STS-109

Launch Report

060:14:00 G.m.t.

The launch of the STS-109 mission was scheduled for February 28, 2002. However, acceptable weather conditions were not predicted and the launch was rescheduled for March 1, 2002. The temperature at the planned time of the first launch attempt was predicted to be below the acceptable level of 38 °F.

The countdown for the rescheduled launch on March 1, 2002, was flawless and resulted in a successful launch at 60:11:22.02.021 G.m.t. (6:22:02 a.m. e.s.t.). Orbiter systems performance during ascent was nominal with no problems identified.

The OMS 2 maneuver was performed at the planned time and the orbit was 310.5 by 105.3 nautical miles (nmi.) following the maneuver. The OMS performed satisfactorily throughout the maneuver.

The payload bay doors were opened at 060:13:21:18 G.m.t. (00:01:59:16 MET). All voltages were nominal and the motors opened the doors in nominal dual-motor time.

The Freon loop 1 aft cold-plate flow-rate is degraded. The initial evaluation of the data indicates a possible partial blockage caused the degraded flow-rate. Investigation into the cause and impact of this condition is continuing.

/s/ Brenda Eliason GMT 060:13:46

Brenda Eliason
STS-109 Lead MER Manager

STS-109

FIRST DAILY REPORT

061:13:00 G.m.t.

The STS-109 mission is progressing nominally and with the exception of a problem with Freon coolant loop (FCL) 1, all Orbiter subsystems are performing satisfactorily. The problem with FCL 1, which was mentioned in the Launch Report, is discussed in the next paragraph. The Orbiter consumables remaining are above the levels required for completion of the planned mission.

Several seconds after main engine cutoff (MECO), the Freon coolant loop (FCL) 1 aft coldplate flow-rate decreased from 304 lb/hr to 226 lb/hr. The FCL 1 interchanger flow and payload heat exchanger flow increased at the same time, which confirmed that a restriction was causing the reduction of flow in the aft coldplate branch. The flow-rate has been stable since the event. The Flight Rules state that the minimum flow-rate in the aft coldplate branch is 211 lb/hr actual, and 236 lb/hr when allowing for measurement uncertainty, for a one FCL entry. The analysis and assumptions used to determine this limit are being reviewed in an effort to determine if FCL 1 will provide adequate cooling during entry in the event of a failure of FCL 2. An engineering meeting is scheduled for this morning to discuss this problem prior to a Mission Management Team meeting that is scheduled for noon today.

On flight day 1, when the crew attempted to open the internal airlock hatch, or "A" hatch, they reported that it was difficult to move the hatch actuator locking tab out of the locked position, and therefore the hatch could not unlatched. While "jiggling" the actuator handle, they were able to move it axially, or away from the actuator. When they pressed it back against the actuator, they were able to move the locking lever and unlatch the hatch. While this actuator handle is designed to be removable, it is to be fully seated for both the hatch latching and unlatching operations and should not have the looseness that was reported. It has been recommended that for the duration of the flight, the crew leave the "A" hatch actuator unlocked.

The NC1A maneuver was not required. The NC1B maneuver (OMS 3), performed with the right OMS engine, was initiated at 060:16:43:49 G.m.t. (00:05:21:47 MET) and was 13.8 seconds in duration. The differential velocity (ΔV) imparted was 10.3 ft/sec, and the resultant orbit was 110.9 by 310.6 nautical miles (nmi.) following the maneuver.

The NC2 maneuver, using the –X primary reaction control system (RCS) thrusters, was initiated at 061:05:12:52 G.m.t. (00:17:50:50 MET). The ΔV delivered was 4.5 ft/sec, and the resultant orbit was 112.1 by 310.4 nmi. following the maneuver.

The checkout of the remote manipulator system (RMS) was successfully completed. Checkout of the extravehicular mobility units (EMUs) was in work at the time of this report.

Don L. McCormack Jr. 061:12:30 G.m.t.
Brenda Eliason
STS-109 Lead MER Manager

STS-109

SECOND DAILY REPORT

062:13:00 G.m.t.

The STS-109 mission is progressing nominally and all Orbiter subsystems are performing satisfactorily. The current status of the problem with Freon coolant loop (FCL) 1, which was mentioned in the previous Daily Report, is discussed in the next paragraph. The rendezvous with the Hubble Space Telescope (HST) has been completed and the HST has been berthed to the Flight Support System. The Orbiter consumables remaining are above the levels required for completion of the planned mission.

The FCL 1 aft cold-plate flow-rate has been stable since the decrease in flow-rate observed shortly after main engine cutoff (MECO). Analysis performed by the engineering team has shown that despite the degraded flow, FCL 1 will be able to provide adequate cooling during entry in the event of a failure of FCL 2. As a result, the Mission Management Team, which met on Saturday to consider the problem's impact to the mission, decided that the mission should continue as planned.

The NC3 maneuver was a 12.6-second multi-axis reaction control system (RCS) firing initiated at 061:14:17:34 G.m.t. (01:02:55:32 MET). The differential velocity (ΔV) delivered was 3.1 ft/sec, and the resultant orbit was 113.7 by 310.4 nautical miles (nmi.) following the maneuver.

Following the NC-3 maneuver, the left orbital maneuvering system (OMS) quantity gages started to exhibit abnormal behavior, eventually failing to zero. The LOMS fuel and oxidizer total and aft quantity indications experienced a sudden downward shift at approximately 061:14:35 G.m.t. (01:03:13 MET), followed approximately 99 seconds later by another downward shift. About 5 minutes and 40 seconds after the latter occurrence, the fuel and oxidizer total and aft quantity indications failed off-scale low. Analysis of the failure signature indicates a probable failure in the power-supply circuitry of the OMS quantity totalizer. The OMS gaging function is criticality 3/3 and the failure does not impact the mission.

The NH maneuver (OMS 4), performed with both OMS engines, was initiated at 062:04:07:30 G.m.t. (01:16:45:28 MET) and was 207 seconds in duration. The ΔV imparted was 326.6 ft/sec, and the resultant orbit was 302.9 by 312.2 nmi.

The NC4 maneuver was a 20.4-second multi-axis RCS firing, mostly –X, initiated at 062:05:09:03 G.m.t. (01:17:47:01 MET). The ΔV delivered was 4.8 ft/sec, and the resultant orbit was 302.4 by 309.3 nmi. The NCC maneuver was a 5.5-second multi-axis RCS firing initiated at 062:06:00:59 G.m.t. (01:18:38:57 MET). The ΔV delivered was 1.3 ft/sec, and the resultant orbit was 302.3 by 309.2 nmi. following the maneuver.

The Ti maneuver (OMS 5), performed using the left OMS engine being cross fed from the right OMS tanks, was initiated at 062:07:01:05 G.m.t. (001:19:39:03 MET). The maneuver was 10.8 seconds in duration. The ΔV delivered was 8.4 ft/sec, and the resultant orbit was 303.5 by 313.5 nmi.

Maneuver	Time, G.m.t./MET	ΔV, ft/sec	Firing time, sec	Orbit, nmi.
MC-1 (Multi-Axis RCS)	062:07:21:06 01:19:59:04	0.8	3.2	303.6 by 313.5
Out of Plane Null (Multi-Axis RCS)	062:07:33:51 01:20:11:49	N/A	N/A	No change
MC-2 (Multi-Axis RCS)	062:07:56:29 01:20:34:27	0.4	1.79	303.4 by 313.5
MC-3 (+X RCS)	062:08:13:28 01:20:51:26	1.9	8.1	303.4 by 313.8
MC-4 (Multi-Axis RCS)	062:08:23:29 01:21:01:28	1.9	8.1	303.4 by 314.8

The Remote Manipulator System (RMS) was powered and uncradled at 062:06:08 G.m.t. (01:17:46 MET), and the HST was captured at 062:09:31:21 G.m.t. (01:22:09:19 MET). The HST was successfully berthed in the flight support structure (FSS) at 062:10:31 G.m.t. (01:23:10 MET). The RMS was then used to perform a video survey of the HST using the wrist camera.

/s/ Brenda Eliason GMT 062:13:18

Brenda Eliason
STS-109 Lead MER Manager

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THIRD DAILY REPORT

063:11:30 G.m.t.

The STS-109 mission is progressing nominally and all Orbiter subsystems are performing satisfactorily. Several minor problems, none of which will impact the mission, are discussed in the following paragraphs. The first extravehicular activity (EVA) for Hubble Space Telescope (HST) was concluding at the time of this report. The Orbiter consumables remaining are above the levels required for completion of the planned mission.

The first EVA was initiated at 063:06:37 G.m.t. (02:19:15 MET) to begin servicing of the HST. Activities the crew completed included the installation of –V2 solar array and diode box. The remote manipulator system (RMS) performed nominally in support of the EVA.

At approximately 061:03:22 G.m.t. (00:16:00 MET), the auxiliary power unit (APU) 3 fuel-pump seal-cavity drain line pressure began to slowly decay (approximately 1.1 psi/day). There is no evidence in the data that fuel has leaked into the line so the line contents are predominantly nitrogen (N_2). Since the drain-line relief valve has a burst disc, the leakage is expected to be into the aft fuselage instead of overboard through the relief valve. There is no mission impact.

During RMS checkout on flight day (FD) 2, when the crew commanded the wrist yaw joint during the direct drive (DD) test, a DD built-in test equipment (BITE) was annunciated. It is believed that this BITE is a nuisance alarm that was caused by a timing issue when DD switch contacts are opened/closed, that is, when the switch is actuated. In some conditions, if the switch status contact is open when the enable and command contacts are closed, the DD BITE will be annunciated. DD is a contingency mode of operation and no impact to RMS operations is expected. Postflight troubleshooting will be performed.

The fuel cell 3 alternate product-water line temperature indicates that there is a slight leak past the check valve. As a precaution, the supply water system has been reconfigured to preclude water from the alternate line being used for the extravehicular mobility unit (EMU) recharges. Tanks C and D have been isolated from tanks A and B. Tank B, which will be used for EMU recharges, was dumped and then refilled with water from tank A, which does not contain hydrogen.

The S-band system has experienced unexpected dropouts on the forward and return links throughout the mission. The problem has been seen on multiple antennas as well as Tracking and Data Relay Satellites (TDRSs). As is typical, the mission was started on string 2. At approximately 062:16:07 G.m.t. (02:02:45 MET), the S-band system was switched to string 1. Dropouts have also been observed on string 1. Data evaluation is continuing.

On FD 3, it was reported that when payload interrogator (PI) 1 is not locked on to radio frequency (RF) telemetry from the HST, output signals (noise) from the PI that affect the

Ku-band signal processor assembly and the HST laptop are causing loss of data. The PI 1 will be turned off when the HST transmitter is off.

At 062:06:09 G.m.t. (01:18:47 MET), the crew reported what they called a multifunction electronic display system (MEDS) anomaly. While performing the RMS power-up, three expected messages were annunciated. When the crew pressed the aft keyboard message-reset key, the text portion of the message line cleared, but the time tag associated with the message did not clear. Pressing the message-reset key a second time cleared the time tag. No mission impact is expected. Flight software personnel are investigating the cause of this occurrence.

The crew reported that when switching between the RMS wrist and elbow cameras on FD 3, the newly powered camera would come up with the video scene present, instead of with the iris closed as expected. This indicates that either the camera was remaining on or the iris was remaining open. The concern is that if the camera iris is not closing down as expected, the camera could be damaged. This condition will be investigated.

/s/Brenda J. Eliason 063:11:30 G.m.t.
Brenda J. Eliason
STS-109 Lead MER Manager

STS-109

FOURTH DAILY REPORT

064:12:00 G.m.t.

The STS-109 mission is progressing nominally and all Orbiter subsystems are performing satisfactorily. Two main propulsion system (MPS) anomalous indications, neither of which will impact the mission, are discussed in this report. The second extravehicular activity (EVA) for Hubble Space Telescope (HST) was still in progress at the time of this report. The Orbiter consumables remaining are above the levels required for completion of the planned mission.

The second EVA, which was initiated at 064:06:41 G.m.t. (03:19:19 MET) to continue servicing of the HST, was progressing nominally. Activities for the crew included the installation of +V2 solar array and diode box and a reaction wheel assembly. The remote manipulator system (RMS) was performing nominally in support of the EVA.

The LH_2 engine 1 prevalve (PV4) open-position indicator A failed off approximately 14 minutes after the LH_2 prevalves were opened for the LH_2 dump. The indication went off at 060:11:46 G.m.t. (00:00:24 MET) and remained off for 2 hours and 43 minutes, and then recovered to the expected on-state at 060:14:29 G.m.t. (00:03:07 MET). Both of the PV4 closed indication and the open indicator B were in their proper state during the entire time period. The prevalves will remain in the open position for the remainder of the mission and this failure will not affect MPS on-orbit operations. Postflight troubleshooting plans are in work.

Review of valve-timing data determined that the MPS LH_2 4-inch recirculation line disconnect was slow to close when commanded at main engine cutoff (MECO). The requirement is maximum of 2.8 seconds from signal-to-switch (close power on to close indication on). The signal-to-switch time for the disconnect was 13.79 seconds. The disconnect-open indication was lost approximate 0.5 second after the loss of open power indicating partial movement of the disconnect. The close-indication on coincided with the ET/Orbiter umbilical retract implying a back-up mechanical closure. The 4-inch recirculation disconnect is not operated after closure at MECO, and this slow response has no mission impact. Troubleshooting plans are in work.

The first EVA was completed in 7 hours and 1 minute and all planned tasks were completed. The EVA lasted about 30 minutes longer than planned; however, this delay in completing the EVA had no impact on the mission.

/s/Brenda J. Eliason 064:11:36 G.m.t.
Brenda J. Eliason
STS-109 Lead MER Manager

STS-109

FIFTH DAILY REPORT

065:12:00 G.m.t.

The STS-109 mission is progressing nominally and all Orbiter subsystems are performing satisfactorily. The third extravehicular activity (EVA) for Hubble Space Telescope (HST) was still in progress at the time of this report. The EVA was approximately 2 hours late in starting due to a problem in extravehicular mobility unit (EMU) 1 that is discussed in the next paragraph. The Orbiter consumables remaining are above the levels required for completion of the planned mission.

During preparations for the third EVA, anomalous indications were seen on EMU 1 and it was discovered that water had leaked into the primary life support system (PLSS). The hard upper torso (HUT) for EMU 3 was re-sized for the extravehicular (EV) 1 crewman so the planned EVA could proceed. As a result, the EVA was initiated approximately 2 hours late at 065:08:28 G.m.t. (04:21:06 MET). The primary activity for the crew during this EVA is the replacement of the power control unit (PCU).

The second EVA was completed in 7 hours and 16 minutes. The crew completed all of their scheduled tasks plus several get-ahead tasks. The major tasks were the change out of the +V2 solar array and the replacement of the reaction wheel assembly.

Brenda J. Eliason 065:12:07 G.m.t.
Brenda J. Eliason
STS-109 Lead MER Manager

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SIXTH DAILY REPORT

066:12:00 G.m.t.

The STS-109 mission is progressing nominally and all Orbiter subsystems are performing satisfactorily. No new issues have arisen with the Orbiter in the past 24-hours. The fourth extravehicular activity (EVA) for the servicing of the Hubble Space Telescope (HST) was still in progress at the time of this report. The Orbiter consumables remaining are above the levels required for completion of the planned mission.

The fourth EVA for the HST was initiated at 066:09:00 G.m.t. (05:21:38 MET) and was progressing nominally. The primary objectives of the EVA are to replace the Faint Object Camera (FOC) with the new Advanced Camera for Surveys (ACS), install an Electronics Support Module (ESM) and perform some remaining Power Control Unit (PCU) cleanup tasks.

The remote manipulator system (RMS) camera problem, documented in the Third Daily Report, has been better characterized after receiving answers to questions sent to the crew. It was initially thought that when switching between the RMS wrist and elbow cameras, the newly powered camera would come up with the video scene present, instead of with the iris closed as expected. It has been determined that when switching from the wrist to the elbow camera, the elbow camera is performing nominally. However, when switching from the elbow to the wrist camera, the wrist camera is coming up with its iris open. This indicates that the iris in the wrist camera is not closing when the camera powers off. The problem is occurring each time the wrist camera is selected. The crew has been instructed to manually close the iris prior to powering the wrist camera down. Otherwise, the RMS cameras are working normally and are completely useable for the mission.

The third EVA was completed in 6 hours and 48 minutes. All required tasks, including the PCU change out, and bay 2 and 3 battery mate and de-mate occurred without problems.

/s/Brenda J. Eliason 066:12:11 G.m.t.
Brenda J. Eliason
STS-109 Lead MER Manager

STS-109

SEVENTH DAILY REPORT

067:13:00 G.m.t.

The STS-109 mission is progressing nominally and all Orbiter subsystems are performing satisfactorily. Several issues that have arisen during the mission are documented in the following paragraphs. The fifth and final planned extravehicular activity (EVA) for the servicing of the Hubble Space Telescope (HST) was still in progress at the time of this report. The Orbiter consumables remaining are above the levels required for completion of the planned mission.

The fifth EVA for the HST was initiated at 067:08:46 G.m.t. (06:21:24 MET) and was progressing nominally. The primary objectives of the EVA were to install the Near-Infrared Camera and Multi-Object Spectrometer (NICMOS) Cryogenic Cooler and NICMOS Cooling System Radiator.

Review of the data for the orbital maneuvering subsystem (OMS) crossfeed lines has indicated an off-nominal response from the temperature sensors in heater zones 1 and 2. The heaters in zones 3 and 4 are strongly influencing the response of the temperature sensors in zones 1 and 2, respectively. The most likely cause is that the zone 1 and 2 sensors are in a location that does not provide the optimum indication for zone 1 and 2 thermal performance. Closeout photographs indicate that the temperature sensor for zone 2 is not in the desired location. A photograph could not provide validation of the location of temperature sensor for zone 1, and based on the flight data, it is suspected that its location is also undesirable. The thermal responses of the OMS crossfeed system temperature sensors will be monitored closely for the remainder of the mission, and a postflight inspection will be performed.

At 061:05:12:58 G.m.t (00:17:50:56 MET), channel C on the forward translational hand controller (THC) in the -X direction turned off earlier than expected during the NC_2 firing. The problem has not repeated in subsequent -X pulses. The switch inside the THC is a snap-action rotary device using magnets and Hall-effect sensors to ensure simultaneous activation and deactivation of all three discrete channels. According to the manufacturer, it is impossible for one sensor to turn off by itself without a fault in the sensor or the signal path from the sensor to the multiplexer/demutiplexer (MDM), or momentary loss of power to the THC. There is no mission impact. Data evaluation is continuing.

During the prelaunch External Tank (ET) LH_2 pre-pressurization operation, the Space Shuttle main engine (SSME) 1 LH_2 ullage pressure transducer data were intermittently flat-lined. The SSME 1, 2 and 3 LH_2 ullage pressure transducers typically track each other as the pre-pressurization pulses maintain the LH_2 tank pressure within the control band. The SSME 1 transducer data were flat-lined for approximately 7 seconds at T-90 seconds and again for approximately 36 seconds starting at T-1 minute. At approximately T-24 seconds, the transducer output recovered and closely tracked the other two transducers throughout ascent. Troubleshooting steps are being developed to perform a postflight check of the Orbiter ullage-pressure signal-conditioning system.

During the second EVA, the biomedical data from extravehicular mobility unit (EMU) 2 was lost for about 77 minutes. During the third EVA, biomedical data from EMU 3 behaved erratically for several minutes then dropped out completely. Additional biomedical data dropouts were seen during the fourth EVA from EMUs 3 and 4. The biomedical data dropouts are most likely due to one of the sternal harness pads separating from the crewman's chest. This is the first flight of the sternal harness with the disposable electrodes. The disposable electrodes are peel-and-stick similar to a Band-Aid. It was confirmed that the anomalous data appears similar to disconnected electrodes with the old system. This condition does not impact the EVAs.

Regarding the auxiliary power unit (APU) 3 fuel-pump seal-cavity drain-line pressure decay discussed in the Third Daily Report, it has been determined that helium was left in the drain line following a leak check. It is believed that the helium is slowly permeating the Teflon in the flex-hose, accounting for the pressure decay. There is no mission impact. A revision of ground procedures to ensure a nitrogen purge is performed following the helium leak check is in work.

Regarding the S-band system unexpected dropouts on the forward and return links discussed in the Third Daily Report, data review indicates that the dropouts have a variety of causes. These include Mission Control Center (MCC)/network data errors, Orbiter antenna look-angles to the Tracking and Data Relay Satellite (TDRS), false lock, radio frequency (RF) "multipath" regions, the known interruption potential during antenna switching, short occasional radio frequency interference (RFI), and HST-rendezvous RFI (seen on other HST missions). No apparent on-board S-band system failure has been identified. Data evaluation is continuing.

At 066:10:29 G.m.t. (05:23:07 MET), a 6-second 32-ampere spike, was observed on fuel cell 3. Orbiter data were reviewed and no current spikes were observed, indicating that the current draw was on the payload side of the interface.

The fourth EVA was completed in 7 hours and 30 minutes. All required tasks, including the replacement of the Faint Object Camera (FOC) with the new Advanced Camera for Surveys (ACS), the installation of an Electronics Support Module (ESM), and completion of some remaining Power Control Unit (PCU) cleanup tasks, were completed without problems.

/s/ Brenda Eliason GMT 067:14:10

Brenda J. Eliason
STS-109 Lead MER Manager

STS-109

EIGHTH DAILY REPORT

068:13:00 G.m.t.

The STS-109 mission is progressing nominally and all Orbiter subsystems are performing satisfactorily. One minor Orbiter issue has arisen in the past 24-hours and it is discussed in this report. The Hubble Space Telescope (HST) has been successfully deployed. The Orbiter consumables remaining are above the levels required for completion of the planned mission.

The fifth extravehicular activity (EVA) was completed in 7 hours and 21 minutes. All required tasks, including the installation of the Near-Infrared Camera and Multi-Object Spectrometer (NICMOS) Cryogenic Cooler and NICMOS Cooling System Radiator, were completed successfully.

Following the EVA, the remote manipulator system (RMS) was positioned in the extended park position to perform a single-drive test. The test was performed to support troubleshooting of the built-in test equipment (BITE) annunciation observed during the direct-drive test portion of the RMS checkout on flight day 2 (reference the Third Daily Report). The RMS operator performed a sequence of ten positive and negative single drive commands of the wrist yaw joint to obtain engineering data on the performance of the single/direct-drive switch. The anomaly noted earlier in the mission did not recur.

The HST reboost session was started at 067:17:18:04 G.m.t (07:05:56:02 MET) when primary reaction control subsystem (RCS) thrusters F5L, F5R, L5D, and R5D were fired. The session lasted nearly 36 minutes. There was no predefined duty cycle and the thrusters were turned off as necessary to maintain attitude within the 5-degree deadband. The reboost delivered a differential velocity (ΔV) of 11.8 ft/sec, resulting in an overall average altitude increase of 3.6 nautical miles (nmi.) for a final orbit of 314.7 by 310.6 nmi. The RCS performed satisfactorily throughout the maneuver.

The HST was grappled by the RMS at 068:07:08 G.m.t. (07:19:46 MET). During grapple, the digital readout of the RMS wrist camera horizontal field of view (HFOV) was drifting approximately 3.5 degrees in both directions. The downlink of the camera video also indicated that the zoom telemetry appeared to be drifting. The crew power-cycled the camera but the problem did not clear. Although the HST grapple was successful, the inability to determine the actual HFOV impacted the grapple accuracy. The HST was unberthed from the Orbiter at 068:08:34 G.m.t. (07:21:12 MET) and released at 068:10:04 G.m.t. (07:22:42 MET).

Following the release of the HST, two RCS separation maneuvers were performed. The first was initiated at 068:10:05:08 G.m.t. (07:22:43:06 MET) and consisted of ten 0.48-second pulses. The ΔV delivered to the Orbiter was 1.2 ft/sec. The second separation maneuver was initiated at 068:10:37:16 G.m.t. (07:23:15:14 MET) with a total firing duration of 10.24 seconds. The ΔV delivered was 2.5 ft/sec, and the orbit after the two maneuvers was 309.4 by 314.6 nmi.

The orbital maneuvering subsystem (OMS) dual-engine orbit-adjust maneuver was performed at 068:12:01:02 G.m.t. (08:00:39:46 MET). The maneuver was 45.4 seconds in duration, and the ΔV delivered was 74.8 ft/sec. The vehicle was placed in an orbit of 266.4 by 312.3 nmi. The OMS performed satisfactorily throughout the maneuver.

Brenda Eliason 068:13:33 G.m.t.

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Brenda J. Eliason
STS-109 Lead MER Manager

STS-109

NINTH DAILY REPORT

069:13:00 G.m.t.

The STS-109 mission is progressing nominally and all Orbiter subsystems are performing satisfactorily. One Orbiter issue has arisen in the past 24-hours and it is discussed in the following paragraph. The Orbiter consumables remaining are above the levels required for completion of the planned mission.

At approximately 069:02:37 G.m.t. (08:15:15 MET), the FES accumulator/high-load feedline B (starboard) heater system 2 failed off. The thermostat is located on the accumulator line and the temperature sensor on the accumulator line had been indicating the heater turning on at approximately 68 °F. When the accumulator line temperature dropped to 50 °F, the crew switched to heater system 1, which is performing nominally.

/s/Brenda J. Eliason 069:12:10 G.m.t.
Brenda J. Eliason
STS-109 Lead MER Manager

STS-109

TENTH DAILY REPORT

070:13:00 G.m.t.

The STS-109 mission is progressing nominally and all Orbiter subsystems are performing satisfactorily. One new issue has arisen with the Orbiter in the past 24-hours and is discussed in this report. The Orbiter consumables remaining are above the levels required for completion of the planned mission.

The flight control subsystem (FCS) checkout was performed using auxiliary power unit (APU) 1 to support the checkout with a APU start time of 070:07:13 G.m.t. (09:19:51 MET). The run time was 5 minutes, 34 seconds, and 16 pounds of fuel were used during the APU 1 operation. The total run time was too short to require the water spray boiler (WSB) to provide spray cooling. FCS, APU and hydraulics performance was nominal.

Following FCS checkout, the reaction control system (RCS) hot-fire was performed. The hot-fire began at 070:08:14:35 G.m.t. (09:20:52:33 MET) and ended at 070:08:22:03 G.m.t. (09:21:00:01 MET). During the RCS hot-fire, primary RCS thruster R3R failed off when first commanded to fire and was auto-deselected by the RCS redundancy management (RM). The reaction jet driver (RJD) output was nominal, however, the chamber pressure reached only 11 psia prior to the thruster being deselected. The thruster did not leak propellant following the failure. The thruster-injector temperatures and chamber pressure suggest a problem with a thruster pilot-operated valve. The thruster will remain deselected for the duration of the flight, and no flight impact is expected. Each of the remaining primary thruster firings was satisfactory.

An orbit-adjust maneuver that used the –X primary RCS thrusters was performed at 070:10:07:32.3 G.m.t. (09:22:45:30.3 MET). The maneuver was 48.3 seconds in duration, and the differential velocity (ΔV) delivered was 11.6 ft/sec. The vehicle was placed in an orbit of 259 by 312.5 nautical miles (nmi.).

/s/Brenda J. Eliason 070:12:11 G.m.t.
Brenda J. Eliason
STS-109 Lead MER Manager

STS-109

LANDING PLUS 2 HOUR REPORT

The launch of the STS-109 mission was scheduled for February 28, 2002. However, acceptable weather conditions were not predicted and the launch was rescheduled for March 1, 2002. The temperature at the planned time of the first launch attempt was predicted to be below the acceptable level of 38 °F.

During the prelaunch External Tank (ET) LH_2 pre-pressurization operation, the Space Shuttle main engine (SSME) 1 LH_2 ullage pressure transducer data were intermittently flat-lined. The SSME 1, 2 and 3 LH_2 ullage pressure transducers typically track each other as the pre-pressurization pulses maintain the LH_2 tank pressure within the control band. The SSME 1 transducer data were flat-lined for approximately 7 seconds at T-90 seconds and again for approximately 36 seconds starting at T-1 minute. At approximately T-24 seconds, the transducer output recovered and closely tracked the other two transducers throughout ascent. Troubleshooting steps are being developed to perform a postflight check of the Orbiter ullage-pressure signal-conditioning system.

The countdown for the rescheduled launch on March 1, 2002, was flawless and resulted in a successful launch at 060:11:22.02.021 G.m.t. (6:22:02 a.m. e.s.t.). Orbiter systems performance during ascent was nominal.

Several seconds after main engine cutoff (MECO), the Freon coolant loop (FCL) 1 aft coldplate flow-rate decreased from 304 lb/hr to 226 lb/hr. The FCL 1 interchanger flow and payload heat exchanger flow increased at the same time, which confirmed that a restriction was causing the reduction of flow in the aft coldplate branch. The Flight Rules state that the minimum acceptable flow-rate in the aft coldplate branch is 211 lb/hr actual, and 236 lb/hr when allowing for measurement uncertainty, for a one FCL entry. Analysis performed by the engineering team showed that despite the degraded flow, FCL 1 would be able to provide adequate cooling during entry in the event of a failure of FCL 2. The FCL 1 degraded aft cold-plate flow-rate remained stable throughout the mission.

The LH_2 engine 1 prevalve (PV) 4 open-position indicator A failed off approximately 14 minutes after the liquid hydrogen (LH_2) prevalves were opened for the LH_2 dump. The indication went off at 060:11:46 G.m.t. (00:00:24 MET) and remained off for 2 hours and 43 minutes, and then recovered to the expected on-state at 060:14:29 G.m.t. (00:03:07 MET). The PV4 closed indication and open indicator B were in their proper state during the entire time period. The prevalves remained in the open position for the remainder of the mission and this failure did not affect main propulsion system (MPS) on-orbit or entry operations.

Review of valve-timing data determined that the MPS LH_2 4-inch recirculation-line disconnect was slow to close when commanded at MECO. The requirement is a maximum of 2.8 seconds from signal-to-switch (close power on to close indication on). The actual signal-to-switch time for the disconnect was 13.79 seconds. The disconnect-open indication was lost approximately 0.5 second after the loss of open power indicating partial movement of the disconnect. The close-indication on coincided with

the ET/Orbiter umbilical retract implying a back-up mechanical closure. The 4-inch recirculation disconnect is not operated after closure at MECO, and this slow response had no mission impact.

The orbital maneuvering subsystem (OMS) 2 maneuver, performed with both OMS engines, was initiated at 060:12:05:59 G.m.t. (00:00:43:57 MET) and was 87.6 seconds in duration. The differential velocity (ΔV) imparted was 134 ft/sec, and the resultant orbit was 310.4 by 105.2 nautical miles (nmi.) following the maneuver. The OMS performed satisfactorily throughout the maneuver.

The payload bay doors were opened at 060:13:21:18 G.m.t. (00:01:59:16 MET). All voltages were nominal and the motors opened the doors in nominal dual-motor time.

On flight day (FD) 1, when the crew attempted to open the internal airlock hatch, or "A" hatch, they reported that it was difficult to move the hatch actuator-locking tab out of the locked position, and therefore the hatch could not be unlatched. While "jiggling" the actuator handle, they were able to move it axially, or away from the actuator. When they pressed it back against the actuator, they were able to move the locking lever and unlatch the hatch. While this actuator handle is designed to be removable, it is to be fully seated for both the hatch latching and unlatching operations and should not have the looseness that was reported. For the duration of the flight, the crew left the "A" hatch actuator unlocked. A closeout technician had noted a similar condition prior to launch.

At 061:05:12:58 G.m.t (00:17:50:56 MET), channel C on the forward translational hand controller (THC) turned off earlier than expected during the -X NC_2 firing. The problem did not repeated in subsequent -X pulses. The switch inside the THC is a snap-action rotary device using magnets and Hall-effect sensors to ensure simultaneous activation and deactivation of all three discrete channels. According to the manufacturer, it is impossible for one sensor to turn off by itself without a fault in the sensor or the signal path from the sensor to the multiplexer/demutiplexer (MDM), or momentary loss of power to the THC. There was no mission impact.

Following the NC-3 maneuver, the left OMS quantity gages started to exhibit abnormal behavior, eventually failing to zero. The left OMS fuel and oxidizer total and aft quantity indications experienced a sudden downward shift at approximately 061:14:35 G.m.t. (01:03:13 MET) followed approximately 99 seconds later by another downward shift. About 5 minutes and 40 seconds after the latter occurrence, the fuel and oxidizer total and aft quantity indications failed off-scale low. Analysis of the failure signature indicates a probable failure in the power-supply circuitry of the OMS quantity totalizer. The OMS gaging function is criticality 3/3 and the failure did not impact the mission.

Extravehicular mobility unit (EMU) checkout was performed satisfactorily. The secondary oxygen package (SOP) pressure on EMU 4 was 5807 psia when 6200 psia was expected. Evaluation showed that as long as that pressure was above 5489 psia, it would provide the 30-minute emergency oxygen supply if required. The EMU was declared satisfactory for use during the EVA operations.

The following table lists the pertinent data for each of the rendezvous maneuvers.

RENDEZVOUS MANEUVERS

Maneuver	Time, G.m.t./MET	ΔV, ft/sec	Firing time, sec	Orbit, nmi.
NC1A (OMS 3) (Right engine)	060:16:43:49 00:05:21:47	10.3	13.8	110.9 by 310.6
NC2 (-X RCS)	061:05:12:52 00:17:50:50	4.5	19.7	112.1 by 310.4
NC3 (Multi-axis RCS)	061:14:17:34 01:02:55:32	3.1	12.6	113.7 by 310.4
NH (OMS 4) (Dual Engine)	062:04:07:30 01:16:45:28	326.6	207	302.9 by 312.2
NC4 (Multi-axis RCS)	062:05:09:03 01:17:47:01	4.8	20.4	302.4 BY 309.3
NCC (Multi-axis RCS)	062:06:00:59 01:18:38:57	1.3	5.5	302.3 by 309.2
TI (OMS 5) (Left engine)	062:07:01:05 01:19; 39:03	8.4	10.8	303.5 BY 313.5
MC-1 (Multi-axis RCS)	062:07:21:06 01:19:59:04	0.8	3.2	303.6 by 313.5
Out of Plane Null (Multi-axis RCS)	062:07:33:51 01:20:11:49	N/A	0	No change
MC-2 (Multi-axis RCS)	062:07:56:29 01:20:34:27	0.4	1.79	303.4 by 313.5
MC-3 (+X RCS)	062:08:13:28 01:20:51:26	1.9	8.1	303.4 by 313.8
MC-4 (Multi-Axis RCS)	062:08:23:29 01:21:01:28	1.9	8.1	303.4 by 314.8

The Remote Manipulator System (RMS) was powered and uncradled at 062:06:08 G.m.t. (01:17:46 MET), and the Hubble Space Telescope (HST) was captured at 062:09:31:21 G.m.t. (01:22:09:19 MET). The HST was successfully berthed in the flight support structure (FSS) at 062:10:31 G.m.t. (01:23:10 MET). The RMS was then used to perform a video survey of the HST using the wrist camera.

The first extravehicular activity (EVA) was initiated at 063:06:37 G.m.t. (02:19:15 MET) to begin servicing of the HST. EMU 1 did not send EMU data scans through the real-time data system (RTDS) at the expected 2-minute intervals. These data are typically sent by interrupting the EMU biomedical signal every two minutes. As a result, the EV1 crewmember provided Mission Control with verbal data from the EMU every hour. The EVA ended at 063:13:38 G.m.t. (03:02:16 MET) for a total EVA time of 7 hours and 1 minute. All planned tasks were completed. The EVA lasted about 30 minutes longer than planned; however, this delay in completing the EVA had no impact on the mission. After the completion of the EVA, the RTDS power was cycled and satisfactory data were obtained from the EMU.

At approximately 061:03:22 G.m.t. (00:16:00 MET), the auxiliary power unit (APU) 3 fuel-pump seal-cavity drain line pressure began to slowly decay (approximately 1.1 psi/day). It was determined that helium was left in the drain line following a preflight

leak check. It is believed that the helium was permeating the Teflon in the flex-hose, thus accounting for the pressure decay. There was no mission impact. A revision of ground procedures to ensure a nitrogen purge is performed following the helium leak check is in work.

During RMS checkout on flight day (FD) 2, when the crew commanded the wrist yaw joint during the direct-drive (DD) test; a DD built-in test equipment (BITE) was annunciated. It is believed that this BITE is a nuisance alarm that was caused by a timing issue when DD switch contacts are opened/closed, that is, when the switch is actuated. In some conditions, if the switch status contact is open when the enable and command contacts are closed, the DD BITE will be annunciated. DD is a contingency mode of operation, thus, there was no impact to nominal RMS operations.

The fuel cell 3 alternate product-water line temperatures indicate a slight leak past the check valve. As a precaution, the supply water system was reconfigured to preclude water from the alternate line being used for the EMU recharges. Tanks C and D were isolated from tanks A and B. Tank B, used for EMU recharges, was dumped and then refilled with water from tank A, which did not contain hydrogen.

The S-band system has experienced more frequent than expected dropouts on the forward and return links throughout the mission. The problem was seen on multiple antennas as well as Tracking and Data Relay Satellites (TDRS). As is typical, the mission was started on string 2. At approximately 062:16:07 G.m.t. (02:02:45 MET), the S-band system was switched to string 1. Dropouts were also observed on string 1. Data review indicates that the S-band dropouts have a variety of causes. These include Mission Control Center (MCC)/network data errors, Orbiter antenna look-angles to the Tracking and Data Relay Satellite (TDRS), false lock, radio frequency (RF) "multipath" regions, the known interruption potential during antenna switching, short occasional radio frequency interference (RFI), and HST-rendezvous RFI (seen on other HST missions). No apparent on-board S-band system failure was identified.

On FD 3, it was reported that when payload interrogator (PI) 1 was not locked on to radio frequency (RF) telemetry from the HST, output signals (noise) from the PI affected the Ku-band signal processor assembly and the HST laptop caused loss of data. The PI 1 will be turned off when the HST transmitter is off. This feature of PI operation without telemetry lock has been noted in previous missions, and is to be expected.

At 062:06:09 G.m.t. (01:18:47 MET), the crew reported what they called a multifunction electronic display system (MEDS) anomaly. While performing the RMS power-up, three expected messages were annunciated. When the crew pressed the aft keyboard message-reset key, the text portion of the message line cleared, but the time tag associated with the message did not clear. Pressing the message-reset key a second time cleared the time tag. A note in the Level A software requirements explains that this can occur due to software timing in certain situations.

The crew reported that when switching between the RMS wrist and elbow cameras on FD 3, the newly powered camera would come up with the video scene present, instead of with the iris closed as expected. The RMS camera problem was better characterized after receiving answers to questions sent to the crew. It was initially thought that when switching between the RMS wrist and elbow cameras, the newly powered camera would

come up with the video scene present, instead of with the iris closed as expected. It was determined that when switching from the wrist to the elbow camera, the elbow camera performed nominally. However, when switching from the elbow to the wrist camera, the wrist camera came up with its iris open. The iris in the wrist camera did not close when the camera power was off. The problem occurred each time the wrist camera was selected. The crew was instructed to manually close the iris prior to powering the wrist camera down.

The second EVA was completed in 7 hours and 16 minutes. The crew completed all of their scheduled tasks plus several get-ahead tasks. The major tasks were the change-out of the +V2 solar array and the replacement of the reaction wheel assembly. The RMS performed nominally in support of the EVA.

During the second EVA, the biomedical data from extravehicular mobility unit (EMU) 2 was lost for about 77 minutes. During the third EVA, biomedical data from EMU 3 behaved erratically for several minutes then dropped out completely. Additional biomedical data dropouts were seen during the fourth EVA from EMUs 3 and 4. The biomedical data dropouts are most likely due to one of the sternal harness pads separating from the crewman's chest. This was the first flight of the sternal harness with the disposable electrodes. The disposable electrodes are peel-and-stick similar to a Band-Aid. The anomalous data were similar to disconnected electrodes with the old system. This condition did not impact the EVAs.

During preparations for the third EVA, anomalous indications were seen on EMU 1 and it was discovered that water had leaked into the primary life support system (PLSS). The hard upper torso (HUT) for EMU 3 was re-sized for the extravehicular (EV) 1 crewman so the planned EVA could proceed. As a result, the EVA was initiated approximately 2 hours late at 065:08:28 G.m.t. (04:21:06 MET). The third extravehicular activity ended at 065:15:16 G.m.t. (05:03:54 MET). The primary activity for the crew during this EVA was the replacement of the power control unit (PCU), and this was completed satisfactorily.

Review of the data for the OMS crossfeed lines indicated an off-nominal response from the temperature sensors in heater zones 1 and 2. The heaters in zones 3 and 4 strongly influenced the response of the temperature sensors in zones 1 and 2, respectively. The most likely cause is that the zone 1 and 2 sensors are in a location that does not provide the optimum indication for zone 1 and 2 thermal performance. Closeout photographs indicate that the temperature sensor for zone 2 is not in the desired location. A photograph could not provide validation of the location of temperature sensor for zone 1, and based on the flight data, it is suspected that its location is also undesirable. A postflight inspection will be performed, and if needed, the sensors and or thermostats will be relocated to more desirable locations.

The fourth EVA for the HST was initiated at 066:09:00 G.m.t. (05:21:38 MET) and progressed nominally during the 7-hour and 30-minute EVA. The primary objectives of the EVA were the replacement of the Faint Object Camera (FOC) with the new Advanced Camera for Surveys (ACS), installation of an Electronics Support Module (ESM) and performance of some remaining Power Control Unit (PCU) cleanup tasks. The fourth EVA was completed at 66:16:30 G.m.t. (06:06:05 MET).

The fifth EVA for the HST was initiated at 067:08:46 G.m.t. (06:21:24 MET) and was progressing nominally. The primary objectives to install the Near-Infrared Camera and Multi-Object Spectrometer (NICMOS) Cryogenic Cooler and NICMOS Cooling System Radiator were completed successfully.

At 066:10:29 G.m.t. (05:23:07 MET), a 6-second 32-ampere spike, was observed on fuel cell 3. Orbiter data were reviewed and no current spikes were observed, indicating that the current draw was on the payload side of the interface.

Following the EVA, to support troubleshooting of the built-in test equipment (BITE) annunciation observed during the direct-drive test portion of the RMS checkout on flight day 2, the remote manipulator system (RMS) was positioned in the extended park position to perform a single-drive test. A sequence of ten positive and negative single drive commands of the wrist yaw joint were executed to obtain engineering data on the performance of the single/direct-drive switch. The anomaly noted earlier in the mission did not recur.

The HST reboost session was started at 067:17:18:04 G.m.t (07:05:56:02 MET) when primary reaction control subsystem (RCS) thrusters F5L, F5R, L5D, and R5D were fired. The session lasted nearly 36 minutes. There was no predefined duty cycle and the thrusters were turned off as necessary to maintain attitude within the 5-degree deadband. The reboost delivered a differential velocity (ΔV) of 11.8 ft/sec, resulting in an overall average altitude increase of 3.6 nautical miles (nmi.) for a final orbit of 314.7 by 310.6 nmi. The RCS performed satisfactorily throughout the maneuver.

The RMS grappled the HST at 068:07:08 G.m.t. (07:19:46 MET) in preparation for deploying the HST. During grapple, the digital readout of the RMS wrist camera horizontal field of view (HFOV) was drifting approximately 3.5 degrees in both directions. The downlink of the camera video also indicated that the zoom telemetry appeared to be drifting. The crew power-cycled the camera but the problem did not clear. Although the HST grapple was successful, the inability to determine the actual HFOV impacted the grapple accuracy.

The HST was unberthed from the Orbiter at 068:08:34 G.m.t. (07:21:12 MET) and released at 068:10:04 G.m.t. (07:22:42 MET).

Following the release of the HST, two RCS separation maneuvers were performed. The first was initiated at 068:10:05:08 G.m.t. (07:22:43:06 MET) and consisted of ten 0.48-second pulses. The ΔV delivered to the Orbiter was 1.2 ft/sec. The second separation maneuver was initiated at 068:10:37:16 G.m.t. (07:23:15:14 MET) with a total firing duration of 10.24 seconds. The ΔV delivered was 2.5 ft/sec, and the orbit after the two maneuvers was 309.4 by 314.6 nmi.

The OMS dual-engine orbit-adjust maneuver was performed at 068:12:01:02 G.m.t. (08:00:39:46 MET). The maneuver was 45.4 seconds in duration, and the ΔV delivered was 74.8 ft/sec. The vehicle was placed in an orbit of 266.4 by 312.3 nmi. The OMS performed satisfactorily throughout the maneuver.

At approximately 069:02:37 G.m.t. (08:15:15 MET), the FES accumulator/high-load feedline B (starboard) heater system 2 failed off. The thermostat is located on the

accumulator line and the temperature sensor on the accumulator line had been indicating the heater turning on at approximately 68 °F. When the accumulator line temperature dropped to 50 °F, the crew switched to heater system 1, which performed nominally.

The flight control subsystem (FCS) checkout was performed using auxiliary power unit (APU) 1 to support the checkout with an APU start time of 070:07:13 G.m.t. (09:19:51 MET). The run time was 5 minutes, 34 seconds, and 16 pounds of fuel were used during the APU 1 operation. The total run time was too short to require the water spray boiler (WSB) to provide spray cooling. FCS, APU and hydraulics performance was nominal.

Following FCS checkout, the reaction control system (RCS) hot-fire was performed. The hot-fire began at 070:08:14:35 G.m.t. (09:20:52:33 MET) and ended at 070:08:22:03 G.m.t. (09:21:00:01 MET). During the RCS hot-fire, primary RCS thruster R3R failed off when first commanded to fire and was auto-deselected by the RCS redundancy management (RM). The reaction jet driver (RJD) output was nominal, however, the chamber pressure reached only 11 psia prior to the thruster being deselected. The thruster did not leak propellant following the failure. The thruster-injector temperatures and chamber pressure suggest a problem with a thruster pilot-operated valve. The thruster remained deselected for the duration of the flight, and no flight impact occurred. Each of the remaining primary thruster firings was satisfactory.

An orbit-adjust maneuver that used the –X primary RCS thrusters was performed at 070:10:07:32.3 G.m.t. (09:22:45:30.3 MET). The maneuver was 48.3 seconds in duration, and the differential velocity (ΔV) delivered was 11.6 ft/sec. The vehicle was placed in an orbit of 259 by 312.5 nautical miles (nmi.).

The payload bay doors were closed and latched for the first KSC landing opportunity at 070:05:54 G.m.t. (10:18:32 MET). All payload bay door close and latch operations occurred in dual motor time.

During deorbit preparations when the right vent door 3 was closed at 071:07:57:38 G.m.t. (010:20:35:36 MET), the close 1 microswitch initially indicated closed. Approximately 4.5 seconds later, the microswitch transferred off where it remained for approximately 4 minutes and 43 seconds. Following that period, the microswitch transferred back on and remained in that position. The data indicate that the door closed nominally in dual motor time. The door close 1 indication was also momentarily lost during door-closure after landing. Similar behavior occurred on STS-93.

The deorbit maneuver for the first KSC landing opportunity, a two-engine straight-feed firing, was performed on orbit 165 at 071:08:22:39.365 G.m.t. (10:21:04:42.344 MET). The maneuver was 244.80 seconds in duration with a ΔV of 418.3 ft/sec.

Entry interface occurred at 071:09:00:52 G.m.t. (10:21:38:50 MET), and entry was completed satisfactorily. Main landing gear touchdown occurred on KSC concrete runway 33 at 071:09:31:53 G.m.t. (10:22:09:51 MET) on March 12, 2002. The drag chute was deployed at 071:09:31:55 G.m.t. The nose gear touchdown occurred at approximately 071:09:32:04 G.m.t. The drag chute was jettisoned at

071:09:32:37 G.m.t. Wheels stop occurred at 071:09:33:05 G.m.t. The rollout was normal in all respects. The flight duration was 10 days 22 hours 09 minutes 51 seconds. The APUs were shut down approximately 20 minutes after landing.

During entry at approximately 071:09:09 G.m.t. (10:21:47 MET), the APU 2 exhaust gas temperature sensor (EGT) 1 temperature sensor became erratic. The temperature sensor will probably be replaced.

/s/ Don L. McCormack 071:11:00 G.m.t

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