STS-90

LAUNCH REPORT

107:20:20 G.m.t.

During the countdown for the STS-90 scheduled launch on April 16, 1998, Network Signal Processor (NSP) 2 failed to acquire frame synchronization during the switch from NSP 1 to NSP 2. Downlink was not affected by the problem. The system was cycled from NSP 1 to NSP 2 nine times using several different modes. Each time, NSP 1 operated satisfactorily but NSP 2 did not. No uplink communications could be established on NSP 2. As a result, the launch was delayed 24 hours so that NSP 2 could be replaced and checkout could be completed.

The STS-90 mission was launched at 107:18:18:59.988 G.m.t. (2:19: p.m. e.d.t.). The ascent phase was satisfactory and a nominal orbit of 147.2 by 41.3 nautical miles was achieved. All Orbiter subsystems performed nominally except water spray boiler (WSB) 3, which experienced an under-cooling condition that is discussed in a following paragraph.

During the ascent, an Orbital Maneuvering Subsystem (OMS) assist maneuver was performed for the first time during the Space Shuttle Program. Ignition for the OMS assist maneuver was 107:18:21:15 G.m.t. [00:00:02:15 Mission Elapsed Time (MET)], the maneuver was 102.4 seconds in duration, and the OMS engines performed satisfactorily.

During the ascent phase, WSB 3 experienced an under-cooling condition of 334 °F. The specification value for this temperature is no greater than 275 °F. The controller was switched from A to B when the temperature reached approximately 300 °F, and no spray cooling was observed. The Auxiliary Power Unit (APU) 3 lubrication oil return temperature increased to approximately 334 °F when APU 3 was prematurely shut down at 107:18:32:12 G.m.t. (00:00:14:12 MET), approximately 2 minutes earlier than the other two APUs.

The OMS 2 maneuver was performed at 107:19:00:27.2 G.m.t. (00:00:41:34.2 MET). The maneuver was 110.3 seconds in duration and the differential velocity (ΔV) was 171.1 ft/sec. The resultant orbit was 154 by 138 nmi.

/s/ Kenneth L. Brown 107:20:03 G.m.t.
for

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Don L. McCormack
STS-90 Lead MER Manager

STS-90

FIRST DAILY REPORT

108:12:00 G.m.t.

The STS-90 mission is progressing satisfactorily with no significant Orbiter problems.

The External Tank (ET)-liquid hydrogen (LH_2) 98-percent liquid-level sensor no.2 failed wet at 107:18:20:06 G.m.t (00:00:01:06 MET). There is no impact to the mission.

The LH_2 Space Shuttle main engine (SSME) 1 inlet pressure shifted upward approximately 3 psia at about 107:18:22:30 G.m.t. (00:00:03:30 MET). A similar signature has been observed on previous flights of this and other Orbiter vehicles. There is no impact to the remainder of flight.

Water spray boiler (WSB) 3 experienced an under-cooling condition during ascent and the lubrication oil return temperature reached 334 °F. The specification value for this temperature is no-greater-than 275 °F. The WSB 3 controller was switched from A to B at an auxiliary power unit (APU) lubrication oil return temperature of about 300 °F at 107:18:30:46 G.m.t. (00:00:11:46 MET), with no spray cooling observed at that time. APU 3 was shutdown about 2 minutes early at 107:18:32:12 G.m.t. (00:00:13:12 MET). The APU lubrication oil return temperature was about 334 °F at the time of shut down. Preliminary data review indicates no spraying was achieved during the operation of either WSB 3 controller.

The starboard payload bay door was opened at 107:19:54:46 G.m.t. (00:01:35:46 MET), and the port payload bay door was opened at 107:19:56:07 G.m.t. (00:01:37:07 MET). The door operation was satisfactory in all respects.

The left-hand nose landing gear pressure sensor 2 exhibited erratic behavior prior to launch and throughout ascent. Prior to launch, the sensor was reading low compared to sensor 1. This problem was first found during the turnaround operations and was accepted based on the presence of the redundant measurement and the successful wheel/tire leak checks performed previously. During ascent, the sensor 2 output alternately dropped out and recovered several times. The sensor is currently providing a biased-low output, and the sensor will remain suspect throughout the remainder of the mission.

Stokes McMillan for 108:11:20 G.m.t.

Don L. McCormack
STS-90 Lead MER Manager

STS-90

SECOND DAILY REPORT

109:12:00 G.m.t.

The STS-90 mission is progressing satisfactorily with no significant Orbiter problems.

During the previous sleep period, the reaction control subsystem (RCS) thruster F5L injector temperature was approaching the 130 °F redundancy management (RM) limit because of the limited number of thruster firings. Thruster R5R was deselected in an effort to cause thruster F5L to fire more frequently. Also, during the current sleep period, the -Z pitch attitude was changed to have a 5-degree pitch bias. As a result of the attitude change and deselection of thruster R5R, thruster F5L is firing more often and that is causing the injector temperatures to be maintained well above the minimum RM limit.

/s/ Stokes McMillan 109:11:55

Don L. McCormack
STS-90 Lead MER Manager

STS-90

THIRD DAILY REPORT

110:12:00 G.m.t.

The STS-90 mission is progressing satisfactorily with no significant Orbiter problems. Consumables remaining are above the level required to complete the planned 16 +1 + 2 day mission.

/s/ Stokes McMillan 110:10:53

Don L. McCormack
STS-90 Lead MER Manager

STS-90

FOURTH DAILY REPORT

111:12:00 G.m.t.

The STS-90 mission is progressing satisfactorily with no significant Orbiter problems. Consumables remaining are above the level required to complete the planned 16 + 1 + 2 day mission.

The Fuel Cell Performance Monitor (FCMS) was activated and on-orbit fuel cell individual-cell-voltage data were recorded for 12 minutes, from 109:19:13:54 G.m.t. (02:00:54:54 MET) to 109:19:25:54 G.m.t. (02:01:06:54 MET). A review of the data shows that all of the cell voltages were nominal.

The flash evaporator system (FES) primary A controller shut down at approximately 111:02:06 G.m.t. (03:07:47 MET). At that time, the FES inlet temperatures were averaging around 48 °F. The crew restarted the FES primary A controller 5 minutes after the shutdown occurred. The restart was successful, and the FES went into standby at 111:02:35 G.m.t. (03:08:16 MET); however, the FES failed to come out of the standby mode. At 111:03:13 G.m.t. (03:08:54 MET), the crew switched from the primary A to the primary B controller. The FES gained control for 10 minutes on the primary B controller and then shut down. The FES core flush procedure was implemented. After the flush procedure was completed, the FES primary B controller was successfully restarted. The FES topping duct heaters were placed on heater string A/B for the duration of the crew sleep period and will be reconfigured to heater string A following the sleep period. Data evaluation is ongoing.

/s/ Don L. McCormack 111:11:47 G.m.t.

Don L. McCormack
STS-90 Lead MER Manager

STS-90

FIFTH DAILY REPORT

112:12:00 G.m.t.

The STS-90 mission is progressing satisfactorily with no significant Orbiter problems. Consumables remaining are above the level required to complete the planned 16 + 1 + 2 day mission.

The flash evaporator system (FES) has operated satisfactorily on the primary B controller after the successful restart of the FES following the flush procedure that was mentioned in the previous daily report. Following the sleep period, the topping duct heaters were reconfigured from A/B to A as planned. It is believed that the most probable cause of the shut-down was a rapid FES heat-load transient that occurred while in the -ZLV +YVV (top-to-Earth local vertical, starboard wing on the velocity vector) water-dump attitude. This transient resulted in the formation of ice in the FES topper core and this eventually lead to the shut-down. The Orbiter water-dump attitudes have been changed from -ZLV +YVV to +ZLV +YVV (bottom to Earth local vertical, starboard wing on the velocity vector) to preclude the FES shut-down conditions from recurring.

/s/ Don L. McCormack 112:11:17 G.m.t.

Don L. McCormack
STS-90 Lead MER Manager

STS-90

SIXTH DAILY REPORT

113:12:00 G.m.t.

The STS-90 mission is progressing satisfactorily with no significant Orbiter problems. Consumables remaining are above the level required to complete the planned 16 + 1 + 2 day mission.

The reaction control system (RCS) orbit adjust 1 maneuver was performed at 112:20:14:00 G.m.t. (05:01:55:00 MET). The duration of the maneuver was 15 seconds with a resultant differential velocity (ΔV) of 3.34 ft/sec. All thrusters fired nominally.

/s/ Don McCormack 113:12:00 G.m.t.

Don L. McCormack
STS-90 Lead MER Manager

STS-90

SEVENTH DAILY REPORT

114:12:00 G.m.t.

The STS-90 mission is progressing satisfactorily with no significant Orbiter problems. Consumables remaining are above the level required to complete the planned 16 + 1 + 2 day mission.

At 114:02:08 G.m.t. (006:07:49 MET), the Ku-band radio frequency (RF) power output measurement became erratic for approximately six minutes. The downlink signal-strength was unaffected, indicating that the erratic behavior was in the telemetry signal only. This condition was a repeat of a problem seen during STS-87 that could not be duplicated during ground testing.

/s/ Don L. McCormack 114:11:20 G.m.t.

Don L. McCormack
STS-90 Lead MER Manager

STS-90

EIGHTH DAILY REPORT

115:12:00 G.m.t.

The STS-90 mission is progressing satisfactorily with the exception of a significant problem with the regenerative carbon dioxide removal system (RCRS) discussed in the following paragraph.

At 115:03:49:46 G.m.t. (07:09:30:46 MET), the RCRS shut down while on controller 2. The crew reconfigured the RCRS to controller 1, but it too shut down. The crew was told to use lithium hydroxide (LiOH) canisters for carbon dioxide removal during their sleep period. A fault tree to investigate the cause of the shutdown and subsequently develop an in-flight maintenance (IFM) procedure to recover usage of the RCRS is being developed. In the meantime, the LiOH canisters will continue to be used for carbon dioxide removal. With 28 unused LiOH canisters on board, the capability exists for an additional 5 + 2 days mission duration, if the RCRS cannot be recovered.

Data review has shown that the External Tank (ET) liquid oxygen (LO_2) 100-percent liquid-level sensor (LLS) 2 flashed about a dozen times between wet and dry over a 15-second period beginning at approximately 107:18:23:56 G.m.t. (00:00:04:56 MET). The sensor read dry at all other times during ascent (as expected). This sensor is only used during loading. There is no impact to the remainder of the mission.

The auxiliary power unit (APU) 2 gas generator valve module (GGVM), fuel pump and injector tube temperatures were noted to decrease following the heater B reconfiguration at 114:18:53 G.m.t. (07:34:00 MET). At approximately 114:19:51 G.m.t. (07:01:32 MET), the crew cycled the GGVM/fuel pump system B heater switch to off and then back to auto. Proper heater response followed, and the heater is now cycling normally.

At 114:18:07 G.m.t. (06:23:48 MET), the vernier driver power and logic power for the forward, left and right reaction control subsystem (RCS) all went off. This resulted in two vernier thrusters failing off when they were subsequently commanded to fire. During vernier thruster operation, the logic power switches are positioned to off and depend on the logic latch to keep the logic power and vernier power on. The vernier driver and logic switches were cycled and operation of all vernier thrusters was recovered. Investigation into the cause of this anomaly is ongoing.

The crew reported that a camcorder failed to power up while connected to a video interface unit (VIU) by a camcorder video/power cable. The camcorder was then powered by a battery with the video interface performing nominal. Utilizing a second camcorder to isolate the failed component, the crew reported that the VIU had failed. The failed VIU was identified and stowed.

/s/Don L. McCormack 115:12:38 G.m.t.
Don L. McCormack
STS-90 Lead MER Manager

STS-90

NINTH DAILY REPORT

116:12:00 G.m.t.

The STS-90 mission is progressing satisfactorily with no significant Orbiter problems. Consumables remaining are above the level required to complete the planned 16 + 1 + 2 day mission.

An in-flight maintenance (IFM) procedure was performed and the regenerative carbon dioxide removal system (RCRS) was recovered. The IFM isolated a check valve which was leaking cabin air into the RCRS system. The isolation was regained by disconnecting the outlet hose from the check valve and covering the fitting with aluminum tape. In addition, power was removed from the compressor since it is in the flow path blocked by the IFM procedure. Following the IFM, the RCRS was activated at 115:20:43 G.m.t. (008:02:24 MET) using controller 1. RCRS performance was as expected in light of the IFM modifications.

/s/Don L. McCormack 116:12:04 G.m.t.
Don L. McCormack
STS-90 Lead MER Manager

STS-90

TENTH DAILY REPORT

117:12:00 G.m.t.

The STS-90 mission is progressing satisfactorily with no significant Orbiter problems. Consumables remaining are above the level required to complete the planned 16 + 1 + 2 day mission.

/s/ Don L. McCormack 117:11:11 G.m.t.

Don L. McCormack
STS-90 Lead MER Manager

STS-90

ELEVENTH DAILY REPORT

118:12:00 G.m.t.

The STS-90 mission is progressing satisfactorily with no significant Orbiter problems. Consumables remaining are above the level required to complete the planned 16 + 1 + 2 day mission.

The reaction control system (RCS) orbit adjust 2 maneuver was performed at 117:18:28:59 G.m.t. (10:00:09:59 MET). The duration of the maneuver was 7 seconds with a resultant differential velocity (ΔV) of 1.51 ft/sec. All thrusters fired nominally.

It was reported in the Eighth Daily Report that the auxiliary power unit (APU) 2 system B heater for the gas generator bed, and the system B heater for the gas generator valve module (GGVM), fuel pump and fuel lines did not operate when these heaters were initially reconfigured from system A to system B. Both of these heaters are controlled by the same switch. It is believed that the most probable cause of this failure was a condition referred to as switch tease, in which the switch is positioned so that all of the contacts of the switch are not made. Cycling the switch corrected the problem.

Also in the Eighth Daily Report, it was reported that the vernier driver power and logic power for the forward, left and right reaction control subsystem (RCS) all went off. It has since been learned that the crew indicated that the vernier driver power switch was probably bumped. A momentary loss of contact in this switch, even though the switch was not completely thrown, would explain the loss of vernier driver and logic power. Therefore, it is believed that a switch bump was the most probable cause of this problem.

/s/Don L. McCormack 118:11:53 G.m.t.
Don L. McCormack
STS-90 Lead MER Manager

STS-90

TWELFTH DAILY REPORT

119:12:00 G.m.t.

The STS-90 mission is progressing satisfactorily with no significant Orbiter problems. Consumables remaining are above the level required to complete the planned 16 + 1 + 2 day mission.

/s/Don L. McCormack 119:12:00 G.m.t.
Don L. McCormack
STS-90 Lead MER Manager

STS-90

THIRTEENTH DAILY REPORT

120:12:00 G.m.t.

The STS-90 mission is progressing satisfactorily with no significant Orbiter problems. Consumables remaining are above the level required to complete the planned 16 + 1 + 2 day mission.

A simultaneous supply and waste water dump was initiated at 119:20:54:07 G.m.t. (12:02:35:07 MET) when the supply water dump valve was opened. The waste water dump valve was opened at 119:20:59:51 G.m.t. (12:02:40:51 MET). Both dumps proceeded nominally until 119:21:19:355 G.m.t. (12:03:00:35 MET) when the waste water dump rate decreased from 2.0 percent/minute to 0.5 percent/minute and the waste water dump valve was closed. The dump nozzle temperature was allowed to increase to remove any ice that may have been blocking the nozzle. The dump was restarted at 119:21:29:25 G.m.t. (12:03:10:25 MET), but the dump rate continued to be reduced, and the dump was stopped again at 119:21:49:31 G.m.t. (12:03:30:31 MET). The waste water dump was started a final time at 119:21:53:55 G.m.t. (12:03:34:55 MET) to observe the spray pattern with the closed circuit television (CCTV). Although the crew reported that the spray pattern looked like previous dumps, the dump rate continued to be reduced. The dump was again terminated at 119:21:55:19 G.m.t. (12:03:36:19 MET). An in-flight maintenance (IFM) procedure is being planned to bypass a potentially clogged urine solids filter located in the dump line.

/s/ Don L. McCormack 120:11:40 G.m.t.

Don L. McCormack
STS-90 Lead MER Manager

STS-90

FOURTEENTH DAILY REPORT

121:12:00 G.m.t.

The STS-90 mission is progressing satisfactorily. Consumables remaining are above the level required to complete the planned mission plus contingency days.

An in-flight maintenance (IFM) procedure was performed at 120:15:08 G.m.t. (12:20:49 MET) to bypass a potentially clogged urine solids filter located in the waste water dump line (discussed in the Thirteenth Daily Report). The initial dump rates appeared normal (1.73 percent/minute); however, at 120:15:19 G.m.t. (12:21:00 MET) the dump rate decreased to near zero. The dump was stopped and the dump nozzle bake out was performed. A second cycle was attempted, with no corresponding change in tank quantity. A bakeout of the supply and waste water dump nozzles was initiated to determine if ice was present on either nozzle assembly. No ice was indicated.

In an effort to further confirm the lack of ice on the supply and waste dump nozzles, the Orbiter was placed into a +ZLV, +YVV (bottom-to-Earth local vertical, starboard wing on the velocity vector) water-dump attitude for two orbits. The nozzle temperature profiles in response to environmental heating were then compared to those under similar conditions earlier in the flight and prior to the dump problems. Again no evidence of ice was indicated.

A supply water dump through the supply nozzle was initiated at 121:10:46 G.m.t. (13:16:27 MET). At the time of this report, the dump was proceeding nominally.

/s/ Don L. McCormack 121:11:45 G.m.t.

Don L. McCormack
STS-90 Lead MER Manager

STS-90

FIFTEENTH DAILY REPORT

122:12:00 G.m.t.

The STS-90 mission is progressing satisfactorily. Consumables remaining are above the level required to complete the planned mission plus contingency days.

A supply water dump was initiated at 121:10:46 G.m.t. (13:16:27 MET) and completed 121:12:40 G.m.t. (13:18:21 MET), with a final supply quantity of 282 lb. The dump was nominal with no indication if icing on the nozzle.

As a result of the problems with dumping waste water through the waste line (discussed in the Thirteenth and Fourteenth Daily Reports), no more waste water overboard dumps will occur. An in-flight maintenance (IFM) procedure, which off-loaded the waste tank contents into a contingency water container (CWC), was performed satisfactorily. The waste tank quantity was reduced to 4.8 percent, and this condition will provide sufficient ullage to allow normal waste-tank operations for the nominal end-of-mission + two contingency days.

/s/ Don L. McCormack 122:11:32 G.m.t.

Don L. McCormack
STS-90 Lead MER Manager

STS-90

SIXTEENTH DAILY REPORT

123:12:00 G.m.t.

The STS-90 mission is progressing satisfactorily. Consumables remaining are above the level required to complete the planned mission plus contingency days.

Flight control system (FCS) checkout was performed with no anomalies in the flight control system.

FCS checkout was performed utilizing auxilliary power unit (APU) 3 due to the undercool of water spray boiler (WSB) 3 observed during ascent. APU 3 was started at 122:12:13:12 G.m.t. (14:17:54:12 MET). When no spray cooling was observed while on the WSB 3 controller A, the WSB 3 controller B was selected at 122:12:22:24 G.m.t. (14:18:03:24 MET). The APU 3 lube oil return temperature was 291 °F at the time of switchover from contoller A to B. When no cooling was observed on controller B, APU 3 was shut down at 122:12:23:33 G.m.t. (14:18:04:33 MET).. The lube oil return temperature at the time of APU shutdown was 307 °F. APU 3 ran for 10 min, 21 sec, and consumed 24 lbs of fuel.

As a result of the loss of WSB 3, the start of APU 3 for entry will be delayed until TAEM. WSB 3 controller B will be used for entry and APU 3 will be run post wheel stop until normal shutdown, or the APU 3 lube oil return FDA limit (290 °F) is reached.

At 122:13:22 G.m.t. (14:19:03 MET), the RCS hot fire procedure was initiated. It was completed at 122:13:40 G.m.t. (14:19:21:00 MET). All primary thrusters were pulsed successfully, with no problems noted.

Because of the flash evaporator system (FES) shutdown (discussed in the Fourth Daily Report), a FES primary A controller water dump test was began at 122:15:33 G.m.t. (14:21:14 MET). The test lasted 2 hours 7 minutes. There was no indication of water carryover in the core or icing during the dump. A FES core flush procedure was performed, being completed at 122:18:50 G.m.t. (15:00:31 MET). Again, there was no indication of icing.

During the Ku-Band stow procedure, the crew reported that the hundreds digit on the range rate/azimuth display on panel A2 was not showing the value 1. A lamp test verified that the hundreds digit was not working. There is no mission impact.

Don L. McCormack
STS-90 Lead MER Manager

STS-90

LANDING REPORT

123:17:00 G.m.t.

During the countdown for the STS-90 scheduled launch on April 16, 1998, network signal processor (NSP) 2 failed to acquire frame synchronization during the switch from NSP 1 to NSP 2 (Flight Problem STS-90-V-01). Downlink communications were not affected by the problem. The system was cycled from NSP 1 to NSP 2 nine times using several different modes. Each time, NSP 1 operated satisfactorily, but NSP 2 did not. No uplink communications could be established on NSP 2. As a result, the launch was delayed 24 hours, and NSP 2 was replaced and the checkout was completed satisfactorily.

The STS-90 mission was launched at 107:18:18:59.988 G.m.t. (2:19: p.m. e.d.t.). The first and second stage ascent phases were satisfactory and a nominal orbit of 147.2 by 41.3 nautical miles was achieved. All Orbiter subsystems performed nominally except water spray boiler (WSB) 3, which experienced an under-cooling condition that is discussed in a following paragraph.

During the second stage of ascent, an orbital maneuvering subsystem (OMS) assist-maneuver was performed for the first time during the Space Shuttle Program. Ignition for the OMS-assist-maneuver was 107:18:21:15 G.m.t. [00:00:02:15 Mission Elapsed Time (MET)], the maneuver was 102.4 seconds in duration, and the OMS engines performed satisfactorily.

Water spray boiler (WSB) 3 experienced an under-cooling condition during ascent. The lubrication oil return temperature reached 334 °F, and the specification value for this temperature is no-greater-than 275 °F (Flight Problem STS-90-V-06). The WSB 3 controller was switched from A to B at 107:18:30:46 G.m.t. (00:00:11:46 MET) when the auxiliary power unit (APU) 3 lubrication oil return temperature was approximately 300 °F. No spray cooling was observed at that time. APU 3 was shut down about 2 minutes early at 107:18:32:12 G.m.t. (00:00:13:12 MET). Data review indicates no spraying was achieved during the operation of either WSB 3 controller.

The External Tank (ET)-liquid hydrogen (LH_2) 98-percent liquid-level sensor no. 2 failed wet at 107:18:20:06 G.m.t (00:00:01:06 MET). This sensor is only used during loading. There was no impact to the mission.

The LH_2 Space Shuttle main engine (SSME) 1 inlet pressure shifted upward approximately 3 psia at about 107:18:22:30 G.m.t. (00:00:03:30 MET) (Flight Problem STS-90-V-02). A similar signature was observed on previous flights of this and other Orbiter vehicles. There was no impact to the flight.

Data review also showed that the ET liquid oxygen (LO_2) 100-percent liquid-level sensor no. 2 flashed about a dozen times between wet and dry over a 15-second period beginning at approximately 107:18:23:56 G.m.t. (00:00:04:56 MET). The sensor read dry as expected at all other times during ascent. This sensor is only used during loading. There was no impact to the mission.

The OMS 2 maneuver was performed at 107:19:00:27.2 G.m.t. (00:00:41:34.2 MET). The maneuver was 110.3 seconds in duration and the differential velocity (ΔV) was 171.1 ft/sec. The resultant orbit was 154 by 138 nmi.

The starboard payload bay door was opened at 107:19:54:46 G.m.t. (00:01:35:46 MET), and the port payload bay door was opened at 107:19:56:07 G.m.t. (00:01:37:07 MET). The door operation was satisfactory in all respects with dual-motor times recorded.

The left-hand nose landing gear pressure sensor 2 exhibited erratic behavior prior to launch and throughout ascent. Prior to launch, the sensor was reading low compared to sensor 1. During ascent, the sensor 2 output alternately recovered and dropped out several times. The sensor output was increasingly erratic during the first two days of the mission and failed off-scale-low (231 psia) at 109:20:47 G.m.t. (02:02:28 MET). This problem was first found during the flow, and was accepted based on the presence of the redundant measurement and the successful wheel/tire leak checks performed previously.

During the first sleep period, the reaction control subsystem (RCS) thruster F5L injector temperature approached the 130 °F redundancy management (RM) limit because of the limited number of thruster firings. Thruster R5R was deselected in an effort to cause thruster F5L to fire more frequently. Also, during the second sleep period, the -Z pitch attitude was changed to have a 5-degree pitch bias. As a result of the attitude change and deselection of thruster R5R, thruster F5L fired more often and this maintained the injector temperatures well above the minimum RM limit. Thruster R5R was deselected for the majority of the mission to force firings of F5L.

The fuel cell performance monitor (FCMS) was activated and on-orbit fuel cell individual-cell-voltage data were recorded for 12 minutes, from 109:19:13:54 G.m.t. (02:00:54:54 MET) to 109:19:25:54 G.m.t. (02:01:06:54 MET). A review of the data showed that all of the cell voltages were nominal.

The flash evaporator system (FES) shut down while operating on the primary A controller at approximately 111:02:06 G.m.t. (03:07:47 MET) (Flight Problem STS-90-V-04). The crew restarted the FES primary A controller 5 minutes after the shutdown occurred. The restart was successful, and the FES went into standby at 111:02:35 G.m.t. (03:08:16 MET); however, the FES failed to come out of the standby mode. At 111:03:13 G.m.t. (03:08:54 MET), the crew switched from the primary A to the primary B controller. The FES gained control for 10 minutes on the primary B controller and then shut down. The FES core flush procedure was implemented. After the flush procedure was completed, the FES primary B controller was successfully restarted. The FES topping duct heaters were placed on heater string A/B for the duration of the crew sleep period. Following the sleep period, the topping duct heaters were reconfigured from A/B to A as planned. It is believed that the most probable cause of the shut-down was a rapid FES heat-load transient that occurred while in the -ZLV +YVV (top-to-Earth local vertical, starboard wing on the velocity vector) water-dump attitude. This transient resulted in the formation of ice in the FES topper core and this eventually lead to the shut-down. Note that the FES is certified to handle a transient of the magnitude seen. The Orbiter water-dump attitudes were changed from -ZLV +YVV to +ZLV +YVV (bottom to Earth local vertical, starboard wing on the velocity vector) to preclude the thermal condition that was believed to cause the FES shut down.

The RCS orbit adjust 1 maneuver was performed at 112:20:14:00 G.m.t. (05:01:55:00 MET). The duration of the maneuver was 15 seconds with a resultant ΔV of 3.34 ft/sec. All thrusters fired nominally.

At 114:02:08 G.m.t. (006:07:49 MET), the Ku-band radio frequency (RF) power output measurement became erratic for approximately six minutes. The downlink signal-strength was unaffected, indicating that the erratic behavior was in the telemetry signal only. This condition was a repeat of a problem seen during STS-87 that could not be duplicated during ground testing.

At 115:03:49:46 G.m.t. (07:09:30:46 MET), the regenerative carbon dioxide removal system (RCRS) shut down while on controller 2. The crew reconfigured the RCRS to controller 1, but it too shut down (Flight Problem STS-90-V-03). The crew was told to use lithium hydroxide (LiOH) canisters for carbon dioxide removal during their sleep period. A fault tree was developed to investigate the cause of the shutdown and an in-flight maintenance (IFM) procedure was prepared to recover usage of the RCRS. The IFM procedure was performed and the RCRS was recovered. The IFM isolated a check valve which was leaking cabin air into the RCRS. The isolation was regained by disconnecting the outlet hose from the check valve and covering the fitting with aluminum tape. In addition, power was removed from the compressor since it is in the flow path blocked by the IFM procedure. Following the IFM, the RCRS was activated at 115:20:43 G.m.t. (08:02:24 MET) using controller 1 and it operated satisfactorily for the remainder of the mission.

At 114:18:07 G.m.t. (06:23:48 MET), the vernier driver power and logic power for the forward, left and right RCS went off. This resulted in two vernier thrusters failing off when they were subsequently commanded to fire. The vernier driver and logic switches were cycled and operation of all vernier thrusters was recovered. When operating on the vernier thrusters during the on-orbit phase of the mission, the logic power switches are positioned to off and depend on the logic latch to keep the logic power and vernier power on. Discussions with the crew indicated that the vernier driver power switch was probably bumped by one of the crewmembers. This bumping caused a momentary loss of power that resulted in the loss of driver power to all RCS thrusters. A momentary loss of contact in this switch, even though the switch was not completely thrown, would explain the loss of vernier driver and logic power. Therefore, it is believed that a switch bump was the most probable cause of this problem.

The APU 2 system B heater for the gas generator bed, and the system B heater for the gas generator valve module (GGVM), fuel pump and fuel lines did not operate when these heaters were initially reconfigured from system A to system B at 114:18:53 G.m.t. (07:34:00 MET). Both of these heaters are controlled by the same switch. At approximately 114:19:51 G.m.t. (07:01:32 MET), the crew cycled the GGVM/fuel pump system B heater switch to off and then back to auto. Proper heater response followed, and the heater cycled normally for the remainder of the mission. It is believed that the most probable cause of this failure was a condition referred to as switch tease, in which the switch is positioned so that all of the contacts of the switch are not made. Cycling the switch corrected the problem.

The crew reported that a camcorder failed to power up while connected to a video interface unit (VIU) by a camcorder video/power cable. The camcorder was then powered by a battery with the video interface performing nominal. The crew reported that they had isolated the failure to the VIU. The failed VIU was identified and stowed.

The RCS orbit adjust 2 maneuver was performed at 117:18:28:59 G.m.t. (10:00:09:59 MET). The duration of the maneuver was 7 seconds with a resultant ΔV of 1.51 ft/sec. All thrusters fired nominally.

A simultaneous supply and waste water dump was initiated at 119:20:54:07 G.m.t. (12:02:35:07 MET) when the supply water dump valve was opened. The waste water dump valve was opened at 119:20:59:51 G.m.t. (12:02:40:51 MET). Both dumps proceeded nominally until 119:21:19:355 G.m.t. (12:03:00:35 MET) when the waste water dump rate decreased from 2.0 percent/minute to 0.3 percent/minute and the waste water dump valve was closed (Flight Problem STS-90-V-05). The dump nozzle temperature was allowed to increase to remove any ice that may have been blocking the nozzle. The dump was restarted at 119:21:29:25 G.m.t. (12:03:10:25 MET), but the dump rate continued to be reduced, and the dump was stopped again at 119:21:49:31 G.m.t. (12:03:30:31 MET). The waste water dump was started a final time at 119:21:53:55 G.m.t. (12:03:34:55 MET) to observe the spray pattern with the closed circuit television (CCTV). The crew reported that the spray pattern looked like previous dumps with both nozzles flowing; however, the dump rate reduced greatly when the supply water dump was stopped during the observation period. The dump was again terminated at 119:21:55:19 G.m.t. (12:03:36:19 MET).

An in-flight maintenance (IFM) procedure was performed at 120:15:08 G.m.t. (12:20:49 MET) to bypass a potentially clogged urine solids filter located in the waste water dump line. The initial dump rates appeared normal (1.73 percent/minute); however, at 120:15:19 G.m.t. (12:21:00 MET) the dump rate decreased to near zero. The dump was stopped and the dump nozzle bake out was performed. A second cycle was attempted, with no corresponding change in tank quantity. A bake-out of the supply and waste water dump nozzles was initiated to determine if ice was present on either nozzle assembly. No ice was indicated.

In an effort to further confirm the lack of ice on the supply and waste dump nozzles, the Orbiter was placed into a +ZLV, +YVV (bottom-to-Earth local vertical, starboard wing on the velocity vector) water-dump attitude for two orbits. The nozzle temperature profiles in response to environmental heating were then compared to those under similar conditions earlier in the flight and prior to the dump problems. Again no evidence of ice was indicated.

A supply water dump was initiated at 121:10:46 G.m.t. (13:16:27 MET) and completed 121:12:40 G.m.t. (13:18:21 MET), with a final supply quantity of 282 lb. The dump was nominal with no indication if icing on the nozzle.

As a result of the problems with dumping waste water through the waste line, a decision was made that no more waste water overboard dumps would occur. An in-flight maintenance (IFM) procedure, which off-loaded the waste tank contents into a contingency water container (CWC), was performed satisfactorily. The waste tank quantity was reduced to approximately 5 percent, and this condition provided sufficient ullage to allow normal waste-tank operations for the nominal end-of-mission plus two contingency days.

Flight control system (FCS) checkout was performed with no anomalies in the flight control system. APU 3 was used because of the under-cooling of WSB 3 observed during ascent. APU 3 was started at 122:12:13:12 G.m.t. (14:17:54:12 MET). When no spray cooling was observed while on the WSB 3 controller A, the WSB 3 controller B was selected at 122:12:22:24 G.m.t. (14:18:03:24 MET). The APU 3 lubrication oil return temperature was 291 °F at the time of switch-over from controller A to B. When

no cooling was observed on controller B, APU 3 was shut down at 122:12:23:33 G.m.t. (14:18:04:33 MET). The lubrication oil return temperature at the time of APU shutdown was 307 °F. APU 3 ran for 10 minutes and 21 seconds, and consumed 24 lb of fuel.

As a result of the loss of WSB 3, the start of APU 3 for entry was delayed until terminal area energy management (TAEM) was reached. WSB 3 controller B was used for entry and APU 3 was run until the APU 3 lubrication oil return fault detection and annunciation limit of 290 °F was reached.

At 122:13:22 G.m.t. (14:19:03 MET), the RCS hot fire procedure was initiated. It was completed at 122:13:40 G.m.t. (14:19:21:00 MET). All primary thrusters were pulsed successfully, with no problems noted.

Because of the FES shut down, a FES primary A controller water dump test was began at 122:15:33 G.m.t. (14:21:14 MET). The test lasted 2 hours 7 minutes. There was no indication of water carryover in the core or core icing during the dump. However, a FES core flush procedure was performed, being completed at 122:18:50 G.m.t. (15:00:31 MET), and there was no indication of icing during the core flushing procedure.

During the Ku-Band stow procedure, the crew reported that the hundreds digit on the range rate/azimuth display on panel A2 was not showing the value 1. A lamp test verified that the hundreds digit was not working. There was no mission impact.

The payload bay doors were closed and latched for landing at 123:12:35:35 G.m.t. (15:18:16:35 MET). The dual-engine deorbit maneuver for the first landing opportunity at the Shuttle Landing Facility (SLF) was performed on orbit 255 at 123:15:10:09 G.m.t. (15:20:51:09 MET). The maneuver was 139 seconds in duration with a ΔV of 213 ft/sec.

Entry was completed satisfactorily, and main landing gear touchdown occurred on KSC concrete runway 33 at 123:16:08:58 G.m.t. (15:21:49:58 MET) on May 3, 1998. The Orbiter drag chute was deployed at 123:16:09:06.2 G.m.t. and the nose gear touchdown occurred 4 seconds later. The drag chute was jettisoned at 123:16:09:39 G.m.t. with wheels stop occurring at 123:16:09:57 G.m.t. The rollout was normal in all respects. The flight duration was 15 days 21 hours 49 minutes 58 second.

The APU 1 exhaust gas temperature (EGT) sensor 2 and APU 3 EGT sensor 2 operated erratically during entry. This condition did not affect the entry operations. APU 3 was shut down 2 minutes 28 seconds after landing. The remaining two APUs were shut down by 16 minutes 58 seconds after landing.

The crew reported that the right ET door uplock latch release talkback indicated barberpole after telemetry indicated that the latches were open. The door opened nominally.

/s/Don L. McCormack 123:17:07 G.m.t.
Don L. McCormack
STS-90 Lead MER Manager