyros (CMGs) were saturated while the Space Station Remote Manipulator System (SSRMS) was maneuvering the MPLM from the Node 1 Nadir Port to the Low-Hover position. During the execution of this procedure, the SSRMS was in coarse rates. The mated stack remained in free drift until the Orbiter resumed attitude control. Due to the Orbiter going free drift at various points during robotic operations, the mated stack briefly drifted out of the approved attitude envelope. In addition, the handover from Orbiter-to-CMG control utilizing the U.S. Thruster Only controller expended 1.89 kg of Russian propellant. Post mission, it was determined that CMG saturation during coarse rates was considered possible and no anomaly had actually occurred.</p>
STS-114-P-05	FPP Fasteners Disengaging	<p>Analysis of images taken of the Floating Potential Probe (FPP) during the third extravehicular activity (EVA) revealed a minimum of two FPP dowel pins had backed out from the EVA latch handle. Analysis was performed to alleviate concerns that the FPP would come loose and cause a potential recontact with the ISS or Orbiter during undocking. Post STS-114, the FPP was removed and jettisoned during the ISS stage EVA in November 2005.</p>

APPENDIX B
 FLIGHT OPERATIONS AND INTEGRATION (PAYLOAD) IN-FLIGHT ANOMALIES

STS-114-P-06	Liquid on CMG FSE During EVA2	<p>During the second EVA, the failed CMG (no.1) was removed and replaced with the spare CMG launched on the Lightweight Mission Peculiar Equipment Support Structure Carrier (LMC). After the spare CMG was removed from the Flight Support Equipment (FSE) on the LMC, one of the EVA crew performed a check of the mounting stanchions. Some fluid, which appeared to be lubricant, was noted on the FSE stanchion to which bolt no. 6 was attached.</p> <p>During post-mission processing of the Orbiter at KSC, a spectroscopic analysis identified the fluid as fluorinated oil consistent with Braycote 815Z. The issue of oil leakage from the CMG is understood and is not detrimental to nominal ISS operations or EVA crewmembers.</p>
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APPENDIX C **DOCUMENT SOURCES**

MER DAILY REPORTS

The following STS-114 MER Daily Reports by David S. Moyer, Lead MER Manager:

- Ascent Plus 2-Hour Report, dated July 26, 2005
- First Daily Report, dated July 27, 2005
- Second Daily Report, dated July 28, 2005
- Third Daily Report, dated July 29, 2005
- Fourth Daily Report, dated July 30, 2005
- Fifth Daily Report, dated July 31, 2005
- Sixth Daily Report, dated August 1, 2005
- Seventh Daily Report, dated August 2, 2005
- Eighth Daily Report, dated August 3, 2005
- Ninth Daily Report, dated August 4, 2005
- Tenth Eleventh Daily Report, dated August 5, 2005
- Eleventh Daily Report, dated August 6, 2005
- Twelfth Daily Report, dated August 7, 2005
- Thirteenth Daily Report, dated August 8, 2005
- Landing Plus 2-Day Report, dated October 25, 2005

ET/SRB/RSRM/SSME REPORTS

STS-114 SRB and RSRM SEI Monthly Anomaly Status. Dale Walker, Marshall Space Flight Center, received January 23, 2006.

STS-114 SRB Integration Anomalies. Eric Alexander, Boeing/Huntsville, received January 17, 2006.

STS-114 Reusable Solid Rocket Motor (RSRM), TR016331, Dale Walker, MSFC, received October 27, 2005

STS-114 Reusable Solid Rocket Motor (RSRM) Flash Report. Glen Ricks, Chief Engineer, ATK Thiokol, dated July 26, 2005.

STS-114 Flash Report. E. R. Alexander, USA/Huntsville, Marshall Space Flight Center (MSFC), Propulsion Systems Engineering and Integration Office, received August 4, 2005.

STS-114 Solid Rocket Booster (SRB) Post Flight Retrieval Assessment, KSC Ice/Debris Team, Armando Oliu, NASA KSC, July 29, 2005.

STS-114 Preliminary Event Times, E. R. Alexander, USA/Huntsville, MSFC-MP71, dated August 3, 2005.

STS-114/ET-121 Quick-Look Assessment. E. R. Alexander, USA/Huntsville, dated July 26, 2005.

STS-114 Space Shuttle Main Engine. Received October 7, 2005.

ORBITER REPORTS

STS-114 Hazard Analysis Final Report. NA05HOU347, Chip Heinol, Boeing/Houston, dated October 24, 2005.

STS-114 Orbiter Post Landing Inspection Debris Assessment. Robert Speece and Thomas Ford, NASA/KSC; Carlos Ortiz and Farid Rafla, Boeing/JSC; and Abdi Khodadoust and Jeff Stone, Boeing/Huntington Beach; dated August 11, 2005.

STS-114 Orbiter Landing/Deceleration Flight Notes. C. Heinol and Tom Hoffman, Boeing/Houston; data source, dated August 9, 2005.

STS-114, Hydraulic/Water Spray Boiler (WSB) System Mission Report. Charles Ritrivi received September 1, 2005.

STS-114 Development Test Objective (DTO) 850, Water Spray Boiler. Charles A. Ritrivi, Boeing-Houston, received September 7, 2005.

STS-114 Mission Report, Purge, Vent, and Drain System. Chip Heinol, Boeing-Houston, dated August 9, 2005.

STS-114 Star Tracker Post Flight Report. J. R. Trinta, Jacobs Sverdrup/Houston, dated September 12, 2005.

STS-114 Mission Report, Auxiliary Power Unit. P. Grout, Boeing-Houston, August 9, 2005.

STS-114 30-Day Mission Report, Orbital Maneuvering System (OMS). James M. Garza, Boeing-Houston, received September 27, 2005.

STS-114 Reaction Control System (RCS) Mission Report. James M. Garza, Boeing-Houston, received October 27, 2005.

STS-114 Fuel Cell/PRSD Systems Postflight Report. Kenneth P Adams, Boeing-Houston, received September 28, 2005.

STS-114 Mission Report, Flight Control System. Jaime K. Mani, Boeing-Houston, received September 29, 2005.

STS-114 Active Thermal Control System (ATCS) Postflight Report. Carmelo Asuncion, dated October 27, 2005.

STS-114 Communications and Tracking (C&T) Postflight Report. Charles J. Stafford, Boeing-Houston, dated September 29, 2005.

STS-114 Orbiter Docking System (ODS) Postflight Report. Glenn Jenkinson, Boeing, received September 30, 2005.

STS-114 Displays and Controls (D&C). Quoc P. Ngo, Boeing- Houston, received September 30, 2005.

STS-114 Structures and Mechanical System. Received October 13, 2005.

STS-114, Life Support Systems, including Atmospheric Revitalization Pressure Control System (ARPCS), Airlock/ODS, Smoke Detection and Fire Suppression System, Supply and Waste Water Management System. Isaac Andu, received October 14, 2005.

STS-114 Air Data Transducer Assembly. Howard A. Damoff, Boeing-Houston, received October 14, 2005.

STS-114 Structures and Mechanical System. Michael J. Dunham, Boeing-Houston, received October 19, 2005.

STS-114 Thermal Protection System. Received October 13, 2005.
STS-114 Electrical Power Distribution and Control (EPDC) System. William D. Peterson, Boeing-Houston, received October 14, 2005.
STS-114 SRMS Post Mission Report. Mike Hiltz, MDA Corporation, received January 23, 2006.
Sts-114 Aeroheating Report. Dennis C. Chao, Boeing-Houston, received January 3, 2006.
STS-114 Main Propulsion System. Jeffery F. Stinnett, Boeing-Houston, September 28, 2005.
STS-114 Data Processing System Hardware Postflight Report. Vinh Q. Nguyen, Boeing-Houston, received October 3, 2005.
STS-114 Thermal Control System. Daniel F. Reynolds, Boeing-Houston, received September 28, 2005.
STS-114 Gas Sample Analysis. Chip C. Heinol, Boeing-Houston, received February 13, 2006.
STS-114 Operational Instrumentation and Modular Auxiliary Data System. Dwight Favors, Boeing-Houston, received December 12, 2005.

OTHER REPORTS

STS-114 Post Launch Pad Debris Inspection Report, Day 2. KSC Debris Team, John Blue, NASA/JSC; Casey Heinrich, USA/KSC; Doug Powell, Lockheed Martin/KSC; and Carlos Ortiz, Boeing/JSC, dated July 27, 2005.
STS-114 Photography and Television Analysis. Armanado Oliu, NASA-KSC, received October 20, 2005.
STS-114 Mission Events. Vernon Hill and Marilyn Borchers, received October 13, 2005.
STS-114 Extravehicular Activity Summary. Bridget Z. Johnson, NASA-JSC, November 08, 2005.

APPENDIX D

ACRONYMS AND ABBREVIATIONS

AA	accelerometer assemblies
ADTA	Air Data Transducer Assembly
AFRSI	Advanced Flexible, Reusable, Surface Insulation
AGT	adaptive guidance throttling
APFR	Articulating Portable Foot Return
APU	Auxiliary power unit
ARC	Ames Research Center
ARPCS	Atmospheric Revitalization Pressure Control System
ARS	Atmospheric Revitalization System
ATCS	Active Thermal Control System
AVIU	Audio Visual Interface Unit
BGA	Beta Gimbal Assembly
BITE	built-in test equipment
BSM	Booster separation motor
C&T	Communications and Tracking
CDR	Commander
CMG	Control Moment Gyroscope
CST	comprehensive self-test
CWC	contingency water container
D&C	Displays and Controls
DDU	display driver unit
DPS	Data Processing System
DTN	Data Trend Notice
DTO	Development Test Objective
EAFB	Edwards Air Force Base
ECLSS	Environmental Control and Life Support System
ECO	engine cutoff
EDT	Eastern daylight time
EI	Entry Interface
EMU	extravehicular mobility unit
EOM	end of mission
EPDC	Electrical Power Distribution and Control
ESP	External Stowage Platform
ESPAD	External Stowage Platform Attachment Device
ET	External Tank
ETSD	EVA Tool Storage Device
EV1	designation for extravehicular crewmember 1
EV2	designation for extravehicular crewmember 2
EVA	extravehicular activity
EWA	Emittance Wash Applicator
FBMBT	flexible bearing mean bulk temperature
FCMS	Fuel Cell Monitoring System
FCS	Flight Control System
FES	Flash Evaporator System
FHRC	Flex Hose Rotary Cover
FID	failure identifier
FPP	Floating Potential Probe

FRCS	Forward Reaction Control System
FSS	Flight Service Structure
GEI	ground environmental instrumentation
GMT	Greenwich mean time
GN&C	Guidance, Navigation, and Control
GPC	General Purpose Computer
GPS	Global Positioning System
GUCP	ground umbilical carrier plate
HPFTP	high-pressure fuel turbopump
HPOTP	high-pressure oxidizer turbopump
HRF	Human Research Facility
ICD	Interface Control Document
IDP	integrated display processor
IFA	In-flight anomaly
IPR	interim problem report
ISIS	Integrated Sensor Inspection System
ISS	International Space Station
ITVC	Intensified Television Camera
KSC	John F. Kennedy Space Center
lbm	pounds mass
LCC	Launch Commit Criteria
LCG	liquid-cooling garment
LCS	Laser Camera System
LCVG	liquid cooling and ventilation garment
LDRI	Laser Dynamic Range Imager
LESS	Leading Edge Structural System
LH	left hand
LP	left pod
LRSI	low-temperature, reusable, surface insulation
LVLH	local vertical, local horizontal
LWT	lightweight tank
LWTSA	lightweight tool stowage assembly
MC	mid-course correction
MCC	Mission Control Center
MDD	mate/demate device
MDU	multifunction display unit
ME	main engine
MECO	main engine cutoff
MEDS	Multifunction Electronic Display System
MET	mission elapsed time
MISSE	Material International Space Station Experiment
Mlbf	Million pounds force
MLI	multilayer insulation
MMT	Mission Management Team
MMU	manned maneuvering unit
MPLM	multipurpose logistics module
MPM	manipulator positioning mechanism
MPS	Main Propulsion System
MRL	manipulator release latch
N/A	not applicable
NASA	National Aeronautics and Space Administration

NAVAID	Navigation Aid
NOAX	Non-Oxide Adhesive Experiment
NSI	NASA Standard Initiator
NSLD	NASA Shuttle Logistics Depot
NWS	nose wheel steering
OBSS	Orbiter Boom Sensor System
ODS	Orbiter Docking System
OFI	operational flight instrumentation
OME	Orbital Maneuvering Engine
OMRSD	Operational Maintenance Requirements and Specifications Document
OMS	Orbital Maneuvering System
OPS	Operational Sequence
ORGA	Orbiter rate gyro assembly
OV	Orbiter Vehicle
PASS	Primary Avionics Software System
PCMCIA	portable computer memory card international adapter
PCS	pressure control system
PEC	Payload Experiment Carrier
PGME	Propylene Glycol Monomethyl Ether
PGSC	payload general support computer
PGT	pistol-grip tool
PLBD	payload bay door
PMBT	propellant mean bulk temperature
ppm	parts per million
PRT	Problem Resolution Team
PTU	pan-and-tilt unit
PV&D	Purge, Vent, and Drain
PWR	payload water reservoir
RCC	reinforced carbon-carbon
RCS	Reaction Control System
RH	right hand
RHC	rotational hand controller
RIV	(Pogo) Recirculation Isolation Valve
RJD	reaction jet driver
RJMC	Rotary Joint Motor Controller
RM	Redundancy Management
RMS	Remote Manipulator System
RP	right pod
RPC	Remote Power Controller
RPM	R-bar pitch maneuver
RSB PDU	Rudder/Speed Brake Power Drive Unit
RSC	RMS sideview camera
RSRM	Reusable Solid Rocket Motor
S&A	safe and arm
S/N	serial number
SAM	System Area Manager
scim	standard cubic inches per minute
SMRD	spin motor rotation detector
SODB	Shuttle Operational Data Book
SP	sensor package

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
SSRMS	Space Station Remote Manipulator System
STS	Space Transportation System
SWWMS	Supply and Waste Water Management System
TCS	Thermal Control System
TEA	torque-equilibrium attitude
THC	transitional hand controller
TIG	time of ignition
TPS	Thermal Protection System
TSA	Tool Stowage Assembly
TSM	Tail Service Mast
TVC	thrust vector controller
VRCS	Vernier Reaction Control System
VTR	Video Tape Recorder
WCL	water coolant loop
WCS	Waste Collection System
WIF	Worksite Interface Fixture
WLE	wing leading edge
WLEIDS	Wing Leading Edge Impact Detection System
WLES	Wing Leading Edge System
WSB	water spray boiler

Symbols:

ΔV	differential velocity
GH_2	gaseous hydrogen
GN_2	gaseous nitrogen
GO_2	gaseous oxygen
I_{sp}	specific impulse
LH_2	liquid hydrogen
LiOH	lithium hydroxide
LO_2	liquid oxygen
P_c	chamber pressure
SiC	silicon carbide