STS-87

Launch Report

323:21:45 G.m.t.

The launch of the STS-87 vehicle occurred at 323:19:45:59.993 G.m.t. (2:46 p.m. e.s.t. on November 19, 1997) following a countdown with no significant problems and no unexpected holds.

During the prelaunch cabin leak checks, a seal at the port used to pressurize the cabin came off. The seal was replaced and the cabin leak check was completed satisfactorily. The problem delayed the cabin leak check, thus initiating a concern over residual oxygen (O_2) concentration in the aft compartment. However, the aft compartment O_2 readings did drop below the 500-ppm level just prior to the end of the planned hold period, and the countdown was resumed at the planned time.

During ascent, the auxiliary power unit (APU) 3 lubrication oil return temperature reached approximately 304 °F before the crew switched from the water spray boiler (WSB) 3 B controller to the A controller. No spraying was evident after switching to the A controller. As a result, the crew was instructed to shut down APU 3 approximately 1 minute early. Evidence of spraying was observed after APU 3 shut down and prior to shutting off the WSB 3 A controller. In addition, WSB 2, which initially controlled the APU 2 lubrication oil temperature at 246 °F, experienced an over-cooling down to a temperature of 203 °F approximately 1.5 minutes after spray initiation. The system recovered to 246 °F approximately 2.5 minutes later.

The orbital maneuvering subsystem (OMS) 1 maneuver was not required because of the satisfactory direct ascent trajectory that was flown. The OMS 2 maneuver was performed at 323:20:27:08.9 G.m.t. [(00:41:08.9 Mission Elapsed Time (MET)] . The maneuver was 127.5 seconds in duration, and a differential velocity (ΔV) of 193.8 ft/sec was imparted to the vehicle.

The payload bay door opening sequence was completed at 323:21:17:02 G.m.t. (00:01:31:02 MET). Nominal dual motor times were recorded for the door opening operations.

Don L. McCormack 323:22:00 G.m.t.

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for C. Stokes McMillan
STS-87 Lead MER Manager

STS-87

FIRST DAILY REPORT

324:13:00 G.m.t.

The STS-87 mission is progressing satisfactorily with no significant Orbiter problems.

Recent medical findings, which link iodine consumption to thyroid problems, resulted in the development of a method for removing iodine from the drinking water being stowed for the this flight. The crew installed the Iodine Removal Mineral Injection System (IRMIS) cartridges to remove iodine (I2) and iodide (I-) from the drinking water. The crew reported that the system was less cumbersome to install in zero-g. The IRMIS cartridges are the same cartridges used to remove iodine and iodide from the water being transferred to the Mir.

The Remote Manipulator System (RMS) was powered up at 324:00:50 G.m.t. (00:05:04 MET). The on-orbit checkout commenced at 324:02:05 G.m.t. (00:06:19 MET), and was completed at 324:04:46 G.m.t. (00:09:00 MET). Initial indications are that all operations were nominal.

At approximately 324:02:25:26 G.m.t. (00:06:39:26 MET), supply-water tank A reached full quantity, the water-inlet pressure reached 39.58 psia, and the tank A/B check/relief valve cracked open. The supply-water storage inlet-pressure increased from 33.21 psia to 39.58 psia over a 5-minute period before the relief valve opened. The pressure rise to crack the check valve was approximately 6 psia, whereas past flights have shown a range between 0.4 and 0.8 psia for the crack pressure. The specification value for relief valve cracking is between 0.8 psid and 2.5 psid. The valve reseats at 0.8 psid. The check/relief valve will stay open until the level in tank A drops below full.

At 324:03:16:50 G.m.t. (00:07:30:50 MET), a reaction control subsystem (RCS) +X trim maneuver of 18.6 seconds duration provided 4.5 ft/sec differential velocity (ΔV) to the vehicle.

At 324:06:16 G.m.t (00:10:30 MET), the crew repressed the right orbital maneuvering subsystem (OMS) engine GN_2 accumulator because there was evidence of a recurring small GN_2 leak. This action was taken to preclude setting off the low-pressure alarm during the crew sleep period.

/s/ C. Stokes McMillan
C. Stokes McMillan
STS-87 Lead MER Manager

STS-87

SECOND DAILY REPORT

325:13:00 G.m.t.

The STS-87 mission is progressing satisfactorily with no significant Orbiter problems. The consumables remaining will meet all requirements of the planned mission plus contingency days.

The right orbital maneuvering subsystem (OMS) oxidizer low point drain line temperature exhibited unusual behavior during the prelaunch period. A rapid temperature rise of 3.1 deg/min for a 3.5-minute period was followed by about 6 hours of operations at a relatively constant temperature. The temperature signature returned to normal cycling prior to launch, and has exhibited nominal operation since that time. Work was performed on this line during the STS-87 flow due to an oxidizer leak. As a result, two of the thermostats on the drain line were replaced with new thermostats, and the test results from the new hardware were satisfactory.

Following the OMS-2 maneuver vacuum inerting and helium repressurization of the main propulsion system (MPS), the LH_2 manifold pressure continued to rise indicating residual hydrogen still had not been expelled during the second vacuum inert. Consequently, a decision was made to perform another vacuum inert. This operation was performed at 324:21:02 G.m.t. (01:06:16 MET), and the manifold pressure was successfully brought down to zero psia.

In an attempt to warm reaction control subsystem (RCS) vernier thruster F5L and prevent it from reaching its operational limit of 130 °F, the aft yaw thrusters were deselected. However, the thruster temperature kept decreasing. As a result, the attitude was biased to force thruster F5L to fire more frequently, and this has proved adequate in maintaining the thruster temperature well above its lower limit.

The Ku-band radio frequency (RF) power output telemetry measurement had erratic indications from 324:14:51 G.m.t. (00:19:05 MET) to 324:15:38 G.m.t (00:19:52 MET), and from 324:16:50 G.m.t. (00:21:04 MET) to 324:17:13 G.m.t. (00:21:27 MET). However, during these time periods, the White Sands Ground Station reported a good Ku-band downlink signal. This measurement should be relatively stable at about 4.5 Vdc; however, during the cited times the uncalibrated signal varied from 0 to 4.3 Vdc.

At 325:05:49 G.m.t (01:10:03 MET), the crew repressed the right OMS engine GN_2 accumulator for the second time this flight. The accumulator pressure was 318 psia prior to the repressurization and was experiencing a 30 scch leak rate. This leak rate is similar to previous flights of this engine.

The first samples of on-orbit fuel cell monitoring system (FCMS) data were gathered between 325:03:40:46 G.m.t. (01:07:54:46 MET) and 325:03:52:46 G.m.t. (001:08:06:46 MET) with a sampling rate of one sample per second. Data review indicated that some fluctuations in the data were the result of changes in the load which resulted in the voltages of one half of a substack being measured at a different load than the other half of the same substack. The second batch of on-orbit data from the FCMS began being

recorded at 325:04:01:49 G.m.t. (01:08:15:49 MET). The recording was continued for 10 hours at a rate of one sample every five minutes.

/s/ C. Stokes McMillan 325:12:44
C. Stokes McMillan
STS-87 Lead MER Manager

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THIRD DAILY REPORT

326:13:00 G.m.t.

The STS-87 mission is progressing satisfactorily with no significant Orbiter problems. The consumables remaining will meet all requirements of the planned mission plus contingency days

The second sample of on-orbit Fuel Cell Monitoring System (FCMS) data was successfully recorded during the crew-sleep period. This 10-hour sample was taken at the rate of 1 sample every 5 minutes. A preliminary review of the FCMS data indicates that the system operated nominally.

The remote manipulator system (RMS) arm was powered up and uncradled at 325:19:19 G.m.t. (01:23:33 MET). The arm was then maneuvered to the SPARTAN pre-grapple position at 325:19:29 G.m.t. (01:23:43 MET), and SPARTAN capture occurred at 325:19:32 G.m.t. (01:23:46 MET). The payload was unberthed and maneuvered to the Video Guidance System (VGS) acquire verification position at 325:20:18 G.m.t. (02:00:32 MET), and was then moved to the SPARTAN release position at 325:20:25 G.m.t. (02:00:39 MET). The derigidize/rigidize command sequence to initialize the SPARTAN was issued at 325:21:04 G.m.t. (02:01:18 MET), and the end effector immediately derigidized and released the SPARTAN. When SPARTAN failed to perform its pirouette attitude maneuver, an attempt to re-grapple the SPARTAN was made at 325:21:10 G.m.t. (02:01:24 MET). The re-grapple maneuver was not successful and a tip-off rate of approximately 2 deg/sec was imparted to the SPARTAN. Telemetry indicated that the end effector operation was nominal during the re-grapple attempt and that the end-effector capture flag did not come on. The subsequent attempt by the Orbiter to reduce the relative rates to allow re-capture had to be terminated because of propellant limitations. The arm was returned to the precradle position at 325:22:28 G.m.t. (02:02:42 MET), cradled and powered down four minutes later.

After the SPARTAN operations problem, the RMS was selected at 326:01:42:31 G.m.t. (02:05:56:31 MET) to perform a test of the end effector. The end effector checkout was completed successfully. A visual inspection with camera B confirmed that the snare wires operated properly and were not damaged. The RMS was deselected at 326:01:58:35 G.m.t. (02:06:12:35 MET). The RMS manipulator arm is presently cradled in the manipulator positioning mechanisms (MPMs), and the arm is in the temperature-monitoring mode.

Primary reaction control subsystem (RCS) thruster attitude control for the SPARTAN deployment was initiated at 325:21:04 G.m.t. (02:01:18 MET). During the attempt to re-grapple the Spartan, the aft RCS was interconnected to the left orbital maneuvering subsystem (OMS) at 325:22:11:30 G.m.t. (02:02:25:30 MET). Following the firings, the heat soak-back caused the fuel injector temperature of thruster L1A to reach 166.5 °F, which is above the 157 °F firing limit. The thruster was not operated during the soak-back period. The Shuttle Operational Data Book (SODB) non-operating primary thruster control valve allowable upper limit of 175 °F was not exceeded.

At 325:23:10:30 G.m.t. (02:03:25:30 MET), a multi-axis RCS posigrade maneuver was performed to move the Orbiter a safe distance from the SPARTAN.

/s/ C. Stokes McMillan 326:12:59 G.m.t.
C. Stokes McMillan
STS-87 Lead MER Manager

STS-87

FOURTH DAILY REPORT

327:13:00 G.m.t.

The STS-87 mission is progressing satisfactorily with no significant Orbiter problems. The consumables remaining will meet all requirements of the planned mission plus contingency days.

The initial evaluation of the second set of fuel cell monitoring system (FCMS) data indicates 288 healthy individual cells and shows no indications of the high-resistance pins noted on the ground prior to fuel cell startup. The data are satisfactory for performing the primary function of providing individual cell voltages over time.

The extravehicular mobility unit (EMU) checkout was completed satisfactorily. Both units are ready to support the EVA on Monday.

The starboard forward radiators were deployed at 327:05:40 G.m.t. (03:09:54 MET).

The crew reported that one of the Hasselblad cameras stopped in the midst of taking pictures. The crew noticed that the battery was dead, took the film magazine off, changed the batteries, verified that the camera was functioning and installed a new film magazine. Two photographs were taken and then the camera stopped with the lens shutter half-closed. The crew performed some in-flight maintenance (IFM) procedures, but camera operation was not restored. Additional troubleshooting steps will be performed later in the mission.

/s/C. Stokes McMillan 327:12:39 G.m.t.
C. Stokes McMillan
STS-87 Lead MER Manager

STS-87

FIFTH DAILY REPORT

328:13:00 G.m.t.

The STS-87 mission is progressing satisfactorily. The consumables remaining exceed all requirements of the planned mission plus contingency days.

The crew reported that the extravehicular mobility unit (EMU) helmet floodlight to be used by the EV2 crewmember was flickering during the EMU checkout. This is a known anomaly that is caused by short connector pins on the bulb not being completely mated. A flight note was sent to the crew for this condition that called for removal of the bulb and then remating the bulb and locking it in place. The procedure was performed, but the light continued to flicker. The EV2 crewmember will use a spot light during the EVA to replace the failed floodlight.

At approximately 327:08:00 G.m.t. (03:12:14 MET), it was determined that the primary reaction control subsystem (RCS) thruster R2D heater had failed off. RCS injector temperatures are desired to be maintained above 40 °F to prevent leakage from the thruster valves. As of 328:00:00 G.m.t. (04:04:14 MET), the R2D temperature had dropped into the 45 to 50 °F range and was being maintained in that range by the external environment and the RCS stinger heater. The redundancy management (RM) will deselect the thruster as failed leak if the oxidizer injector temperature drops below 30 °F or the fuel injector temperature drops below 20 °F.

The NC-4 multi-axis rendezvous maneuver was completed at 328:08:33:17 G.m.t. (04:12:47:17 MET), imparting a 1.4 ft/sec differential velocity (ΔV) to the vehicle. During this maneuver, the RCS R2D primary thruster was fired, resulting in warming it to above 80° F.

The freon coolant loop (FCL) 1 was switched to interchanger flow at 328:04:29 G.m.t. (04:08:43 MET) in preparation for the cabin depressurization to 10.2 psi. In addition, the regenerative carbon dioxide removal system (RCRS) was powered down at 328:04:55 G.m.t. (04:09:09 MET). The cabin depressurization was started at 328:04:59 G.m.t. (04:09:13 MET) and completed 22 minutes later. The RCRS was then reactivated at 328:05:33 G.m.t. (04:09:47 MET).

/s/C. Stokes McMillan 328:12:21 G.m.t.
C. Stokes McMillan
STS-87 Lead MER Manager

STS-87

SIXTH DAILY REPORT

329:13:00 G.m.t.

The STS-87 mission is progressing satisfactorily. The consumables remaining exceed all requirements of the planned mission plus contingency days.

The orbital maneuvering subsystem (OMS) was used to perform two SPARTAN rendezvous maneuvers. Both maneuvers were single engine, straight-feed firings. The first maneuver, NC5, used the right orbital maneuvering engine (OME) and was initiated at 328:21:19:33 G.m.t. (05:01:33:33 MET). The maneuver was 14.6 seconds in duration and imparted a differential velocity (ΔV) of 11.5 ft/sec to the vehicle. The second maneuver (TI) used the left OME and was initiated at 328:22:50:38 G.m.t. (05:03:04:38 MET). The maneuver was 11.5 seconds in duration and imparted a ΔV of 8.9 ft/sec to the vehicle. System performance was nominal during both firings.

Numerous reaction control subsystem (RCS) firings were performed in the course of the rendezvous with the SPARTAN. There were three +X firings (MC1 at 1.2 ft/sec, MC2 at 1.0 ft/sec, and MC3 at 1.3 ft/sec) and one multi-axis firing (MC4 at 0.6 ft/sec). Prior to the planned firings, a warm-up firing of the RCS R2D thruster was performed. Following the MC4 firing, the L1A thruster temperatures were approaching the operational limit of 160 °F, and the L1A thruster as well as the R1A thruster were set to last priority.

At 328:22:20 G.m.t. (05:02:34 MET), the Ku-Band system was placed in the radar mode. The Spartan spacecraft was acquired at 328:23:14 G.m.t. (05:03:28 MET) at an approximate range of greater than 40,000 feet. The radar tracked SPARTAN until 329:00:53 G.m.t. (05:05:07 MET) when the range was approximately 85 feet.

The remote manipulator system (RMS) arm was powered up at 328:22:52 G.m.t. (05:03:06 MET). The three manipulator retention latches (MRL's) were released nominally in dual motor time at 328:22:56:39 G.m.t. (05:03:10:39 MET). In preparation for the SPARTAN rendezvous, the RMS was maneuvered to the modified Poise for Capture position at 328:23:07 (05:03:21 MET).

The regenerative carbon dioxide removal system (RCRS) was deactivated at 328:23:33 G.m.t. (05:03:47 MET), followed by airlock depressurization starting at 328:23:40 G.m.t. (05:03:54 MET). The depressurization was temporarily stopped at 328:23:42 G.m.t. (05:03:56 MET) for the 5.5-psia hold. Airlock depressurization was completed satisfactorily. The cabin repressurization to 14.7 psia was initiated at 329:00:02 G.m.t. (05:04:16 MET) and was completed at 329:00:15 G.m.t. (05:04:29 MET). The Airlock B hatch was opened nominally for the extravehicular activity (EVA) egress at 329:00:02 G.m.t. (05:04:16 MET).

The EVA started when the crew members placed their power switches to battery at 329:00:01 G.m.t. (05:04:15 MET). The RMS was moved to an observation position for the manual SPARTAN retrieval at 329:01:04:00 G.m.t (05:05:18:00 MET). At 329:02:32:58 G.m.t. (05:06:46:58 MET) the arm was maneuvered to grapple SPARTAN. The grapple was completed at 329:02:39:04 G.m.t. (05:06:53:04 MET). SPARTAN was

berthed with the RMS at 329:03:23:22 G.m.t. (05:07:37:22 MET) and un-grappled at 329:03:26:36 G.m.t. (05:07:40:36 MET).

The RMS was maneuvered to support the EVA hardware development test objective (DTO) 671 at 329:03:28:24 G.m.t. (05:07:42:24 MET). The arm was used for viewing-support and to maneuver an EVA crewman with the portable foot restraint (PFR). EVA support was completed at 329:07:21:00 G.m.t. (05:11:35:00 MET).

Astronauts Winston Scott and Takao Doi completed the EVA in 7 hours and 43 minutes. The EVA was successful in the capture and stowage of SPARTAN and the evaluation of equipment to be used on the Space Station. The crew entered the airlock at 329:07:35 G.m.t. (05:11:49 MET) and the airlock B hatch was closed and locked nominally. Airlock repressurization began at 329:07:45 G.m.t. (05:11:59 MET) and was completed at 329:07:58 G.m.t (05:12:12 MET).

The arm was positioned to pre-cradle position at 329:07:35:00 G.m.t. (05:11:49:00 MET) and latched in the manipulator positioning mechanisms (MPMs) at 329:07:45:00 (05:11:59:00 MET). At 329:07:56:00 G.m.t. (05:12:10:00 MET), the MPM's were stowed and the arm was deselected.

The quantities in oxygen (O_2) tanks 4 and 5 began diverging at 327:02:00 G.m.t. (03:16:14 MET), with the tank 5 quantity dropping below tank 4. This was most likely caused by the tank 4 check valve sticking closed momentarily. All tank heater cycles were nominal before and after this one lower cycle. The tank quantities are expected to converge as the mission progresses. There is no concern and no action is required.

Hydrogen (H_2) tank 4 quantity gauge failed off-scale high at 329:03:47 G.m.t. (05:08:01 MET). Evaluation of data are continuing to determine the cause of the failure and its impact on the flight.

/s/ C. Stokes McMillan 329:13:05 G.m.t.
C. Stokes McMillan
STS-87 Lead MER Manager

STS-87

SEVENTH DAILY REPORT

330:13:00 G.m.t.

The STS-87 mission is progressing satisfactorily.

An analysis is being conducted of several possible vehicle-attitude options for the upcoming 72-hour Advanced Automated Directional Solidification Furnace (AADSF) run. The attitudes are designed to be acceptable for AADSF crystal growth while protecting reaction control subsystem (RCS) thruster R2D with its failed heater, as well as honoring all other Orbiter thermal constraints.

/s/C. Stokes McMillan 330:12:21 G.m.t.
C. Stokes McMillan
STS-87 Lead MER Manager

STS-87

EIGHTH DAILY REPORT

331:14:00 G.m.t.

The STS-87 mission is progressing satisfactorily.

Five attitude options were assessed for the 72-hour long Advanced Automated Directional Solidification Furnace (AADSF) run. The options are summarized in the following table.

Attitude Options for the 72-hour AADSF Period

ATTITUDE OPTIONS	POTENTIAL ISSUE	
1) Baseline: bay down, nose forward -ZLV, +XVV	R2D cold thruster	
2) Bottom down, nose forward: +ZLV, +XVV	APU 1 service line exceeding 170°F	
3) Bay down, tail forward: -ZLV, -XVV with +10° pitch bias	Cold forward RCS vernier thrusters	**SELECTED OPTION**
4) Bay down, tail forward: -ZLV, -XVV with -10° pitch bias	Payload science	
5) Bay down, port wing forward: -ZLV, -YVV	Payload science	

At 331:00:49:45 G.m.t. (07:05:03:45 MET) an orbit adjust maneuver was executed to reach the AADSF orbital parameters. The maneuver was performed in the +X axis for approximately 29 seconds with a differential velocity (ΔV) of 6.7 ft/sec. Reaction control subsystem (RCS) thrusters L1A and R1A were used for the maneuver.

The Hasselblad camera lens that was jammed with the camera body, discussed in the Fourth Daily Report, was removed. However, efforts to restore camera operation were unsuccessful. The second Hasselblad camera remains operational.

At 330:19:35 G.m.t. (06:23:49 MET), the left outboard tire pressure 2 measurement failed to the off-scale low value. The loss of this measurement will not impact the mission.

/s/ C. Stokes McMillan 331:13:52 G.m.t.
C. Stokes McMillan
STS-87 Lead MER Manager

STS-87

NINTH DAILY REPORT

332:13:00 G.m.t.

The STS-87 mission is progressing satisfactorily.

The hydrogen (H_2) tank 4 quantity gauging system measurement, which had failed off-scale high at 329:03:26 G.m.t. (05:07:40 MET), began working again at 331:10:29 G.m.t. (07:14:43 MET) as H_2 tanks 4 and 5 neared depletion. Usage continued on these tanks until depletion at quantities of 2.0 percent and 2.4 percent, respectively.

The auxiliary power unit (APU) 2 drain-line pressure is currently at 5.8 psia, which is down from approximately 17 psia 36 hours ago, but the condition poses no problem at this time. The decrease started at 331:01:05 G.m.t. (07:05:19 MET), and this condition will likely result in a failure of the drain-line-pressure File IX requirement.

The passive reaction control subsystem (RCS) hot-fire is continuing. The eight thrusters remaining to be fired are F1F, F1U, F3L, F3U, L1L, R1R, R2R, and R3R.

/s/Dennis Dillman for
C. Stokes McMillan
STS-87 Lead MER Manager

STS-87

TENTH DAILY REPORT

333:13:30 G.m.t.

The STS-87 mission is progressing satisfactorily.

The Shuttle Engineering Simulator (SES) is being used to determine if the plume from a reaction control subsystem (RCS) primary thruster could have impinged on the SPARTAN during the Orbiter separation maneuver. It is currently believed that the SPARTAN entered the Minimum Reserve Shutdown (safe hold) mode shortly after the deployment, and the cause of this mode change is being investigated. This mode change could occur if the SPARTAN body rotational rates exceeded 3.7 deg/sec for five minutes. The estimated remote manipulator system (RMS) tip-off rate was less than 2 deg/sec.

/s/ C. Stokes McMillan 333:13:35 G.m.t.
C. Stokes McMillan
STS-87 Lead MER Manager

STS-87

ELEVENTH DAILY REPORT

334:13:00 G.m.t.

The STS-87 mission is progressing satisfactorily

Shuttle Engineering Simulator (SES) runs were made in an attempt to simulate the effect of Orbiter separation firings on the SPARTAN body rates. In the initial runs, the SPARTAN was positioned at the tip of the remote manipulator system (RMS) arm and the Orbiter was maneuvered to the separation attitude. However, following this maneuver, SPARTAN was located at an unrealistic position with respect to the Orbiter. This is believed to be due to the fact that SPARTAN had translation rates that were not simulated. Therefore, runs were made using three SPARTAN positions and two SPARTAN attitudes with respect to the Orbiter payload bay. All positions were at RMS end effector height over the Orbiter payload bay. In one set of runs, SPARTAN was rotating at the start of each run and the separation firings started one second after run start. In these cases the maximum spin rate attained was -2.286 deg/sec. Spin rate decreases were seen in several cases. In a second set of runs, SPARTAN was rotating at the start of each run and the separation firings started 60 seconds after run start. In these cases, the maximum spin rate was -2.459 deg/sec.

The reaction control subsystem (RCS) primary thruster R5R was reselected at 334:00:43:17 G.m.t. (10:04:57:17 MET) prior to maneuvering out of the 72-hour tail-first, bay-to-Earth AADSF attitude. At 334:16:31 G.m.t. (10:20:45 MET), the Orbiter will maneuver to a nose-forward bay-to-Earth AADSF attitude for 9.25-hours, which is expected to cool the R2D thruster injector to near 40°F. The final temperature will depend on the amount of aft RCS-housing drain-panel heater operation. The current timeline calls for three additional AADSF attitudes lasting 11.22 hours, 17.75 hours, and 8.25 hours.

The port radiator was stowed and latched nominally in dual motor time at 334:03:35:51 G.m.t. (10:07:49:51 MET).

/s/ C. Stokes McMillan 334:12:45 G.m.t.
C. Stokes McMillan
STS-87 Lead MER Manager

STS-87

TWELFTH DAILY REPORT

335:13:00 G.m.t.

The STS-87 mission is progressing satisfactorily with no significant Orbiter problems. The consumables remaining will meet all requirements of the remaining planned mission plus contingency days.

The primary reaction control subsystem (RCS) thruster R2D injector temperature decreased to approximately 45 °F during the 9.25-hour nose-forward bay-to-Earth Automated Directional Solidification Furnace (AADSF) attitude. During the AADSF run, the AADSF experienced a failure of two controlling thermocouples of the booster heater and was deactivated for the remainder of the mission. The R2D thruster injector temperature concerns noted in Eleventh Daily Report with the ADDSF attitudes have been eliminated with the deactivation. The attitude was shifted to the Materials for the Study of Interesting Phenomena of Solidification on Earth and in Orbit (MEPHISTO) attitude at about 335:03:17 G.m.t. (11:07:31 MET), where R2D has warmed to approximately 70 °F.

/s/C. Stokes McMillan 335:12:04 G.m.t.
C. Stokes McMillan
STS-87 Lead MER Manager

STS-87

THIRTEENTH DAILY REPORT

336:13:00 G.m.t.

The STS-87 mission is progressing satisfactorily with no significant Orbiter problems. The consumables remaining will meet all requirements of the remaining planned mission plus contingency days.

The port radiator was deployed at approximately 336:10:21 G.m.t. (12:14:35 MET) in dual motor time.

An extravehicular activity (EVA) has been scheduled for early Wednesday morning with a duration of approximately five hours. EVA Demonstration Flight Test (EDFT-05) crane operations and Autonomous EVA Robotic (AER) Camera/Sprint deployment/retrieval operations will be performed during this EVA.

Immediately preceding the EVA, SPARTAN/Video Guidance Sensor (VGS) operations on the remote manipulator system (RMS) will be accomplished. The SPARTAN will be reberthed prior to crew egress for the EVA.

Orbiter attitude timelines are currently being assessed for the remainder of the mission including the Loop Heat Pipe (LHP) payload activity, which is scheduled for a duration of approximately 21 hours. These attitudes are being evaluated for temperature issues concerning the reaction control subsystem (RCS) thruster R2D injector temperature and main landing gear (MLG) temperature.

/s/C. Stokes McMillan 336:12:38 G.m.t.
C. Stokes McMillan
STS-87 Lead MER Manager

STS-87

FOURTEENTH DAILY REPORT

337:13:00 G.m.t.

The STS-87 mission is progressing satisfactorily with no significant Orbiter problems. The consumables remaining will meet all requirements of the remaining planned mission plus contingency days.

During Autonomous EVA Robotic (AER) Camera/Sprint software checkout, the crew reported a blank screen on the payload (PL) 5 payload general support computer (PGSC). The Sprint hard drive was replaced with the original PL5 hard drive and the problem repeated itself. Subsequently, the crew called and reported that PL5 appeared to be operating correctly with the Sprint hard drive. The cause of the problem is being investigated.

The remote manipulator system (RMS) was powered up at 337:03:29 G.m.t. (013:07:43 MET) in support of the SPARTAN/Video Guidance Sensor (VGS) operations. The Spartan grapple occurred at 337:04:52 G.m.t. (013:09:06 MET), and the SPARTAN was unberthed at 337:05:52 G.m.t. (013:10:06 MET). The SPARTAN was berthed at 337:09:11 G.m.t. (013:13:25 MET) and latched at 337:09:12 G.m.t. (013:13:26 MET) after a successful completion of VGS operations. The RMS is currently parked in the extravehicular activity (EVA) hatch-viewing position.

A 10.2-psia cabin depressurization was initiated at 336:14:54 G.m.t. (012:19:08 MET) and completed at 336:15:18 G.m.t. (012:19:32 MET). The deactivation of the regenerative carbon dioxide removal system (RCRS) occurred at 337:08:38 G.m.t. (013:12:52 MET) in support of the airlock depressurization. The airlock depressurization began at 337:08:47 G.m.t. (013:13:01 MET) and completed at approximately 337:09:05 G.m.t. (013:13:19 MET). The RCRS was reactivated at 337:09:18 G.m.t. (013:13:32 MET). The EVA started when the crew members placed their power switches to battery at 337:09:10 G.m.t. (013:13:24 MET). The cabin repressurization to 14.7 psia was completed at 337:11:03 G.m.t. (13:15:17 MET). As this report was being written, the EVA Demonstration Flight Test (EDFT-05) crane operations were completed, and Autonomous EVA Robotic (AER) Camera/Sprint deployment/retrieval operations were progressing well.

/s/ C. Stokes McMillan 337:13:12 G.m.t.
C. Stokes McMillan
STS-87 Lead MER Manager

STS-87

FIFTEENTH DAILY REPORT

338:13:00 G.m.t.

The STS-87 mission is progressing satisfactorily with no significant Orbiter problems.

The second extravehicular activity (EVA) began at 337:09:09 G.m.t. (013:13:23 MET) and was concluded with the start of airlock repressurization at 337:14:08 G.m.t. (013:18:22 MET) for a total time of 4 hours and 59 minutes. Airlock repressurization was completed at 337:14:17 G.m.t. (013:18:31 MET). Astronauts Winston Scott and Takao Doi completed the EVA Demonstration Flight Test (EDFT-05) tasks successfully and satisfactorily deployed and retrieved Autonomous EVA Robotic (AER) Camera/Sprint during this second EVA. The total STS-87 EVA time during the mission was 12 hours and 42 minutes.

After supporting SPARTAN/video guidance system operations, the remote manipulator system (RMS) arm was latched in the manipulator positioning mechanisms (MPMs) at 337:14:08:09 (013:18:22:09 MET). At 337:14:11:08 G.m.t. (013:18:25:08 MET), the MPM's were stowed, and all planned RMS activities were completed for this mission.

The Midcourse Space Experiment (MSX) reaction control subsystem (RCS) maneuver 1 consisted of two firings. The first firing of 5-seconds duration occurred at approximately 338:08:29 G.m.t. (014:12:43 MET). RCS primary thrusters F3F and F2F were used for the -X axis firing. The second MSX RCS firing used thrusters L3A and R3A for the 10-second +X axis firing.

The flight control system (FCS) checkout was performed using auxiliary power unit (APU) 3. APU 3 was started at 338:09:51:25 G.m.t. (014:14:05:25 MET) and ran for 11 minutes and 59 seconds with 21 lb of fuel consumed.

During the positive stimulus test of FCS speedbrake channel 3, the secondary differential pressure (ΔP) exhibited a delayed response of 1.43 seconds before achieving the expected value. The results of the negative stimulus test were nominal. This condition is not expected to have any effect on entry and landing operations.

A slight over-cooling was observed immediately after spray cooling was achieved on the water spray boiler (WSB) 3B controller. Spray cooling was observed for approximately 2 minutes and 24 seconds before switching to controller 3A. Steady-state cooling was nominal on controller 3A. Controller 3B was reselected immediately prior to APU shutdown. Water usage during FCS checkout was approximately 3.36 lb. Steam vent heater operation was nominal during FCS checkout.

The RCS hot-fire was performed immediately following FCS checkout. All primary thrusters fired nominally during the hot-fire.

/s/C. Stokes McMillan 338:12:48 G.m.t.
C. Stokes McMillan
STS-87 Lead MER Manager

STS-87

Landing Report

339:14:15 G.m.t.

The launch of the STS-87 vehicle occurred at 323:19:45:59.993 G.m.t. (2:46 p.m. e.s.t. on November 19, 1997) following a countdown with no significant problems and no unexpected holds.

The right orbital maneuvering subsystem (OMS) oxidizer low-point-drain line temperature exhibited unusual behavior during the prelaunch period. A rapid temperature rise of 3.1 deg/min for a 3.5-minute period was followed by about 6 hours of operations at a relatively constant temperature. The temperature signature returned to normal cycling prior to launch, and exhibited nominal operation throughout the mission. Work was performed on this line during the STS-87 flow because of an oxidizer leak. As a result, two of the thermostats on the drain line were replaced with new thermostats, and the test results from the new hardware were satisfactory.

During the prelaunch cabin leak checks, a seal on the port used to pressurize the cabin came off (Flight Problem STS-87-V-01). The seal was replaced and the cabin leak check was completed satisfactorily. The problem delayed the cabin leak check, thus causing a concern over residual oxygen (O_2) concentration in the aft compartment exceeding the limits required to come out of the planned hold. However, the aft compartment O_2 readings did drop below the 500-ppm level just prior to the end of the planned hold period, and the countdown was resumed at the planned time.

During ascent, the auxiliary power unit (APU) 3 lubrication oil return temperature reached approximately 304 °F before the crew switched from the water spray boiler (WSB) 3B controller to the A controller. No spraying was evident after switching to the A controller. As a result, the crew was instructed to shut down APU 3 approximately one minute early. Evidence of spraying was observed after APU 3 shut down and prior to shutting off the WSB 3A controller. In addition, WSB 2, which initially controlled the APU 2 lubrication oil return temperature at 246 °F, experienced an over-cooling down to a temperature of 203 °F approximately 1.5 minutes after spray initiation. The system recovered to 246 °F approximately 2.5 minutes later.

The OMS 1 maneuver was not required because of the satisfactory direct ascent trajectory that was flown. The OMS 2 maneuver was performed at 323:20:27:08.9 G.m.t. [00:41:08.9 mission elapsed time (MET)]. The maneuver was 127.5 seconds in duration, and a differential velocity (ΔV) of 193.8 ft/sec was imparted to the vehicle.

After the OMS-2 maneuver and following vacuum inerting and helium repressurization of the main propulsion system (MPS), the liquid hydrogen (LH_2) manifold pressure continued to rise indicating residual hydrogen still had not been expelled during the second vacuum inerting. Consequently, a decision was made to perform another vacuum inerting. This operation was performed at 324:21:02 G.m.t. (01:06:16 MET), and the manifold pressure was successfully brought to zero psia where it remained throughout the remainder of the flight.

The payload-bay-door opening sequence was completed at 323:21:17:02 G.m.t. (00:01:31:02 MET). Nominal dual motor times were recorded for the door-opening operations.

Recent medical findings that link iodine consumption to thyroid problems resulted in the preflight development of a method for removing iodine from the drinking water and that equipment was stowed for this flight. The crew installed the Iodine Removal Mineral Injection System (IRMIS) cartridges to remove iodine and iodide from the drinking water. The IRMIS cartridges are the same cartridges used to remove iodine and iodide from the water that is transferred to the Mir Space Station.

The remote manipulator system (RMS) was activated at 324:00:50 G.m.t. (00:05:04 MET). The on-orbit checkout commenced at 324:02:05 G.m.t. (00:06:19 MET), and was completed at 324:04:46 G.m.t. (00:09:00 MET). Data indicated that all operations were nominal.

At approximately 324:02:25:26 G.m.t. (00:06:39:26 MET), after supply-water tank A reached full quantity, the tank A/B check/relief valve cracked open. The supply-water storage inlet-pressure increased from 33.21 psia to 39.58 psia over a 5-minute period before the relief valve opened. The pressure rise to crack the check valve was approximately 6 psia, whereas past flights have shown a range between 0.4 and 0.8 psia for the crack pressure. The specification value for relief valve cracking is between 0.8 psid and 2.5 psid. The valve reseats at 0.8 psid. The check/relief valve stayed open until the level in tank A dropped below full near the end of the mission. At 339:07:07:29 G.m.t. (015:11:21:29 MET), the A/B check/relief valve cracked open after a 1.35 psia pressure rise.

At 324:03:16:50 G.m.t. (00:07:30:50 MET), a reaction control subsystem (RCS) +X trim maneuver of 18.6 seconds duration provided 4.5 ft/sec ΔV to the vehicle.

At 324:06:16 G.m.t (00:10:30 MET), the crew repressed the right OMS engine gaseous nitrogen (GN_2) accumulator because there was evidence of a recurring small GN_2 leak. This action was taken to preclude setting off the low-pressure alarm during the crew-sleep period. At 325:05:49 G.m.t (01:10:03 MET), the crew repressed the right OMS engine GN_2 accumulator for the second time. Following this second repressurization, the leak stopped. This leak has occurred on previous flights of this engine.

The Ku-band radio frequency (RF) power output telemetry measurement had erratic indications from 324:14:51 G.m.t. (00:19:05 MET) to 324:15:38 G.m.t (00:19:52 MET), and from 324:16:50 G.m.t. (00:21:04 MET) to 324:17:13 G.m.t. (00:21:27 MET) (Flight Problem STS-87-V-02). However, during these time periods, the White Sands Ground Station reported a good Ku-band downlink signal. This measurement is normally relatively stable at about 4.5 Vdc; however, during the cited times the uncalibrated signal varied from 0 to 4.3 Vdc. No other indications of a power output problem or measurement problem occurred during the remainder of the mission.

The first samples of on-orbit fuel cell monitoring system (FCMS) data were gathered between 325:03:40:46 G.m.t. (01:07:54:46 MET) and 325:03:52:46 G.m.t. (01:08:06:46 MET) with a sampling rate of one sample per second. The second batch

of on-orbit data from the FCMS began being recorded at 325:04:01:49 G.m.t. (01:08:15:49 MET), which was during the crew-sleep period. This 10-hour sample was taken at the rate of 1 sample every 5 minutes. The initial evaluation of the FCMS data indicated 288 healthy individual cells. The data are satisfactory for performing the primary function of providing individual cell voltages over time.

The RMS arm was powered up and uncradled at 325:19:19 G.m.t. (01:23:33 MET). The arm was then maneuvered to the SPARTAN pre-grapple position at 325:19:29 G.m.t. (01:23:43 MET), and SPARTAN capture occurred at 325:19:32 G.m.t. (01:23:46 MET). The payload was unberthed and maneuvered to the Video Guidance System (VGS) acquire/verification position at 325:20:18 G.m.t. (02:00:32 MET), and was then moved to the SPARTAN release position at 325:20:25 G.m.t. (02:00:39 MET). The derigidize/rigidize command sequence to initialize the SPARTAN was issued at 325:21:04 G.m.t. (02:01:18 MET), and the end effector immediately derigidized and released the SPARTAN. When the SPARTAN failed to perform its pirouette attitude maneuver, an attempt to re-grapple the SPARTAN was made at 325:21:10 G.m.t. (02:01:24 MET). The re-grapple maneuver was not successful and a tip-off rate of approximately 2 deg/sec was imparted to the SPARTAN. The subsequent attempt by the Orbiter to reduce the relative rates to allow re-capture had to be terminated because of propellant limitations. The arm was returned to the precradle position at 325:22:28 G.m.t. (02:02:42 MET), cradled and powered down four minutes later.

After the SPARTAN operations problem, the RMS was selected at 326:01:42:31 G.m.t. (02:05:56:31 MET) to perform a test of the end effector. The end effector checkout was completed successfully. A visual inspection using closed circuit television (CCTV) camera B confirmed that the snare wires operated properly and were not damaged. The RMS was deselected at 326:01:58:35 G.m.t. (02:06:12:35 MET). The RMS arm was cradled in the manipulator positioning mechanisms (MPMs), and the arm was placed in the temperature-monitoring mode.

At 325:23:10:30 G.m.t. (02:03:25:30 MET), a multi-axis RCS posigrade maneuver was performed to move the Orbiter a safe distance from the SPARTAN.

The extravehicular mobility unit (EMU) checkout was completed satisfactorily. Both units were found ready to support the scheduled extravehicular activity (EVA). The crew reported that the EMU helmet floodlight, one of four lights on the helmet that was used by the EV2 crewmember, was flickering during the EMU checkout (Flight Problem STS-87-X-01). Later, the crew removed and replaced the bulb, but the light continued to flicker. The EV2 crewmember used an EMU helmet spot light during the EVA to replace the failed floodlight.

The starboard forward radiators were deployed at 327:05:40 G.m.t. (03:09:54 MET). This was the first of several starboard and port radiator deployments and stows. These operations were nominal.

The crew reported that one of the Hasselblad cameras stopped in the midst of taking pictures. The crew noticed that the battery was dead, took the film magazine off, changed the batteries, verified that the camera was functioning and installed a new film magazine. Two photographs were taken and then the camera stopped with the lens shutter half-closed. The crew performed some in-flight maintenance (IFM) procedures,

but camera operation was not restored. Later in the flight, the crew reported that the Hasselblad camera lens that was jammed with the camera body had been freed and removed from the camera body. However, efforts to restore camera operation were unsuccessful. The second Hasselblad camera remained operational throughout the remainder of the flight.

At approximately 327:08:00 G.m.t. (03:12:14 MET), it was determined that the primary RCS thruster R2D heater had failed off (Flight Problem STS-87-V-03). RCS injector temperatures are desired to be maintained above 40 °F to prevent leakage from the thruster valves. As of 328:00:00 G.m.t. (04:04:14 MET), the R2D temperature had dropped into the 45 to 50 °F range and was being maintained in that range by the external environment and the RCS stinger heater.

The NC-4 multi-axis rendezvous maneuver was completed at 328:08:33:17 G.m.t. (04:12:47:17 MET), imparting a 1.4 ft/sec ΔV to the vehicle. During this maneuver, the RCS R2D primary thruster was fired, resulting in warming it to a level in excess of 80° F.

The decision was made to rendezvous with SPARTAN and have the two EVA crewmembers manually capture and berth the spacecraft.

The Freon coolant loop (FCL) 1 was switched to interchanger flow at 328:04:29 G.m.t. (04:08:43 MET) in preparation for the cabin depressurization to 10.2 psi. In addition, the regenerative carbon dioxide removal system (RCRS) was powered down at 328:04:55 G.m.t. (04:09:09 MET). The cabin depressurization was started at 328:04:59 G.m.t. (04:09:13 MET) and completed 22 minutes later. The RCRS was then reactivated at 328:05:33 G.m.t. (04:09:47 MET).

The OMS was used to perform two SPARTAN rendezvous maneuvers. Both maneuvers were single engine, straight-feed firings. The first maneuver, NC5, used the right orbital maneuvering engine (OME) and was initiated at 328:21:19:33 G.m.t. (05:01:33:33 MET). The maneuver was 14.6 seconds in duration and imparted a ΔV of 11.5 ft/sec to the vehicle. The second maneuver (TI) used the left OME and was initiated at 328:22:50:38 G.m.t. (05:03:04:38 MET). The maneuver was 11.5 seconds in duration and imparted a ΔV of 8.9 ft/sec to the vehicle.

Numerous RCS firings were performed in the course of the rendezvous with the SPARTAN. There were three +X firings (MC1 at 1.2 ft/sec, MC2 at 1.0 ft/sec, and MC3 at 1.3 ft/sec) and one multi-axis firing (MC4 at 0.6 ft/sec). Prior to the planned firings, a warm-up firing of the RCS R2D thruster was also performed.

At 328:22:20 G.m.t. (05:02:34 MET), the Ku-Band system was placed in the radar mode. The SPARTAN spacecraft was acquired at 328:23:14 G.m.t. (05:03:28 MET) at an approximate range of greater than 40,000 feet. The radar tracked SPARTAN until 329:00:53 G.m.t. (05:05:07 MET) when the range was approximately 85 feet.

The RMS arm was powered up at 328:22:52 G.m.t. (05:03:06 MET). The three manipulator retention latches (MRL's) were released nominally in dual-motor time at 328:22:56:39 G.m.t. (05:03:10:39 MET). In preparation for the SPARTAN rendezvous, the RMS was maneuvered to the modified Poise-for-Capture position at 328:23:07 G.m.t. (05:03:21 MET).

The RCRS was deactivated at 328:23:33 G.m.t. (05:03:47 MET), followed by airlock depressurization starting at 328:23:40 G.m.t. (05:03:54 MET). The depressurization was temporarily stopped at 328:23:42 G.m.t. (05:03:56 MET) for the 5.5-psia hold. Airlock depressurization was completed satisfactorily. The cabin repressurization to 14.7 psia was initiated at 329:00:02 G.m.t. (05:04:16 MET) and was completed at 329:00:15 G.m.t. (05:04:29 MET).

The EVA started when the crew members placed their power switches to the battery position at 329:00:01 G.m.t. (05:04:15 MET). The airlock B hatch was opened nominally for the EVA egress at 329:00:02 G.m.t. (05:04:16 MET). The RMS was moved to an observation position for the manual SPARTAN retrieval at 329:01:04:00 G.m.t (05:05:18:00 MET). When the SPARTAN proved to be difficult to manually berth, the arm was maneuvered to grapple SPARTAN at 329:02:39:04 G.m.t. (05:06:53:04 MET). SPARTAN was berthed with the RMS at 329:03:23:22 G.m.t. (05:07:37:22 MET) and un-grappled at 329:03:26:36 G.m.t. (05:07:40:36 MET).

Following SPARTAN berthing, astronauts Winston Scott and Takao Doi performed several tasks in the EVA Demonstration Flight Test (EDFT-05) development test objective (DTO) 671. The EVA was completed in 7 hours and 43 minutes. The EVA was successful in the capture and stowage of SPARTAN and the evaluation of equipment to be used on the Space Station. The crew entered the airlock at 329:07:35 G.m.t. (05:11:49 MET) and the airlock B hatch was closed and locked nominally. Airlock repressurization began at 329:07:45 G.m.t. (05:11:59 MET) and was completed at 329:07:58 G.m.t (05:12:12 MET).

The RMS arm was moved to the pre-cradle position at 329:07:35:00 G.m.t. (05:11:49:00 MET) and latched in the MPMs at 329:07:45:00 G.m.t. (05:11:59:00 MET). At 329:07:56:00 G.m.t. (05:12:10:00 MET), the MPM's were stowed and the arm was deselected.

Hydrogen (H_2) tank 4 quantity gauge failed off-scale high at 329:03:26 G.m.t. (05:07:40 MET). The measurement began working again at 331:10:29 G.m.t. (07:14:43 MET) as H_2 tanks 4 and 5 neared depletion. Usage continued on these tanks until depletion at quantities of 2.0 percent and 2.4 percent, respectively.

Five attitude options were assessed for the 72-hour long Advanced Automated Directional Solidification Furnace (AADSF) run. The attitudes were designed to be acceptable for AADSF crystal growth while protecting RCS thruster R2D with its failed heater, as well as honoring all other Orbiter thermal constraints. The options are summarized in the following table.

Attitude Options for the 72-hour AADSF Period

ATTITUDE OPTIONS	POTENTIAL ISSUE
1) Baseline: bay down, nose forward	R2D cold thruster

-ZLV, +XVV		
2) Bottom down, nose forward: +ZLV, +XVV	APU 1 service line exceeding 170°F	
3) Bay down, tail forward: -ZLV, -XVV with +10° pitch bias	Cold forward RCS vernier thrusters	**SELECTED OPTION**
4) Bay down, tail forward: -ZLV, -XVV with -10° pitch bias	Payload science	
5) Bay down, port wing forward: -ZLV, -YVV	Payload science	

At 331:00:49:45 G.m.t. (07:05:03:45 MET) an orbit adjust maneuver was executed to reach the AADSF orbital parameters. The maneuver was performed in the +X axis for approximately 29 seconds with a ΔV of 6.7 ft/sec. RCS thrusters L1A and R1A were used for the maneuver.

At 330:19:35 G.m.t. (06:23:49 MET), the left outboard tire pressure 2 measurement failed to the off-scale low value. The measurement began working again at 338:04:43 G.m.t. (014:08:57 MET).

The APU 2 drain-line pressure began decreasing at 331:01:05 G.m.t. (07:05:19 MET) and continued to decrease throughout the mission, eventually reaching vacuum. The drain-line pressure increased as atmospheric pressure increased during entry. The condition posed no problem.

The decision was made to complete SPARTAN/VGS operations. An unscheduled second EVA was also planned to complete those objectives not accomplished during the first EVA.

The RMS was powered up at 337:03:29 G.m.t. (013:07:43 MET) in support of the SPARTAN/VGS operations. The Spartan grapple occurred at 337:04:52 G.m.t. (013:09:06 MET), and the SPARTAN was unberthed at 337:05:52 G.m.t. (013:10:06 MET). The SPARTAN was berthed at 337:09:11 G.m.t. (013:13:25 MET) and latched at 337:09:12 G.m.t. (013:13:26 MET) after a successful completion of VGS operations. The RMS was parked in the EVA hatch-viewing position for monitoring EVA egress and ingress.

A 10.2-psia cabin depressurization was initiated at 336:14:54 G.m.t. (012:19:08 MET) and completed at 336:15:18 G.m.t. (012:19:32 MET). The deactivation of the RCRS occurred at 337:08:38 G.m.t. (013:12:52 MET) in support of the airlock depressurization. The airlock depressurization began at 337:08:47 G.m.t. (013:13:01 MET) and completed at approximately 337:09:05 G.m.t. (013:13:19 MET). The RCRS was reactivated at 337:09:18 G.m.t. (013:13:32 MET). The EVA began when the crew members placed their power switches to battery at 337:09:10 G.m.t. (013:13:24 MET). The cabin repressurization to 14.7 psia was completed at 337:11:03 G.m.t. (13:15:17 MET).

The second extravehicular activity (EVA) was concluded with the start of airlock

repressurization at 337:14:08 G.m.t. (013:18:22 MET) for a total time of 4 hours and 59 minutes. Airlock repressurization was completed at 337:14:17 G.m.t. (013:18:31 MET). Astronauts Winston Scott and Takao Doi completed the EVA Demonstration Flight Test (EDFT-05) tasks successfully and satisfactorily deployed and retrieved Autonomous EVA Robotic (AER) Camera/Sprint during this second EVA. The total STS-87 EVA time during the mission was 12 hours and 42 minutes.

After supporting SPARTAN/VGS operations, the RMS arm was latched in the MPMs at 337:14:08:09 (013:18:22:09 MET). At 337:14:11:08 G.m.t. (013:18:25:08 MET), the MPM's were stowed, and all RMS activities were completed for this mission.

The Midcourse Space Experiment (MSX) RCS maneuver 1 consisted of two firings. The first firing of 5-seconds duration occurred at approximately 338:08:29 G.m.t. (014:12:43 MET). RCS primary thrusters F3F and F2F were used for the -X axis firing. The second MSX RCS firing used thrusters L3A and R3A for the 10-second +X axis firing.

The flight control system (FCS) checkout was performed using APU 3. APU 3 was started at 338:09:51:25 G.m.t. (014:14:05:25 MET) and ran for 11 minutes and 59 seconds with 21 lb of fuel consumed. While APU 3 was running, a slight over-cooling was observed immediately after spray cooling was achieved on the WSB 3B controller. Spray cooling was observed for approximately 2 minutes and 24 seconds before switching to controller 3A. Steady-state cooling was nominal on controller 3A. Controller 3B was reselected immediately prior to APU shutdown. Water usage during FCS checkout was approximately 3.36 lb. Steam vent heater operation was nominal during FCS checkout.

During the FCS checkout, the positive stimulus test of speedbrake channel 3 caused the secondary differential pressure (ΔP) to exhibit a delayed response of 1.43 seconds before achieving the expected value. The results of the negative stimulus test were nominal. This condition had no effect on entry and landing operations.

The RCS hot-fire was performed immediately following FCS checkout. All primary thrusters fired nominally during the hot-fire.

The third sample of on-orbit FCMS data was gathered between 338:05:57 G.m.t. (014:10:11 MET) and 338:06:09 G.m.t. (014:10:21 MET) with a sampling frequency of one sample per second. Evaluation of the data showed that the fuel cells were operating nominally with little or no change from the previous samples of FCMS data taken on flight day 2. The data are also similar to the first two samples in terms of offset of the calculated FCMS differential voltage versus the CPM differential voltage.

The payload bay doors were closed and latched for landing at 339:08:43:14 G.m.t. (015:12:57:14 MET). The dual-engine deorbit maneuver for the landing at the Shuttle Landing Facility (SLF) runway 33 was performed on orbit 251 at 339:11:21:27.9 G.m.t. (015:15:35:27.9 MET). The maneuver was 154.3 seconds in duration with a ΔV of 250.5 ft/sec.

Entry was completed satisfactorily, and main landing gear touchdown occurred on KSC concrete runway 33 at 339:12:20:04 G.m.t. (015:16:34:04 MET) on December 5, 1997.

The Orbiter drag chute was deployed at 339:12:20:09 G.m.t. and the nose gear touchdown occurred 6 seconds later. The drag chute was jettisoned at 339:12:20:38 G.m.t. with wheels stop occurring at 339:12:21:02 G.m.t. The rollout was normal in all respects. The flight duration was 15 days 16 hours 34 minutes 04 seconds. The APUs were shut down 15 minutes 31 seconds after landing.

/s/ C. Stokes McMillan 339:14:16 G.m.t.
C. Stokes McMillan
STS-87 Lead MER Manager