

STS-26 National Space Transportation System Mission Report

January 1989



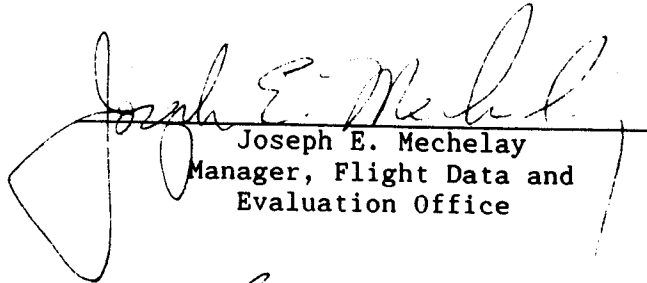
National Aeronautics and
Space Administration

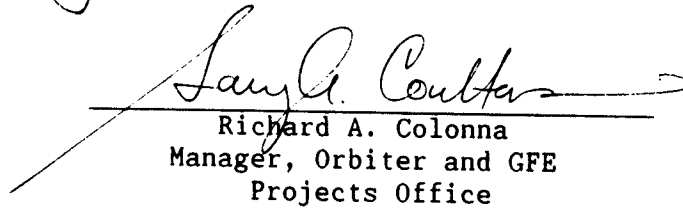
Lyndon B. Johnson Space Center
Houston, Texas

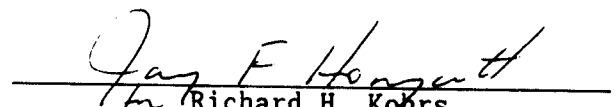
STS-26

NATIONAL SPACE TRANSPORTATION SYSTEM

MISSION REPORT


Joseph E. Mechelay
Manager, Flight Data and
Evaluation Office


Richard A. Colonna
Manager, Orbiter and GFE
Projects Office


for Richard H. Kohrs
Deputy Director, National STS Program

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TEXAS 77058

JANUARY 1989

TABLE OF CONTENTS

<u>Title</u>	<u>Page</u>
<u>INTRODUCTION AND MISSION OBJECTIVES</u>	1
<u>MISSION SUMMARY</u>	2
<u>SOLID ROCKET BOOSTERS ASSESSMENT</u>	4
<u>EXTERNAL TANK ASSESSMENT</u>	6
<u>SPACE SHUTTLE MAIN ENGINES ASSESSMENT</u>	6
<u>ORBITER VEHICLE ASSESSMENT</u>	7
MAIN PROPULSION SYSTEM	7
ORBITAL MANEUVERING SUBSYSTEM	8
REACTION CONTROL SUBSYSTEM	9
AUXILIARY POWER UNIT SUBSYSTEM	10
HYDRAULICS AND WATER SPRAY BOILER SUBSYSTEMS	11
FUEL CELL POWERPLANT SUBSYSTEM	12
POWER REACTANT STORAGE AND DISTRIBUTION SUBSYSTEM	13
WATER AND WASTE MANAGEMENT SUBSYSTEMS	14
ACTIVE THERMAL CONTROL SUBSYSTEM	15
SMOKE DETECTION/FIRE SUPPRESSION SUBSYSTEM	16
ATMOSPHERIC REVITALIZATION SUBSYSTEM	16
AVIONICS SUBSYSTEMS	17
THERMAL CONTROL SUBSYSTEM	20
THERMAL PROTECTION SUBSYSTEM	22
AEROTHERMODYNAMICS SUBSYSTEM	23
AERODYNAMICS	23
MECHANICAL SUBSYSTEMS	24
LANDING AND DECELERATION SUBSYSTEM	24
<u>GOVERNMENT FURNISHED EQUIPMENT</u>	25
<u>PAYLOADS ASSESSMENT</u>	26
<u>EXPERIMENTS ASSESSMENT</u>	26
<u>DETAILED TEST OBJECTIVES ASSESSMENT</u>	27
TABLE I - MISSION EVENTS LIST	28
TABLE II - PROBLEM TRACKING LIST	30

INTRODUCTION AND MISSION OBJECTIVES

The STS-26 National Space Transportation System (STS) Mission Report contains a summary of the major activities and accomplishments of the twenty-sixth Space Shuttle mission (STS-26), and the seventh flight of the OV-103 vehicle, Discovery, and the first flight following the STS 51-L incident.

The primary objectives of the STS-26 mission were to successfully deploy the Tracking and Data Relay Satellite-C/Inertial Upper Stage (TDRS-C/IUS); to perform all operations necessary to support the requirements of the Orbiter experiment (OEX) Autonomous Supporting Instrumentation System (OASIS) payload; and to conduct operations of the 11 middeck payloads. The 11 middeck payloads were:

- a. Automated Directional Solidification Furnace (ADSF),
- b. Physical Vapor Transport of Organic Solids (PVTOS),
- c. Infrared Communications Flight Experiment (IRCFE),
- d. Protein Crystal Growth (PCG),
- e. Isoelectric Focusing (IF),
- f. Phase Partitioning Experiment (PPE),
- g. Aggregation of Red Blood Cells (ARC),
- h. Mesoscale Lightning Experiment (MLE),
- i. Earth-Limb Radiance Experiment (ELRAD),
- j. The Effect of Weightlessness on Grain Formation (SSIP 82-04), and
- k. Utilizing a Semi-Permeable Membrane to Direct Crystal Growth (SSIP 82-05).

The crew for this twenty-sixth mission of the Space Shuttle Program was Frederick H. Hauck, Capt., U. S. Navy, Commander; Richard O. Covey, Col., U. S. Air Force, Pilot; and John M. Lounge, George Nelson, Ph.D., and David C. Hilmers, Lt.Col., U. S. Air Force, Mission Specialists.

MISSION SUMMARY

The STS-26 mission was successfully launched at 273:15:37:00.0093 G.m.t. (10:37:00.0093 a.m.c.d.t.) on September 29, 1988. A timeline of the mission sequence of events is shown in table I.

The launch was delayed 1 hour because the winds aloft were significantly different from the anticipated profile. Prelaunch analysis indicated that Orbiter structural limits would be exceeded. Additional loads data at L-70 minutes indicated exceedances of 2.0 and 2.7 percent of redline limits at wing load indicators WLE-14R and -14L, respectively. Comparison of launch-day wind load conditions with a pre-existing stress analysis having comparable wind loads showed positive margins of safety for the wings and as a result, the launch countdown was resumed.

During the prelaunch orbital maneuvering system (OMS) gimbal profile test, the left secondary (standby) thrust vector controller did not drive the actuators with remote power controller (RPC) 1 enabled (Problem Report STS-26-01). With RPC 2 enabled, the actuators responded to commands. Troubleshooting and analysis indicate that only RPC 2 would provide power to the controller. Both RPC's are required to ensure that the pitch and yaw actuators can be driven simultaneously. This failure did not impact the flight.

An additional delay resulted when the Pilot and Mission Specialist 1 suit vent fans failed after crew ingress to the Orbiter. Two 3A fuses failed, one in each suit fan unit (Problem Report STS-26-03). After evaluation, the decision was made to insert 5A fuses in place of the failed 3A fuses. New fuses were taken to the launch pad and placed in the circuits in the Orbiter. As a result, the suit fans then operated properly and cabin closet for launch was initiated. Subsequently, it was determined that 10A fuses had been installed. Further investigation showed that this posed no hazard for the crew; however, the crew was instructed to replace all suit fan fuses with 5A fuses from the in-flight maintenance kit before entry.

The launch phase was satisfactory in all respects. Evaluation of ascent data indicated that the Space Shuttle main engine gaseous oxygen flow control valves -1 and -2 operated slowly when opening (Problem Report STS-26-07). This problem did not impact external tank pressurization. A two-engine OMS-2 firing was performed satisfactorily at 273:16:16:55 G.m.t. The firing duration was 142 seconds, which provided a differential velocity of 223 ft/sec. An orbit of 162 by 178 nmi. was achieved.

After launch, an excessive amount of evaporative cooling was noted, and this is an indication that moisture condensation formed in the evaporator prior to launch. About 10 minutes into the flight, the temperature of the inboard section of the high-load evaporator steam duct started dropping, indicating either excessive water carryover or ice forming in the duct section. The duct heaters were switched to the 2-heater-operation position with no increase in duct temperature. The evaporator outlet temperature continued to cycle between 40-50°F. At 41 minutes into the mission, the first high-load evaporator outlet duct section temperature dropped to 39°F indicating the duct or evaporator was frozen (Problem Report STS-26-05a). The crew

changed the evaporator configuration to secondary controller on the topping evaporator and this controlled the temperature to 60°F until the radiators were activated.

The solid rocket boosters (SRB) performed as expected with no anomalies or launch commit criteria (LCC) violations identified as a result of the mission. All SRB data indicate very good performance and postflight inspection of the SRB joints shows no evidence of any anomalous behavior. Likewise, all objectives and requirements of the external tank were met with no LCC violations. The Space Shuttle main engines and main propulsion system also performed in a very satisfactory manner with no anomalies.

The TDRS-C predeployment checkout was completed as planned and the satellite was deployed at 273:21:50:04 G.m.t. A reaction control system (RCS) +X separation maneuver was performed at 273:21:58 G.m.t., followed by a 16.6-second 2-engine OMS separation maneuver at 273:22:05:02 G.m.t. The Inertial Upper Stage (IUS) solid rocket motor (SRM) 1 burn was performed 1 hour after deployment and the TDRS-C was placed in a 19,322 by 151 nmi. orbit. The IUS SRM 2 burn was performed at 274:04:06:48 G.m.t., and the resulting TDRS-C orbit was a nominal 19,335 by 19,311 nmi. The TDRS-C antennas and solar arrays were deployed and the satellite is on station. The TDRS-C checkout has progressed satisfactorily and present plans are to use the TDRS-C to support the STS-27 mission.

The second day of the STS-26 mission progressed well and all Orbiter systems operated satisfactorily. After a successful deployment, the Ku-band antenna failed its self-test routine (Problem Report STS-26-06). Downlink operations appeared normal, but the antenna failed to respond properly to commanded angles. The decision was made to stow the antenna, but initial attempts to stow the antenna failed because of antenna oscillations. An alternate stowage procedure was developed, and the antenna was stowed properly on the first alternate attempt.

The third day of the STS-26 mission progressed satisfactorily with all Orbiter subsystems operating satisfactorily, and all consumables remaining well above redline values.

The topping flash evaporator system (FES) was activated at approximately 2:17:06 mission elapsed time (MET) and cooler cabin and atmospheric revitalization subsystem temperatures resulted.

When the crew optical alignment sight (COAS) was calibrated in the forward (+X) station, a 1.97-degree differential bias was reported (Problem Report STS-26-08). The crew reported that the nut on the vehicle to which the COAS adapter plate attaches, and which is above the Commander's window, was missing. The crew had mounted the COAS using its three mounting pins and tape. A recommendation was made to the crew that this +X calibration not be used and that the -Z (overhead window) calibration be used instead.

The mission progressed satisfactorily and all consumables continued to remain above redline limits during the fourth day. All Orbiter systems performed within acceptable limits and were ready for entry. The flight

control system checkout was completed as planned including the reaction control system hot-fire test and the 4-minute 11-second auxiliary power unit operation.

All payload operations during the mission were nominal. All five of the planned runs of the Physical Vapor Transport of Organic Solids (PVTOS) were completed as scheduled. All runs of the Automated Directional Solidification Furnace (ADSF) were completed. The Protein Crystal Growth experiment photographic session and deactivation was completed during the third mission day. All other payload activities were completed.

A procedure was developed and implemented in an attempt to bring the high-load FES evaporator on line for entry. This procedure was successful until the OMS deorbit maneuver, which was performed satisfactorily at 277:15:34:45 G.m.t.

At OMS engine start for the deorbit maneuver, the flash evaporator system had an over-temperature shutdown (Problem Report STS-26-05b). The crew followed established procedures and reactivated the high-load evaporator with the secondary controller. FES operations continued normally through the 12,000 ft/sec velocity point at which time the FES was placed in standby. Radiator cold-soak was then used for cooling through the first 17 minutes of postlanding activity, after which the ammonia system was activated for cooling.

Entry interface occurred at 277:16:06:33 G.m.t., and an assessment of aerodynamic heating showed nominal values during entry. Main gear touchdown occurred at Edwards Air Force Base at 277:16:37:11 G.m.t. Nose landing gear touchdown followed 7 seconds later with wheels stop at 277:16:37:57 G.m.t. The rollout was nominal in all respects, with light braking. All postflight systems reconfigurations were completed as planned and the crew egressed the vehicle at 277:17:32 G.m.t.

SOLID ROCKET BOOSTERS ASSESSMENT

Solid rocket motor (SRM) propulsion performance was normal and within specification limits for this flight. Solid rocket booster (SRB) thrust differentials were within specification throughout the flight. The thrust vector control (TVC) prelaunch redlines had sufficient margins. The TVC subsystem operated normally and the recovery sequence was performed satisfactorily on both SRB's. The performance of the separation subsystems was normal and nose-cap ejection, frustum separation, and nozzle jettison occurred normally on each SRB.

The right-hand SRB sustained minor damage from water impact. The rock APU accumulator lubrication oil drain fitting was broken off, three stiffener rings were buckled, the integrated electronics assembly end cover was missing, and the External Tank (ET) attach ring cover was bent. The left-hand SRB sustained only minimal damage from water impact.

The debris containment system plungers on SRB holddown posts numbers 1, 3, 7, and 8 were not closed, instead they were held open by nut fragments. Other plungers were seated. Many lockwires on exterior bolts were broken and the attachments of plunger-to-holddown bolts were sheared. These were probably sheared at main-engine firing, which would contribute to the plunger not seating.

The field joint J-leg areas of contact with the clevis side inhibitor showed a pattern of slight non-contact in the area aft of the tip. This has been seen before on almost all joints. No soot was observed past the tip of the J-leg on aft or center field joints. The forward joint inhibitor stub had radial tears about every 15 degrees. At every tear location, some soot was deposited past the J-leg tip. The probable cause was that the flapping of the inhibitor stub pulled free from the J-leg bond area, allowing the soot to enter. The rubber was examined and showed no signs of char or other heat effects. These tears are often seen on flight motors, but never on static test motors.

The interference fit of the capture feature leg and the inner clevis exhibited axial scratches emanating from small bead-like spots. The scratches were 3 mils deep and 0.3 inch in length. One joint had 99 scratches, another 21, others 2, and one joint had none. Metallurgists stated that these are the results of "cold welding" caused by high spots on the metal heating to 1500 °F as a result of friction during motor operation. Disassembly then breaks the weld spot which scratches the mating surface. This has not been seen on static motors. It is believed that this is related to flight vibration. All O-rings were in excellent condition. Corrosion was observed on unpainted clevis surfaces, especially at shim locations.

All six field joint cork and moisture barriers contained one to two liters of sea water per joint. At least one of the two vent valves in each joint was stuck in the open position. The valves were sent to the Malfunction Analysis Laboratory for evaluation. The poppets were covered with aluminum oxide and cork material was also found in the valves. The spring-return action was slow on all valves. This is not a safety-of-flight issue.

There was no apparent water intrusion past the vulcanized outer rubber seals of the factory joints. All joints are covered by at least three virgin plies of insulation and met minimum required safety factors of 2.0.

The left-hand and right-hand nozzles were in similar conditions. The aft tip of the outer boot rings shows typical cool-down delaminations. The outer boot ring was in good condition and completely intact at the flex boot. Cowl vent holes were plugged with slag and some post-burn wedge-outs were present in the cowl tip.

The nozzle-to-case joint polysulfide had no blowholes. The vent slots were half filled with polysulfide. A cohesive failure of the polysulfide occurred at disassembly. The joint exhibited no seal damage, no blow-by, and no pressure past the wiper seal.

Left-hand SRB main parachute number 1 had 10 broken ribbons and 10 torn ribbons on gore number 15. All parachutes had minor damage from aft skirt debris. Right-hand SRB parachute number 3 sustained significant damage to gore numbers 120 and 121. Gore number 121 had 18 broken ribbons. Bi-pod strut witness paint was evident on broken ribbons. This is typical of contact abrasion at chute deployment. There were approximately 55 ribbons torn or burned.

During the ascent phase, the Orbiter lower surface was possibly struck with insulation material from either the external tank or an SRB.

EXTERNAL TANK ASSESSMENT

ET preflight operations and propellant loading were accomplished satisfactorily. All ET prelaunch thermal requirements were met. TPS acreage performance was as expected for the existing ambient conditions. There was no excessive ice or frost buildup on the ET.

Flight performance was excellent. Other than a malfunction of an ET liquid hydrogen level sensor, all ET instrumentation performed correctly. Skin and component temperatures during flight were similar to previous flights. Entry was normal with the impact in the footprint as predicted. Tumbling was verified by tracking from the ground.

SPACE SHUTTLE MAIN ENGINES ASSESSMENT

All prelaunch purge operations were executed successfully. The ground support equipment provided adequate control capability for launch preparation. All conditions for engine start were achieved at the appropriate times.

All three Space Shuttle main engines (SSME's) started properly. Thrust buildup, mainstage and shutdown performance of all engines was within specification. The SSME controllers provided proper control of the engine throughout powered flight. Engine dynamic data generally compared well with previous test and flight data. All on-orbit activities associated with the SSME's were accomplished successfully.

A revision was made to the postlanding SSME repositioning procedure to allow entry purge software to open the pneumatic and SSME-2 "B" regulator isolation valves. There was no impact to the postlanding manifold purges. However, the entry purge software left MPS multiplexer/demultiplexer (MDM) commands on. The commands were terminated by cycling MDM power to achieve the proper ferry-flight configuration.

ORBITER VEHICLE ASSESSMENT

Orbiter subsystem operation during STS-26 was exceptional with only a few minor anomalies (see Table II). Technical assessment of Orbiter subsystem performance and anomalies is discussed in the following paragraphs.

MAIN PROPULSION SUBSYSTEM

All pretanking purges were performed as planned. Liquid oxygen and liquid hydrogen propellant loading, prepressurization and pressurization systems performed satisfactorily. No deviations to Operations and Maintenance Requirements and Specifications Document (OMRSD)/Launch Commit Criteria requirements occurred during the terminal launch countdown. All OMRSD File IX in-flight checkout requirements were accomplished.

Main propulsion system (MPS) propulsion and feed system overall performance was nominal. Liquid oxygen and liquid hydrogen propellant conditions were within specified limits during all phases of operation, and net positive suction pressure requirements were met. Trajectory reconstruction indicates that engine specific impulse was near the MPS assessment tag values. At main engine cutoff, liquid oxygen and liquid hydrogen residuals were as predicted.

Problems were encountered with the entry purge procedures, which had been revised due to concerns over possible regulator failures that could overpressurize the aft compartment. The procedures were revised in real-time to preclude nuisance alarms from the caution and warning system.

The helium pneumatic system helium tank exhibited a pressure decay of approximately 18.8 psi/min during purge sequence 4. The OMRSD allows a pressure decay of 25 psi/30 min. A pressure decay of 16.8 psi/minute was also experienced before the STS-26 mission during the flight readiness firing (FRF). The post-FRF, troubleshooting attributed the pressure decay to an internal leak in engine 3 Orbiter helium check valve that started at a low differential pressure and stopped at a high differential pressure. Preflight, the leak was attributed to the interconnect outlet check valve (CV44) and/or the interconnect inlet solenoid (LV63). A waiver was approved to fly STS-26 with no additional corrective action.

The gaseous oxygen flow control valves on SSME 1 and 2 operated sluggishly during the first cycle (Problem Report STS-26-07), and ET pressurization was not impacted. A similar condition was experienced with flow control valves 1 and 3 during the STS-26 flight readiness firing.

The MPS instrumentation exhibited erratic liquid hydrogen engine inlet pressures on SSME 2 and 3. SSME 2 inlet pressure indicated low during loading and mainstage operations, while SSME 3 indicated erratic operation during mainstage operations and zero at main engine cutoff (Problem Reports STS-26-04F and STS-26-04B, respectively). Also, the liquid hydrogen 98-percent liquid level sensor 2 was flashing (dry/wet) at lift-off plus 70 seconds (Problem Report STS-26-04H). MPS operations were not impacted by any of the instrumentation anomalies.

The liquid hydrogen 4-inch ET/Orbiter recirculation disconnect had an audible leak during post-landing inspection, and it was later determined to be caused by a damaged seal (Problem Report STS-26-14). During the STS-26 post-FRF checkout, the liquid hydrogen propellant system had a pressure decay of 2.7 psi/hr versus the specification value of 1.91 psi/hr leakage. A waiver was approved to fly as is.

ORBITAL MANEUVERING SUBSYSTEM

The orbital maneuvering subsystem (OMS) performance was normal. Both OMS engines were used simultaneously for 3 maneuvers for a total firing time of 326.4 seconds. OMS-to-RCS propellant interconnect was not used during this mission. Helium usage during OMS firings was as predicted, verifying no detectable external usage. Vapor isolation valves opened on command and tank ullage pressure during the firing was as expected. No motor valve cycling was performed during the mission and feed system pressure drops were as expected, indicating no discernible flow restrictions. Gaseous nitrogen usage during firings was as expected, verifying no detectable external leakage. The purge valves operated as commanded and gaseous nitrogen usage during purges was as expected, verifying no detectable flow restrictions. Inlet pressures, chamber pressure, and regeneration jacket temperatures for both engines was as expected. OMS firings times and propellant consumption were consistent with predictions, also verifying proper performance.

All OMS firings were performed with at least one helium isolation valve in manual position, so that the regulators went to lockup after the firing; verification of helium isolation valve internal leakage is not possible under these conditions. The OMS-2 and deorbit firings were performed with dual regulator legs; OMS-3 was performed with the B-leg only. Tank ullage pressure during OMS firings was as expected, verifying proper flow through the B-leg valve.

The left pod inboard-Y-web thermostat on pod heater system A exhibited dithering behavior. All crossfeed heaters operated as required with the exception of the zone 5 heaters on system A; at about 6 hours MET, measurement V43T6242A indicated a nearly constant temperature (consistent with a "dithering" thermostat). The A system heaters are considered usable with this condition.

The OMS-2 firing reduced propellant quantities to approximately 32 percent. Gage data from OMS-3 show no loss of propellant from the aft compartment, confirming the propellant acquisition system bulkhead screen integrity. Propellant quantity at the start of the deorbit firing was approximately 30 percent, and again, no loss of propellant from the aft compartment was measured.

A failure in the right OMS pod fuel gaging system was encountered during preflight activities. Following an Orbiter power-down period, the total quantity output from the right fuel gaging system shifted from the proper reading of 53 percent to 93.4 percent (the aft channel shifted from 29.2 percent to off-scale high). Gaging data from OMS-2 show that the right-pod

fuel gage went into the ungageable region at the same time as the other gages, indicating that the forward probe was most likely operating correctly. When compared to vendor failure simulations, the data from the OMS-2 firing indicated that the failure may be the result of an open or short in the aft fuel probe density compensator circuit. If this failure scenario is correct, the right-pod fuel gage will be at least partially functional for propellant loading on subsequent missions. During the deorbit firing, the right fuel aft probe readout was consistently a factor of two higher than the actual tank quantity. All other gages performed properly. A low-level indication was received from both oxidizer and fuel gages on the left pod several seconds before the end of the deorbit firing. This warning was expected and indicated a total tank quantity of 5 percent remaining. The right-pod fuel did not trigger the low-level warning because of the failure discussed previously. The right oxidizer quantity was just above the low-level trigger point at the conclusion of the firing.

The OMS engines were armed at T-30 minutes; with the holds encountered, the isolation valve was powered on for approximately 3 hours before the first OMS firing. The gaseous nitrogen manifold pressure increase in the left OMS engine was 23 psi, and the pressure increase in the right engine was 14 psi. Most, if not all of this pressure increase can be attributed to heat input from the gaseous nitrogen isolation valve solenoid in addition to ascent heating. A precise assessment of the lockup performance of the gaseous nitrogen regulators is not possible from the available data. The regulator outlet pressure from the right engine was slightly below specification requirements during the post-firing purges; however, the short duration of the flow demand precludes an accurate assessment of regulator behavior. The regulator performance will be examined during turnaround operations.

REACTION CONTROL SUBSYSTEM

The reaction control system (RCS) hardware configuration used for STS-26 was the FRC3 forward module, LPO4 left pod, and RPO3 right pod. The RCS performed nominally during the mission. No RCS Launch Commit Criteria violations occurred during the countdown. RCS propellant consumption was within nominal predicted ranges.

During prelaunch inspections, water was found in primary thruster F1F. After the thruster was vacuum dried, a small chip was found in the disilicide coating. The chip was reported to be 0.25 inch upstream of the throat, 0.04 inch by 0.05 inch and down to the "parent metal". A review of qualification and test data confirmed that chips in this section of the thruster had been extensively tested and were found to be acceptable with no restrictions. Approximately 1 minute and 30 seconds after lift-off, it was noted that the oxidizer injector temperatures of 30 primary thrusters were decreasing. The lowest temperature of any injector was on thruster R3R which had dropped from 88 °F to 46 °F by 3 minutes and 10 seconds into the flight. After this time, the thruster temperatures started to rise, and by main engine cutoff (MECO) all temperatures were again nominal. If the oxidizer injector temperature had

dropped below 30°F, the thruster would have been deselected. This trend was seen only on the oxidizer injectors. The fuel injector temperatures did not show any decrease during ascent. A limited review of previous mission data showed that this phenomenon occurred on at least two previous missions. The STS 51-I and STS 61-C missions had thrusters with decreasing fuel and oxidizer injector temperatures during ascent. The possible causes for the drop in oxidizer injector temperatures is evaporation of water or nitric acid. Since the temperatures were not close to the 30°F deselection limit and all flight data indicate normal operations, the temperature response is considered normal.

The RCS operated nominally during the on-orbit phase of the mission. The crew selected vernier mode once during on-orbit operations. Following TDRS deployment, the primary thrusters were enabled and used to move the Orbiter away from the payload before performing an OMS maneuver. After the OMS maneuver, the vernier mode was reselected.

The RCS hot fire test was performed on schedule one day before entry. All primary thrusters were manually fired for approximately 80 to 400 ms. All thrusters fired nominally.

During entry preparations, the primary mode was reselected and it was noted that the left-hand oxidizer leg "B" regulator primary stage lockup was on the low side of the tolerance band (242 to 243 psia). A review of preflight data indicated it was initially low during ground checkout. The regulator maintained adequate tank pressure during entry thruster usage.

Postlanding sniff checks of the LP04 pod revealed no detectable propellant leaks. The helium isolation valves were closed and the vehicle was powered down before adequate oxidizer pressure data could be obtained to determine the status of the clamshell integrity. When turnaround data from OV-103 are available, the oxidizer tank pressure will be monitored and sniff checks of the LP04 pod purge will be performed regularly.

AUXILIARY POWER UNIT SUBSYSTEM

The auxiliary power unit (APU) subsystem performance was nominal throughout the mission, except for low chamber pressure and high fuel consumption. The three APU's ran for a total of 259.4 minutes consuming a total of 629 lb of fuel.

APU 3 exhaust gas temperature (EGT) sensor number 2 was erratic during ascent and descent (Problem Report STS-26-04A) and APU 1 EGT sensor number 1 was erratic during descent (Problem Report STS-26-04C).

During the mission, high fuel consumption was observed on APU 3 as compared to APU's 1 and 2. This was also seen during the wet countdown demonstration test (WCDDT), flight readiness firing attempt, and FRF. The acceptance test plan data also show that this APU had higher than normal fuel consumption, but was within specification. The second concern, which also involves APU 3, was the low chamber pressure seen throughout the mission as compared to APU's 1 and 2 (Problem Report STS-26-12). There was a large bubble present at start-up, but after it had cleared, the chamber pressure did not fully recover. A hydraulic load test was performed postlanding to determine if the APU would respond to a high hydraulic load and the APU had fully recovered. It should be noted that APU 1 also experienced low chamber pressure during descent start-up operations. This was observed before hydraulic pressurization and with a bubble. After hydraulic pressurization and the bubble had cleared, the chamber pressure came up to normal and the APU ran normally.

HYDRAULICS AND WATER SPRAY BOILER SUBSYSTEMS

Temperature data associated with fluids cooled by the water spray boilers (WSB's) during the ascent portion of flight with APU's running indicates normal warm-up profiles for hydraulic fluid. Data taken when the WSB's were still operating indicate water spraying was initiated for APU lubrication oil cooling (spraying occurs at 250 °F or above), but not for hydraulic fluid cooling (spraying occurs at 208 °F or above) during ascent. Examination of APU lubrication oil data shows the 250 °F point was reached in the lubrication oil system approximately 2 1/2 minutes before WSB shutdown or about 2 minutes after MECO. This compares closely with past flight data. WSB water tank quantity in system 1 dropped from 118 to 117 lb, system 2 remained unchanged, while system 3 dropped from 117 to 114 lb.

Except for the reconfiguration of valves, there was no circulation pump operation during the on-orbit phase, either manual or automatic. This occurred because the designated line temperatures and accumulator pressures did not drop low enough to demand it. By the end of the on-orbit phase, system 2 accumulator had dropped close to the required 1960-psia limit which would have activated that system's circulation pump for accumulator recharge.

System 1 WSB relief valve failed to fully reseat for the first 15 hours of the on-orbit phase. The regulator pressure showed a steady decrease until approximately 15 hours into the mission (Problem Report STS-26-09). The system was isolated during this time (shutoff valve closed).

After orbit was achieved, the gaseous nitrogen tank in system 1 water spray boiler developed a slow leak (Problem Report STS-26-19). This was verified by data which profiles the tank pressures of the three systems from approximately 1 day MET to 3 days MET. Data reflected the temperature of the gaseous nitrogen tanks remained constant during this time. The constant temperatures rule out decrease in system 1 tank pressure due to thermal effects. Leakage during the profiled time was 2.0 psi/hour.

The hydraulics subsystem experienced two instrumentation problems. At T-1 hour in the prelaunch countdown, the hydraulic system 3 circulation pump pressure measurement (V58P0337A) was biased low by 80 psia when at operating pressure (Problem Report STS-26-04E). The bias was considered acceptable. At 03:01:22 mission elapsed time, the hydraulic system 1 B supply pressure (V58P0115A) was biased low by approximately 60 psia (Problem Report STS-26-04D). The bias was within specification limits.

The flight control system checkout was performed nominally using APU 2 and water spray boiler B controller. At approximately 277:15:37 G.m.t., high lubrication oil temperature initiated WSB spraying for APU 1. Spraying for systems 2 and 3 occurred at 277:16:00 G.m.t. This performance was normal. Landing gear isolation valve 3 was opened manually at 277:15:55 G.m.t. and closed 1 minute later. This exercise was to verify no uncommanded brake pressure. Isolation valve 2 was then opened at 277:16:27 G.m.t. This was approximately 6 minutes 33 seconds after a relative velocity of 19,000 ft/sec was achieved. Isolation valve 1 was then opened at 277:16:34 G.m.t. (Mach 0.8). Finally, landing gear isolation valve 3 was reopened by software at nose gear touchdown. Data show the landing gear isolation valve operation was normal.

Water spray boiler water quantities at final shutdown were 90 lb, 96 lb, and 97 lb for systems 1, 2, and 3, respectively. System 1 had used 28 lb, system 2 had used 22 lb, and system 3 had used 21 lb during the hydraulic load test. Higher water usage in system 2 was due to system 2 experiencing the longest duration of loading by the control surfaces during the load test (the load tests were on systems 2 and 3 together, then on systems 1 and 2 together).

FUEL CELL POWERPLANT SUBSYSTEM

Performance of the OV-103 fuel cell subsystem was nominal for STS-26. It should be noted that STS-26 was the first flight of the improved fuel cell (FCP 2) and alternate water removal system. A fault message occurred 15 seconds after lift-off indicating a high ph in fuel cell number 2 which lasted for approximately 5 seconds. The high ph indication has been attributed to passing previously stagnant water, which contains metallic ions, through the sensor.

The fuel cells onboard OV-103 were serial numbers 104, 122, and 115, in positions 1, 2, and 3, respectively. Fuel cell operating time was approximately 142 hours. The accumulated operating times are 1031, 349, and 1044 hours for fuel cells 1, 2, and 3, respectively. Fuel cell startup was initiated at 273:01:43 G.m.t., and was completed at 273:03:23 G.m.t. The startup and prelaunch operations were nominal.

The Orbiter electrical power averaged 13.6 kWh and the total Orbiter load averaged 438 A. For the 97-hour mission, the fuel cells produced 1320 kWh

of electrical energy and 1000 lb of potable water. The fuel cells consumed 890 lb of oxygen and 110 lb of hydrogen. Actual fuel cell voltages averaged 0.05 volt above predicted for fuel cells 1 and 2 and 0.1 volt above predicted for fuel cell 3. Stack exit temperatures ranged between 195 and 205 °F. Condenser exit temperatures ranged between 151 and 156 °F. The cell performance monitor readings from the three fuel cells ranged from 2 to 58 mV.

The fuel cells were shut down 32 hours after Orbiter touchdown. During inerting of fuel cell 3, a problem was encountered with either the oxygen purge valve or the oxygen vent valve. The first pulse purge was accomplished successfully. In the second pulse purge, helium continued to flow after the close purge valve command was issued and the oxygen fuel cell supply valve was shut to stop the helium flow. Since the oxygen system remained exposed to the environment, concern developed about hydrogen overpressure which causes electrolyte to flow into the oxygen system. To avoid this situation, caps were placed on the hydrogen supply and oxygen vent and a hard tube jumper was placed across the oxygen supply and the hydrogen vent. Fuel cell 3 will be sent back to the vendor for failure analysis and conversion to the operational improvement configuration. Fuel cell 1 will also be sent back to the vendor for conversion to the operational improvement configuration.

The thermal performance of the fuel cell water relief and reactant purge systems was nominal. Heater system "A" on the water relief system was used for prelaunch, ascent, and up to 1:18:40:00 MET. At this time, the heaters were reconfigured to the "B" system for the remainder of the flight. While heater system "A" was in use, the nozzle heaters cycled. The water relief valve heaters, relief line heaters, and alternate water line heaters cycled while using heater system "B". Product water line temperatures were in the range of 136 to 145 °F and relief valve temperatures were between 75 and 95 °F. Temperatures at the nozzle indicated that the water nozzle heaters were functioning properly. The end cell heaters on fuel cells 1 and 3 were all observed to be cycling normally. Alternate water line temperatures ranged from approximately 70 to 100 °F.

POWER REACTANT STORAGE AND DISTRIBUTION SUBSYSTEM

The power reactant storage and distribution (PRSD) subsystem performed nominally throughout the mission. The fuel cells were placed on internal reactants at T minus 2 minutes 35 seconds per the nominal timeline. The pressure in the oxygen tanks started dropping at T minus 2 minutes at the rate of 20 psia/min, which was greater than predicted. At T plus 5 minutes, the "A" heaters in oxygen tanks 1 and 2 were automatically powered when the tank pressure reached the lower pressure control point of 811 psia in both tanks. The rate of pressure decrease changed to 10 psia/min, but the tank pressure continued to decrease. At T plus 12 minutes, the oxygen tank pressures stopped decreasing. This corresponds to the time that the crew began using cabin air for breathing. The "B" heaters in oxygen tanks 1 and 2 were enabled and the tank pressures in both tanks increased to the upper pressure control point of 846 psia. The heaters maintained the tank pressures in the control band for the remainder of the flight.

The oxygen flowrate to the launch/entry suits (LES) reached a peak of 28 lb/hr during ascent. The LES is designed to use a maximum of 5 lb/hr each. For a crew of five a maximum flowrate of 25 lb/hr was expected. Preliminary indications are that the crew did not close their visors during ascent, and this could account for the higher flowrate. The PRSD system was only certified to provide a 20 lb/hr maximum flowrate to the ECLSS. Both lines to the ECLSS have the capability of drawing 20 lb/hr from the PRSD system.

One of the two PRSD manifold isolation valves was closed during each of the crew sleep cycles. This resulted in one tank providing reactants to two fuel cells during the sleep cycle. When the crew awoke each morning, the isolation valve was reopened. The heaters in the tank that was supplying two fuel cells were disabled and the heaters in the dormant tank were enabled. The oxygen tank that supplied two fuel cells was thermally stratified at that time and exhibited a pressure collapse due to destratification after the inertial measurement unit (IMU) alignment maneuver each day. The pressure in the tank decreased from its normal pressure (811-846 psia for tanks 1 and 2 or 840-875 psia for tank 3) to approximately 730 psia. Environmental heat leak increased the tank pressure back up to the lower control pressure within 8 hours.

WATER AND WASTE MANAGEMENT SUBSYSTEMS

The supply water and waste management subsystems performed normally throughout the mission. By the completion of the mission, all of the associated in-flight checkout requirements were performed and satisfied.

Supply water was managed through the use of the overboard dump system and the flash evaporator subsystem (when operable). Three supply water dumps were performed at an average dump rate of 1.5 percent per minute (2.5 lb/min). The line temperature of the water system was maintained between 66 and 95 °F throughout the mission with the operation of the line heater.

Waste water was gathered at a lower rate than expected due to the problems with the flash evaporator subsystem. Nevertheless, a normal waste water dump was performed at a dump rate of 1.9 percent per minute (3.1 lb/min). The waste water line temperature was maintained between 57 and 78 °F throughout the mission, while the vacuum vent line temperature was between 60 and 84 °F.

The crew reported that the waste collector subsystem (WCS) operation was normal until day 3. At 75 hours MET, fan separator 1 exhibited a stall current (Problem Report STS-26-10). The crew switched to fan separator 2 which was used successfully for the remainder of the mission.

Postflight troubleshooting has included attempting to run the failed fan separator in the Orbiter prior to the WCS removal. Once again, stall current was seen as the fan separator failed to come up to speed in its normal start time. A detailed inspection and failure analysis will be performed after the WCS is returned to the vendor for cleaning.

ACTIVE THERMAL CONTROL SUBSYSTEM

The active thermal control subsystem (ATCS) performance was nominal for the freon coolant loops, radiators, and ammonia boiler system. One instrumentation problem occurred 3 minutes after lift-off. The freon evaporator outlet temperature (V63T1407A) in freon loop 2 lagged behind freon coolant loop 1 Freon evaporator outlet temperature (V63T1207A) by about 10 °F and about 5 seconds (Problem Report STS-26-04G). Postflight evaluation confirmed a debonded sensor that was removed and replaced. Orbiter cooling was maintained nominally except for flight day 1 when the flash evaporator system (FES) was shut down due to internal icing.

At approximately 1.5 minutes MET, prelaunch condensed water evaporation caused the fuel cell evaporator outlet temperature to drop to 43 °F. (Problem Report STS-26-05). Primary A controller was activated at 140,000 feet altitude (approximately 2:35 MET). The FES operated nominally until approximately 10 minutes MET when the temperature in the first elbow of the high-load duct dropped, indicating excessive water carryover into the duct. The high-load duct temperature continued to drop until 15 minutes MET, when the crew received an alarm for low duct temperature, at which time the system was switched to high load duct heater string B. The evaporator outlet temperature continued to be nominal, but the high load duct temperature continued to drop until approximately 20 minutes MET, when another alarm resulted in the crew activation of A/B heater strings. The evaporator outlet temperature continued nominal (39 °F) until 38 minutes MET, when it increased to 57 °F, and then returned to the normal control point of 39 °F. This was the first indication of an internal FES problem. At approximately 42 minutes MET, the evaporator outlet temperature rose to 43 °F and maintained that temperature for 40 seconds, meeting the criteria for a controller and high load over-temperature shutdown and the high load standby condition. The crew then switched to primary B controller, again decreasing the evaporator outlet temperature to 43 °F, and bringing the high load to standby status. The evaporator outlet temperature then rose to 62 °F, the high load reactivated and caused a brief leveling of the evaporator outlet temperature at 60 °F, but the 40-second shutdown logic time was exceeded and the total FES was then shut down. The crew switched to controller A, and the evaporator outlet temperature dropped to 39 °F, rose to 43 °F, and maintained for 40 seconds again, causing another FES shutdown. This scenario repeated with primary A in GPC position. The crew was then instructed to switch to secondary and to activate the topper only. This caused the topper to pulse both A and B valves, doubling the water flow, and causing a dynamic action that blew a significant amount of the ice out of the topper core, as was indicated by sharp drops of all topping duct section temperatures. The FES then operated properly for 30 minutes on secondary, until the payload bay doors were deployed and radiator cooling initiated.

Later, with the radiators controlled at the high set-point (57 °F), and after data review leading to the conclusion that both primary A and B controllers were good, the primary A controller and topping evaporator were activated. These components operated nominally for 3.5 hours to perform a supply water dump and test the evaporator. Subsequently, primary B controller and topping evaporator were activated and performed nominally for 5 hours.

On flight day 4, prior to deorbit preparations, the radiators were controlled at the normal set-point of 38 °F, and the topper was activated for 10 hours, and operated nominally. With the radiators at high-set point of 57 °F, and with the topper on primary B for normal entry, a 30-minute radiator cold soak (with radiators in bypass position) was obtained with the Orbiter in the tail-Sun attitude.

A deorbit preparation FES checkout procedure was performed prior to OMS ignition to verify FES operations. The checkout included high-load evaporator activation with secondary controller, with three 30-second on/off cycles, pre-determined to clear the evaporator of any ice left from ascent. High load operation occurred subsequently for 10 minutes. No ice was indicated by the duct temperatures. The crew then activated both the topper and high load on primary B, and normal FES operations occurred for the next 3.5 hours.

Just prior to deorbit ignition, the evaporator outlet temperature increased to above 43 °F, indicating high load operation only, with a frozen topper. After the 40-second time period, the controller logic caused another over-temperature shutdown. The crew re-activated the high load with the secondary controller, which operated nominally until normal radiator cold soak was utilized in accordance with the normal entry timeline.

SMOKE DETECTION/FIRE SUPPRESSION SUBSYSTEM

The smoke detection/fire suppression (SDFS) functioned normally. The subsystem was not used and no anomalies were experienced.

ATMOSPHERIC REVITALIZATION SUBSYSTEM

The performance of the atmospheric revitalization subsystem (ARS) air and water coolant loops was normal. Due to active thermal control system (ATCS) problems, the cabin air temperature and relative humidity peaked at 88 °F and 64 percent, respectively. The avionics bays 1, 2, and 3 air outlet temperatures were also affected and peaked at 116, 104 and 90 °F, respectively, as well as each bay's combined cold-plate outlet temperatures that peaked at 98, 98, and 85 °F. The water coolant loop bypass was reset to zero in an attempt to lower Orbiter cabin temperatures. At different points during the mission, the flash evaporator system was reactivated and the cabin and avionics temperatures were observed to decrease accordingly. Even with the elevated temperatures that were experienced on this flight, the flight deck avionics cooling was maintained within satisfactory limits.

During the first sleep period, the waste water tanks were filling at a lower rate than expected. Subsequent data evaluation indicated that the lower water removal rates were caused by the higher-than-normal cabin heat exchanger outlet temperatures, which were induced by the problems with the FES. During the times that the FES was operating at the normal temperatures, humidity separators removed water at normal rates.

Overall, the atmospheric revitalization pressure control subsystem (ARPCS) performance was satisfactory. Automatic cabin pressure and partial pressure

of oxygen (PPO₂) control were utilized and remained within normal limits. Pressure control systems 1 and 2 were utilized to accommodate the in-flight checkout requirements for the redundant systems.

Following launch and for the remainder of the mission, a difference in readings between the PPO₂ sensors A and B was noted that varied between 0.04 and 0.12 psia. These variations were the result of cabin temperature excursions. The sensors remained within acceptable tolerances.

During normal automatic pressure control, a high nitrogen (N₂) flow caution and warning (C/W) alarm occurred. This alarm was coincident with a switchover from oxygen to nitrogen flow (system 2 PCS). Investigation showed that the cabin regulator can exhibit this characteristic (momentary high flow) when two conditions occur simultaneously. These two conditions are: demand flow at or near the high flow trigger point for the regulator, and switchover from oxygen to nitrogen flow. Both of these conditions existed when this alarm occurred. The controlled recovery of the regulator to normal demand rates indicated that the regulator performance was normal.

Cabin leakage was monitored throughout the flight and cabin leak rates indicated a tight cabin with no additional leakage attributed to the side-hatch crew-escape modification.

Two problems occurred prior to orbital insertion. Prior to launch, the dp/dt LCC redline was violated. This violation was shown to be a result of the oxygen flow to the launch/entry suits which appears to be higher than observed with the use of the launch/entry helmets on previous flights. Since this condition was understood, the LCC limit was masked in the ground launch sequencer. A change to the LCC will be made prior to STS-27.

The second problem involved a high PPO₂ C/W alarm that occurred after main engine cutoff (MECO). This problem is also related to the crew usage of the LES's. The pumping up of the suits for comfort increased the cabin PPO₂ prior to launch. This increased the PPO₂ at a high rate. To alleviate these problems for STS-27 and subsequent flights, the crew-comfort positioning procedure will be modified.

AVIONICS SUBSYSTEMS

The overall integrated guidance, navigation and control (GN&C) subsystem performance was satisfactory.

During the prelaunch time frame, no GN&C-related anomalies were noted. The normal elevon/MPS/SRB actuator slew checks were performed nominally. The SSME ignition occurred in staggered order (3, 2, and 1) with SSME 3 starting at T-6.6 seconds as planned. The SSME's properly trimmed from the start position (null) to the launch positions (parallel in yaw axis) prior to lift-off and at the 90-percent rated power level.

No lift-off GN&C-related anomalies were noted. The SRB ignition time of 15:36:59.97 G.m.t., (originally scheduled for 13:59:00 G.m.t.) was recorded by the general purpose computers (GPC's). The lift-off conditions, as determined

from GPC data, indicated a pitch rate of 0.4 deg/sec. Lateral acceleration data following SRB ignition showed no holddown bolt hang-ups, and all acceleration data appeared nominal.

During the first stage of ascent, the vertical rise rate was satisfactory, and a nominal roll maneuver was noted. The adaptive guidance sensed slightly higher-than-predicted SRB motor performance. No unexpected launch-environment-induced trajectory perturbations were observed, nor did any unscheduled elevon load relief occur. All elevon differential pressures were within load-relief initiation limits. No first stage avionics subsystem anomalies were noted.

All SRB separation functions were executed properly. No SRB separation anomalies occurred, and all staging conditions were within design limits.

The ascent second stage/insertion was satisfactory with no anomalies. The second-stage peak altitude of 425,000 ft was as predicted with the guidance-initiate rate transient of +2 deg/sec in pitch being nominal. The ET separation at 8 minutes 50 seconds mission elapsed time was followed by loading of OMS-2 maneuver targets. The subsequent maneuver achieved the desired orbit of 162 by 160 nmi.

No GN&C anomalies were noted during the IUS/TDRS satellite deployment activities.

During descent, no GN&C performance problems were noted. The downlist data were available at approximately 150,000 feet altitude with the data being lost from 5600 feet until 12 feet altitude. The standard procedures were followed throughout entry and touchdown. The automatic flight control system (FCS) was used for the entry and terminal area energy management (TAEM) acquisition phases. Manual takeover occurred just prior to the left-hand heading alignment circle (HAC) turn and continued through the touchdown and rollout phases. Nominal interface conditions existed at entry, TAEM, and TAEM-autoland. Two primary avionics software system (PASS)-to-backup flight system (BFS) state vector transfers were made during the entry phase, one at 110,000 feet altitude, and the second on the HAC just prior to beginning of processing landing data.

The navigation aids performed satisfactorily with all measurements comparing well with previous flights. The navigation aids timeline was as expected with no data editing observed. The PASS/BFS state vector difference was comparable to previous flights. The entry flight control system performed excellently. Rates and elevon/body flap positions matched well with predictions. The rudder engaged at Mach 5.0 instead of the expected Mach 4.2, but the vehicle flew as expected. The main gear touchdown occurred at an estimated air speed of 175 knots and 3500 feet past the runway threshold. The nose gear slardown occurred at an estimated air speed of 155 knots. The load relief moved the elevons to +10 degrees as expected after nose gear touchdown. The nose wheel steering performance matched predicted values with movement of about 1 degree during rollout.

The inertial measurement unit (IMU) performed nominally, and all hardware and software discretetes were proper with no major problems.

The overall startracker performance was nominal with 10 IMU-to-startracker alignments. Frequent shutter closure/target suppression was noted on both startrackers, and this was the result of high background light intensity.

The crewman optical alignment sight (COAS) performance was nominal from the aft position with three repeatable star sightings that were usable for IMU alignments. The performance was unsatisfactory from the forward position. At 275:11:02 G.m.t., the crew attempted a calibration of the COAS from the +X position. A 1.97-degree differential bias was noted from this calibration. The COAS knurled screw could only engage approximately 1 1/4 threads in the nut plate, whereas the screw normally engages 4 to 5 threads (Flight Problem STS-26-08).

The overall performance of the flight control subsystem was nominal. The SSME actuator command versus position differentials before repressurization ranged to a high of 1.63 degrees. This was within the requirement of equal to or less than 2.0 degrees. After repressurization, all differential values were within 0.6 degree. During postlanding operations, the SSME positioning to the rain position was performed with nominal operation.

During the prelaunch OMS gimbal profile test, the left OMS secondary (standby) pitch and yaw actuators did not drive with only the enable 1 (RPC 1) command on. Both pitch and yaw actuators drove with enable 2 command on (Flight Problem STS-26-01). The countdown was continued under LCC guidelines which allow a failure of either the primary or secondary actuator channels of one OMS engine. Postflight troubleshooting identified an open circuit.

The electrical power distribution and control (EPDC) subsystem operation was nominal from prelaunch through landing with no anomalies reported.

The displays and controls (D&C) subsystem operation was normal except for a minor discrepancy reported in the Commander's ADI, AMI, and AVVI during FCS checkout (OPS-8). At approximately 276:13:26 G.m.t., during the dedicated display checkout, discrepancies were noted with the Commander's instruments. The GPC sends a pre-defined set of test values to both the left and right data display unit (DDU) which drive the instruments. The Commander's instrument readings were different than expected (Flight Problem STS-26-20). The errors were not duplicated by subsequent ground troubleshooting.

The data processing (DPS) subsystem operation was nominal from prelaunch through landing with no hardware failures detected.

The communications and tracking subsystem performance was nominal except for an S-Band uplink lock anomaly during prelaunch activities, a Ku-Band antenna pointing anomaly during flight and loss of altitude data at 50 feet on the radar altimeter. During prelaunch communications checks, uplink frame synchronization lock could not be obtained in the transponder 2/NSP1 configuration. (Flight Problem STS-26-02). After cycling the S-Band equipment, the problem would not repeat and was determined to be no constraint to launch.

At 274:14:24:00 G.m.t., the Ku-band antenna did not follow the designated angles that were commanded. (Flight Problem STS-26-06) The decision was made to drive the Ku-Band antenna to the stow-angles and place it in the standby

mode. When the antenna was slewed to near the lock angles, an oscillation was observed and the system was placed in standby until a procedure was developed to enhance the stow activity. The antenna was then successfully slewed to the lock angles, the gimbals were locked and the deployed assembly was stowed.

The radar altimeter lost lock during the landing phase at about 50-foot altitude when the crew reported the off flag appeared on the pilot and commander displays. (Flight Problem STS-26-16). The data became good again at approximately 5 feet altitude. The crew completed a normal landing using alternate visual cues.

The operational instrumentation operated nominally throughout the mission. At 274:13:42 G.m.t., while repositioning the OPS-2 recorder by a rewind command, the ground reported that modulation was seen on the FM frequency (Flight Problem STS-26-15). Troubleshooting verified that when positioning OPS-2 recorder while dumping OPS-1 recorder, an output that causes link interference will emanate from the OPS-2 recorder.

The BFS operated nominally throughout the mission. At 277:16:27:57:516 G.m.t., a BFS entry fault message "I/O error CRT 3" was noted. The fault occurred at the time of a PASS/BFS state vector transfer crew keyboard command. The downlist data analysis indicated the item 17 keyboard entry was incomplete. The crew reinputted the command and a proper state vector transfer occurred.

THERMAL CONTROL SUBSYSTEM

The thermal control system (TCS) performed satisfactorily throughout the mission. Nominal temperature responses were noted on all Orbiter structure and system measurements.

The forward reaction control system heater systems operated nominally. The starboard compartment heater first became activated approximately 54 minutes after launch, and thereafter the port and starboard heaters each alternately cycled twice. The thruster heaters maintained the fuel and oxidizer valves within operational temperature limits. No thermal anomalies were noted.

The environmental control and life support system heaters for the lines and nozzles of the supply water dump, waste water dump, and vacuum vent systems performed nominally. The supply water dump system was used three times to dump water overboard. The nozzle was warmed to at least 100 °F prior to each dump and the temperature was maintained between 150 to 170 °F during each dump. The waste water dump system was used once to dump waste water overboard. The nozzle was heated to 250 °F prior to the dump. The thermal responses of both the supply and waste water dump nozzles were nominal.

All fuel cell water lines, relief valves and nozzle heaters maintained their system temperatures within a nominal temperature range. The fuel cell water line temperatures did not decrease to the heater "ON" temperature, therefore these heaters did not cycle. Both heater systems "A" and "B" on the alternate product water cycled as expected. The overboard relief nozzle heaters were enabled and maintained a nominal temperature range throughout the flight.

The flash evaporator system feedwater line, accumulator, duct and nozzle heaters operated nominally. Feedwater flow occurred on both primary (port) and secondary (starboard) feedlines and all temperatures were maintained within their limits with the exception of the primary high load line. The high load line temperature twice exceeded 250 °F (22:00 and 68:00 hours MET) as cool water from the accumulator passed over the thermostat.

All APU fuel and water cooling heater systems operated nominally and maintained temperatures within the respective system's operational limits during the on-orbit period. At lift-off, APU system 3 exhaust gas temperature sensor failed, however, this did not impact the mission.

All three APU isolation valve set temperatures were maintained within a nominal range, however, the APU system 3 isolation valve set had the lowest average temperature. Each set of valves (3 sets of 2 valves each with one set for each APU) was instrumented with four new sensors. All three sets had similar heater duty cycles, approximately 16 percent, and were exposed to similar environments, 20 °F ± 5 °F. The valve sets registered average temperatures of 72 °F, 83 °F and 58 °F for APU system 1, 2, and 3, respectively.

The OMS crossfeed, bleed and drain lines heaters cycled normally during on-orbit operations. The heater systems were switched from system "A" to system "B" at 21:18 hours MET due to a suspected transducer failure (zone 5 of the crossfeed line heater). The transducer responded properly after the heater reconfiguration and it became apparent that the heater thermostat was dithering. However, during entry preparation, these heaters were reconfigured to "A/B", and there was no evidence of a dithering thermostat.

The seven heater circuits that comprise the compartment heater systems of each OMS pod performed nominally during the on-orbit phase. As expected, several of the heaters did not activate (cycle) because the environment did not cool the thermostats to their on temperature. The keel web heaters in each pod operated on both systems "A" and "B". The port pod (LP04) keel web heater first came on at 18.5 hours MET while the starboard pod (RP03) keel web heater first came on at 27 hours MET. Both pod compartment heater systems were reconfigured from system "A" to system "B" at approximately 43 hours MET.

The port and starboard pod RCS propellant tanks were maintained above 70 °F (the zot limit) throughout the flight. The starboard pod (RP03) system "B" keel web heater thermostat has an on temperature approximately 2 °F higher (60.6 °F) than system "A" (58.8 °F). As a result, the starboard RCS propellant tanks reached a low of 73 °F at 43 hours MET and rose slightly when reconfigured to system "B".

The port pod (LP04) keel web heater has an on temperature of 61.2 °F in heater system "A" and an "on" temperature of 56.7 °F in heater system "B". After heater reconfiguration from system "A" to "B" at 43 hours MET, the RCS propellant tank temperature decreased to 71 °F at 68 hours MET. Prior to that time, the vehicle attitude had been -ZLV, +XVV which is a warm attitude for the OMS pod section containing the keel web thermostat. This attitude

combined with a comparatively low on temperature caused a delay in the heater operation. The vehicle attitude was changed to -ZLV, -XVV at 66 hours MET, a cool attitude for the port pod. The heater system "B" keel web heater came on and the tank temperature slowly increased.

The aft RCS thruster heaters performed nominally. All thrusters temperatures were maintained within acceptable limits.

All hydraulic systems were maintained within their temperature limits during the on-orbit flight phase. Neither circulation pump nor heater operation were required for on-orbit thermal conditioning of hydraulic system components.

The Orbiter structure during the on-orbit phase was thermally benign and all bondline and structure temperatures were nominal. The entry interface bondline temperatures were well below their respective limits.

THERMAL PROTECTION SUBSYSTEM

The thermal protection subsystem (TPS) performance was nominal, based on structural temperature response, and some tile surface temperature measurements. Overall vehicle boundary layer transition from laminar to turbulent flow occurred later than expected (approximately 1135 seconds after entry interface, based on five lower surface tile thermocouple data) and was largely attributed to the smoothing (shaving) of the nose area tiles. The "backed out" nose area analytical equivalent roughness (Keq) was 0.127 inch as compared to the requirement of 0.140 inch and the maximum measured value of 0.135 inch.

The late overall transition minimized the effect of early transition at the large impact damage site on the lower right wing. Increased turbulent heating effects downstream of the large impact site created local melting of the tile material where coating had been removed as a result of particle impacts emanating from the large impact site.

Overall, the TPS damage was less than that normally seen. The most significant damage was a large gouge on the lower surface of the right wing that was approximately 6 inches wide, 8 inches long, and 1 1/4 to 1 1/2 inches deep (Problem Report STS-26-13). No structural damage occurred at the large impact site on the wing based on visual observation, temperature indicator readings inside the wing, and structural integrity tests performed after tile removal.

The runway inspection report indicated the TPS sustained relatively minor damage. The nose cap and wing leading edge looked good. The chin panel tile modification also looked extremely good. The elevon cove modification looked unflown. The typical broken tile corners were found on the left and right main landing gear door outboard corners.

Impact damage was minimal with approximately 50 hits greater than one inch. The base heat shield peppering was more concentrated between the three engine bells. There was one broken tile on the left-hand OMS bolt cover box.

Several instances of advanced felt reusable surface insulation leading edge fraying or protrusion were noted. There was a vertical tear in the outer mold line fabric of the 50-1 door. The ET thermal barriers looked good. The elevon gap had 5 breached gap fibers on the left side and 7 on right side. Window number 3 appeared to have more hazing than others.

The ET arrowhead and attachments looked good. Erosion of carrier plate tile was noted aft and outboard of window number 3. There was protruding gap filler sleeving on the right-hand OMS pod. The usual engine-mounted heat shield blanket damage was noted.

AEROTHERMODYNAMICS SUBSYSTEM

The Orbiter aerothermodynamic entry environment was as expected. Direct conclusions regarding the aerothermodynamic environment can be made because this flight is the first flight since the Orbital Flight Test Program from which surface thermocouple data are available.

The assessment of the aerothermodynamics is based on trajectory parameters from the onboard navigation system. Since these trajectory parameters showed very close agreement with the preflight trajectory, the preflight heating predictions are compared to the flight measurements. There is very close agreement between the preflight and measured laminar and turbulent heating for the windward fuselage and wing.

There was very little local high heating to tiles in the chin panel area, contrary to the experience of previous flights, and this performance is attributed to the careful smoothing of tiles in this area. The transition from laminar to turbulent heating on the fuselage agreed with preflight predictions.

The transition on the wing corresponded to a much smoother surface than measured. The later wing transition reduced the local heating effects in the gouge on the wing, potentially preventing structural damage. Heating to damaged areas of the elevon downstream of the gouge indicated a locally induced early transition, as would be expected from such a significant roughness. Overall, the aerothermodynamic environment was as expected, and valuable data were obtained for the understanding of roughness effects on transition.

AERODYNAMICS

No entry aerodynamics anomalies have been identified. No aerodynamic Detailed Test Objectives (DTO's) were performed during this entry and no maneuvers were planned.

Longitudinal trim was within the expected limits. Elevon deflections were within limits of previous flight experience in the Mach region from 2 to 12. The body flap deflection required to trim was within pitching moment uncertainties.

MECHANICAL SUBSYSTEMS

The Orbiter/ET separation mechanisms, payload retention latches, Ku-band antenna deployment, vent door, ET/umbilical door, startracker door, and air data probe subsystems functioned with no anomalies during the mission.

The payload bay door subsystem encountered one anomaly during the door closure sequence. The number 1 starboard door ready-to-latch indication failed to come on during starboard door closure (Problem Report STS-26-11). This is a triple redundant indication and the anomaly caused no problem for the continued door closure and latch sequence.

The Orbiter/ET umbilical separation system had debris that escaped and fell to the lake bed when the ET/umbilical doors were opened during final approach and landing. The part, about 2 1/2 inches long, was identified as V072-565471 yoke, and is used to lock the frangible nut to the container. A change, already approved, will add a hole plugger designed to close the hole after bolts are ejected so that the debris will be contained.

LANDING AND DECELERATION SUBSYSTEM

The landing and deceleration subsystem performance was normal with no known anomalies. Deployment mechanisms, braking, steering, and tires performed as expected.

The brakes have been visually inspected at the factory, and no damage was detected. X-ray and eddy current tests were successful. These brakes will be put back into service and will be used "as is." The right-hand outboard (RHOB) brake operated slightly warmer than the other three brakes as indicated by tempilabels on the actuator housing. Although the pressures were typical, further evaluation of the pressure will be conducted to determine if any adjustment of the pressure balancing tolerance is required. Moderate brake application started at 134 knots ground speed producing an initial deceleration of 10.5 ft/sec/sec. Subsequent brake pressures varied between 300 and 600 psig, which gradually allowed the deceleration to decay to 2 ft/sec/sec. Just prior to wheel stop, the brake pressure rose to 800 psig for several seconds. Lakebed rutting varied between 0.5 and 2.5 inches which is typical and added to the deceleration during rollout. The 2.5-inch ruts occurred in the nose pitchdown area where the highest tire loads normally occur. The total rollout distance was 7451 feet.

The tires were in very good condition after the landing, showing only those minor scratches typically seen after a lakebed landing. There was no measurable amount of wear or spin-up damage. The main gear tire pressures ranged from 343 to 349 psig following landing. Both nose gear tires had a measured pressure of 319 psig, which were well within allowables.

The landing gear deployment times ranged from 5 to 6 seconds, as compared to the 10-second limit. All systems performed normally; all spring bungees actuated, the uplocks were released by the hydraulic actuators (pyrotechnics are backups), and the nose gear pyrotechnics booster functioned normally. Nose-wheel steering was operated normally for straight-ahead steering with some minor plus or minus 1 degree commands occurring as expected.

GOVERNMENT FURNISHED EQUIPMENT

The government furnished equipment (GFE) operation was considered nominal with only a few minor anomalies that are discussed in the following paragraphs.

Four video cassette tapes jammed in the video cassette recorder (VCR) and one had to be cut with scissors to remove the tape. Some recorded video was lost because of tapes jamming, but this condition did not affect the mission (Problem Report STS-26-17a). The crew noted that the video cassette recorder and cameras are older designs and recommended replacement with more state-of-the-art equipment.

The vacuum cleaner was blowing vacuumed material past the vacuum cleaner flapper, rendering the vacuum cleaner unusable (Problem Report STS-26-17b). There was no affect on the flight other than the inability to use the vacuum cleaner to clean the cabin and filters.

The seat backs failed to fold with parachutes attached (Problem Report STS-26-17c). During ground tests, seat backs with parachutes attached could be folded, however, this could not be done during flight. The seats were stowed unfolded in the airlock with no affect on the mission.

A high reading on one dosimeter was noted during the ground turnaround activities (Problem Report STS-26-17e). There was no affect on the flight since the other dosimeter onboard the Orbiter read expected values.

The forward port floodlight failed off (Problem Report STS-26-18a) with no affect on the mission. The anomaly was duplicated by ground testing and the floodlight was removed and replaced. The forward bulkhead floodlight was flickering during operation (Problem Report STS-26-18b). Ground testing duplicated the flickering for 15 seconds before achieving full brightness. Flickering of floodlights is expected and normal for up to 15 seconds following activation.

During postflight checkout, it was determined that the bridgewires in the pyrotechnics in the second and third bottles on the left side assembly of the

hazardous gas detection subsystem were still intact, and the valves did not open/close to take a gas sample. During the gas sample analysis, it was also discovered that the pyrotechnic valve in the first bottle on the left side failed to close completely and that one of the bottles on the right side leaked to near atmospheric pressure (thus losing the gas sample) after landing (Problem Report STS-26-17D).

PAYLOADS ASSESSMENT

INERTIAL UPPER STAGE/TRACKING AND DATA RELAY SATELLITE

The inertial upper stage (IUS)/tracking and data relay satellite (TDRS) combination was deployed on time at 273:21:50:04 G.m.t. The vehicle was very stable throughout the separation phase and the OMS maneuver to move the Orbiter a safe distance away from the IUS/TDRS vehicle.

The firings of the IUS solid rocket motor (SRM) to place the TDRS in a geosynchronous orbit were completed on schedule. The TDRS was placed in a nominal 19,335 by 19,311 nmi. orbit. The antennas and solar arrays were deployed and the satellite will be operational for the STS-27 mission.

ORBITER EXPERIMENT AUTONOMOUS SUPPORTING INSTRUMENTATION SYSTEM

The Orbiter Experiment (OEX) Autonomous Supporting Instrumentation System (OASIS) payload was configured to interface with the TDRS/IUS to measure thermal, acoustic, vibration, stress, and acceleration data of the vehicle within the Orbiter payload bay. The OASIS components performed as planned.

EXPERIMENTS ASSESSMENT

All experiment operations during the mission were nominal. All five of the planned runs of the Physical Vapor Transport of Organic Solids (PVTOS) were completed as scheduled. All runs of the Automated Directional Solidification Furnace (ADSF) were completed. The Protein Crystal Growth experiment photographic session and deactivation was completed during the third mission day. A listing of the experiments performed during STS-26 is as follows:

AUTOMATED DIRECTIONAL SOLIDIFICATION FURNACE (ADSF)

PHYSICAL VAPOR TRANSPORT OF ORGANIC SOLIDS (PVTOS)

INFRARED COMMUNICATIONS FLIGHT EXPERIMENT (IRCFE)

PROTEIN CRYSTAL GROWTH (PCG)

ISOELECTRIC FOCUSING (IEF)

PHASE PARTITIONING EXPERIMENT (PPE)

AGGREGATION OF RED BLOOD CELLS (ARC)

MESOSCALE LIGHTNING EXPERIMENT (MLE)

EARTH-LIMB RADIANCE EXPERIMENT (ELRAD)

THE EFFECT OF WEIGHTLESSNESS ON GRAIN FORMATION (SSIP 82-04)

UTILIZING A SEMI-PERMEABLE MEMBRANE TO DIRECT CRYSTAL GROWTH (SSIP 82-05)

DETAILED TEST OBJECTIVES ASSESSMENT

All detailed test objectives (DTO) and detailed supplementary objectives (DSO) were satisfactorily accomplished during STS-26. The following table lists each objective and its status.

<u>DTO/DSO</u>	<u>Title</u>	<u>Activity</u>	<u>Status</u>
301	Ascent structural capability evaluation	Data only	Met
305	Ascent compartment venting evaluation	Data only	Met
306	Descent compartment venting evaluation	Data only	Met
307	Entry structural capability	Data only	Met
308	Vibration and acoustic evaluation	Data only	Met
311	POGO stability performance	Data only	Met
318	Direct insertion ET tracking for ETR	Photo and tracking of ET after separation	Met
319	Shuttle payload low frequency environment	Data only	Met
457	Salivary Scop/Dex kinetics	--	Met
458	Salivary Tylenol kinetics	--	Met
459	Otolith tilt-transition reinterpretation	--	Met
460	Changes in total body water	--	Met
623	Cabin air monitoring	Samples of cabin atmosphere	Met
784	Space-ground link system navigation certification	Adequate tracking data to certify network	Met
787	Attitude match update	Data only (4 of 5 data takes)	Met
901	Documentary television	Throughout flight	Met
902	Documentary motion picture photography	Throughout flight	Met
903	Documentary still photography	Throughout flight	Met

TABLE I.- STS-26 MISSION EVENTS LIST

EVENT	SOURCE	DESCRIPTION	ACTUAL G.m.t.
APU activation	V46P0120A	APU-1 GG Chamber pressure	273:15:32:09.850
	V46P0220A	APU-2 GG Chamber pressure	273:15:32:10.929
	V46P0320A	APU-3 GG Chamber pressure	273:15:32:12.075
SRB HPU activation (USBI)	B58K3017X	LH HPU Sys A start cmd	273:15:36:32.044
	B58K3019X	LH HPU Sys B start cmd	273:15:36:32.209
	B58K4017X	RH HPU Sys A start cmd	273:15:36:32.388
	B58K4019X	RH HPU Sys B start cmd	273:15:36:32.534
MPS start	E41M3076D	ME-3 Phase in effect	273:15:36:53.438
	E41M2076D	ME-2 Phase in effect	273:15:36:53.571
	E41M1076D	ME-1 Phase in effect	273:15:36:53.698
SRB ign command	Calculated	SRB ign cmd to SRB	273:15:37:00.009
Throttle down to 102 % thrust	E41M3076D	ME-3 Vehicle command	273:15:37:17.799
	E41M2076D	ME-2 Vehicle command	273:15:37:17.811
	E41M1076D	ME-1 Vehicle command	273:15:37:17.819
Throttle to 65%	E41M3076D	ME-3 Vehicle command	273:15:37:27.719
	E41M2076D	ME-2 Vehicle command	273:15:37:27.732
	E41M1076D	ME-1 Vehicle command	273:15:37:27.739
MAX Q	V95P0500C	Derived Asc dyn press	273:15:37:51.024
Throttle up to 104%	E41M3076D	ME-3 Vehicle command	273:15:37:59.080
	E41M2076D	ME-2 Vehicle command	273:15:37:59.092
	E41M1076D	ME-1 Vehicle command	273:15:37:59.100
Both SRMs PC at 50 psi or below	B47P1302C	LH SRM chamber press Mid range select	273:15:38:59.093
	B47P2302C	RH SRM chamber press Mid range select	273:15:38:58.853
End SRM action	B47P1302C	LH SRM chamber press Mid range select	273:15:39:02.569
	B47P2302C	RH SRM chamber press Mid range select	273:15:39:03.079
SRB sep command	V90X8331X	SRB separation cmd flg	273:15:39:04.506
SRB physical separation	B46R1408C	SRB physical separation LH fwd bsm	273:15:39:04.815
	B46R1409C	LH aft bsm	273:15:39:04.815
	B46R2408C	RH fwd bsm	273:15:39:04.855
	B46R2409C	RH aft bsm	273:15:39:04.855
Throttle down for 3G accel	E41M3076D	ME-3 Vehicle command	273:15:44:33.490
	E41M2076D	ME-2 Vehicle command	273:14:44:33.500
	E41M1076D	ME-1 Vehicle command	273:14:44:33.472
3G Acceleration	V95U0163C	TOT load factor	273:15:44:33.000
MECO	V90X8569X	MECO command flag	273:15:45:32.594
	V90X8561X	MECO confirm flag	273:15:45:33.447

TABLE I.- CONCLUDED

EVENT	SOURCE	DESCRIPTION	ACTUAL G.m.t.
ET separation	V90X8250X	ET separation cmd flag	273:15:45:50.512
APU deactivation	V46P0120A V46P0220A V46P0320A	APU-1 GG chamber press APU-2 GG chamber press APU-3 GG chamber press	273:15:50:34.212 273:15:50:34.482 273:15:50:35.533
OMS 2 Ignition	V43H4655C V43H5655C	L ENG BI-PROP VLV POS R ENG BI-PROP VLV POS	273:16:16:55.905 273:16:16:55.674
OMS 2 Cutoff	V43H4655C V43H5655C	L ENG BI-PROP VLV POS R ENG BI-PROP VLV POS	273:16:19:17.516 273:16:19:17.516
TDRS/IUS deploy	Voice call	Nominal met 6:13	273:21:50:04.000
OMS 3 ignition	V43H4655C V43H5655C	L ENG BI-PROP VLV POS R ENG BI-PROP BLB POS	273:22:05:02.031 273:22:05:02.099
OMS 3 cutoff	V43H4655C V43H5655C	L ENG BI-PROP VLV POS R ENG BI-PROP VLV POS	273:22:05:19.096 273:22:05:18.891
IUS first stage burn	Voice call	Nominal met 7:13	273:22:50:04.000
IUS second stage burn	Voice call	Nominal met 12:30	274:04:06:48.000
FCS checkout APU start APU stop	V46P0220A V46P0220A	APU 2 GG chamber pres APU 2 GG chamber pres	276:12:53:43.447 273:12:57:54.717
APU activation	V46P0120A V46P0220A V46P0320A	APU-1 GG chamber press APU-2 GG chamber press APU-3 GG chamber press	277:15:29:47.021 277:15:53:40.468 277:15:53:41.901
Deorbit burn	V43H4655C V43H5655C	L ENG BI-PROP VLV POS R ENG BI-PROP VLV POS	277:15:34:45.106 277:15:34:45.106
Deorbit burn cutoff	V43H4655C V43H5655C	L ENG BI-PROP VLV POS R ENG BI-PROP VLV POS	277:15:37:33.311 277:15:37:33.311
Entry interface (400K)	V95H0175C	Curr orb alt above ref ellipsoid	277:16:06:33.038
Blackout end	Any MSID	Data locked (high s.r.)	277:16:23:20.000
TAEM	V90Q8001C	Major mode code (305)	277:16:30:46.000
MLG contact	V51X0130X V51X0230X	LH mlg wt on wheels RH mls wt on wheels	277:16:37:11.468
Nlg contact	V51X0330X	Nlg wt on wheels-1	277:16:37:18.396
Wheel stop	V95L0255C	Veloc wrt runway (f/s)	277:16:37:57.509
APU deactivation	V46P0120A V46P0220A V46P0320A	APU-1 GG chamber press APU-2 GG chamber press APU-3 GG chamber press	277:16:52:22.564 277:16:52:23.168 277:16:52:23.625

PROBLEM TRACKING LIST		STS-26 OV103 FINAL REPORT		DATE 11-18-88	PAGE 1
NO.	TITLE	TIME	COMMENTS	MOD NO.	RESP. MGR.
STS-26 -1	OMS Gimbal Standby Enable 1 Fail	273:06:40 GMT CAR #26RF16 Criticality 1R3	<p>During prelaunch OMS Gimbal Profile Test, left secondary (standby) TVC did not drive actuators with RPC 1 enable. During post OMS 2 Gimbal check RPC-2 tripped off after some movement of OMS TVC which indicates RPC-2 functional. No mission impact</p> <p><u>Corrective Action:</u> Launch Commit Criteria (LCC) revised to permit loss of either primary or secondary controller on a given OMS engine. Open circuit to be repaired. Closeout tracked by CAR #26RF16. Problem is closed.</p>	GNC-01	J. Vernon
STS-26 -2	NSP-1 Frame Synchronization Unlock(Transponder-2)	273:02:30 Car #26RF17 Criticality 1R3	<p>During prelaunch Comm C/O uplink was switched from xponder 1 to xponder 2. NSP 1 did not indicate bit or frame sync. Troubleshooting couldn't repeat. Could lose cross strap capability if problem repeats.</p> <p><u>Corrective Action:</u> Since the most probable cause is contamination on the forward link data relay, in XPNDR #2 which cleared with subsequent cycling, no corrective action is required. A UA is being processed. Closeout tracked by CAR #26RF17. Problem is closed.</p>	INCO-1	M. Schmalz

JSC Form 318 (Feb 81)

NASA-JSC

PROBLEM TRACKING LIST		STS-26 OV103 FINAL REPORT		DATE	PAGE
NO.	TITLE	TIME	COMMENTS	MOD NO.	RESP. MGR.
STS-26-3	MS-1/PLT suit vent fans failed	273:12:33 273:12:48 PRACA #EC0380 Criticality 3	During prelaunch ingress both MS-1 and PLT suit fans failed. Fuses replaced with 10 Amp fuses prelaunch. Crew replaced 10 Amp fuses with 5 Amp fuses from IFM kit. <u>Corrective Action:</u> The Suit Fan motor power circuit design has been changed to reflect replacement of 3 AMP fuses with 5 amp fuses. Spare suit fan, cables & fuses will be available at KSC for STS-27R countdown. Problem tracked by PRACA # EC0380. Problem is closed.	MMACS-01	F. McAllister
STS-26-4	Instrumentation a) APU 3 EGT transducer -erratic V46T0340A b) SSME3 LH ₂ inlet pressure-erratic (V41P1300C) c) APU #1 EGT (V460142A) d) HYD SYS #1 "B" supply press-biased (V58P0115A) e) Circ pump press #3 (V58P0337A)-biased f) SSME LH ₂ (V41P1200C)-erratic g) Freon loop 2 evap out temp V63T1407A didn't track freon loop 1 TDCR. h) ET LH ₂ 98% liquid level sensor flashing (T41X1716E)	a) CAR #26RF07 b) CAR #26RF20 c) CAR #26RF08 d) 26RF18/IM e) 26RF19/IM f) 26RF21/IM g) 26RF10/IM h) CAR #26RF14	<u>Corrective Action:</u> a). Postflight troubleshooting confirmed transducer failure. Transducer removed and replaced. Failure analysis will be tracked by CAR 26RF07. This is a criticality 3 measurement. Closed. b). Postflight troubleshooting confirmed transducer failure. Transducer removed and replaced. Failure analysis will be tracked by CAR #26RF20. This is a criticality 3 measurement. Closed. c). Troubleshooting confirmed transducer failure. Transducer was removed and replaced. Failure analysis will be tracked on CAR 26RF08. This is a criticality 3 measurement. Closed. d). Bias is within specification limits. No corrective action required. This is a criticality 1R3 measurement. Closed.	MMACS-02 BOOSTER-02	J. Miller

PROBLEM TRACKING LIST		STS-26 OV103 FINAL REPORT		DATE	PAGE
NO.	TITLE	TIME	COMMENTS	MOD NO.	RESP. MGR.
STS-26 -4 Con't			<p><u>Corrective Action:</u> e) Bias acceptable. No corrective action required. This is a criticality <u>3/3</u> measurement. Closed. f) Bias and slight oscillation acceptable. No corrective action required. This is a criticality <u>1R3</u> measurement. Closed. g) Postflight troubleshooting confirmed debonded sensor. Sensor removed and replaced. Failure analysis will be tracked by CAR <u>26RF10</u>. This is a criticality <u>2R3</u> measurement. Closed. h) Troubleshooting has been completed and the problem is being evaluated. No flight impact. This a criticality <u>1R2</u> measurement. Tracked by CAR #<u>26RF14</u>. Closed.</p>	MMACS-02 BOOSTER-02	J. Miller

NASA-JSC

JSC Form 318 (Feb 81)

PROBLEM TRACKING LIST		STS-26 OV103 FINAL REPORT		DATE	PAGE
NO.	TITLE	TIME	COMMENTS	MOD NO.	RESP. MGR.
STS-26-5	Flash evaporator system a) Ascent high load evaporator freezing b) Entry FES shutdown	273:15:41 CAR #26RF11 Criticality 1R3	Suspected high load evap freezing during ascent. FES temp adjusted to high set point (57° vs 38°F) during first night in order to warm FES. Reentry procedure developed to determine if the high load evaporator FES will be available for entry. FES shutdown occurred after initiation of OMS deorbit burn. <u>Corrective Action:</u> The OV 103 FES will be removed & replaced. The OV-104 FES has been Boroscoped with no moisture & minimum but acceptable contamination visible. For future missions, Removal of the FES duct plugs will be delayed until the end of the T-11 HR hold to minimize FES exposure to water condensation from the atmosphere. Boroscope inspection of the FES cores will also be required prior to each flight. This problem is closed. Track through CAR #26RF11.	EECOM-02	H. Rotter
STS-26-6	Ku-band antenna: a) Failed self test b) Did not follow pointing commands c) Oscillated when attempting to stow	274:15:15 CAR #26RF01 Criticality 1R2	The antenna failed self test shortly after deployment. Also, antenna would not follow pointing commands. OV104 guide lock pin operation verified. <u>Corrective Action:</u> Both the DA S/N 105 & EA-1 S/N 105 were removed & returned to the vendor for failure analysis. The OV104 guide lock P/N operation has been verified. This problem is closed. Track through CAR #26RF01.	INCO-04	M. Schmalz

PROBLEM TRACKING LIST		STS-26 OV103 FINAL REPORT		DATE	PAGE
NO.	TITLE	TIME	COMMENTS	MOD NO.	RESP. MGR.
STS-26-7	Gox flow control valves on SSME 1 and 2 operated sluggishly.	273:15:37 CAR #26RF03 Criticality 1R2	GOX flow control valve 1 and 2 (SSME 1 and 2) operated sluggishly during first cycle. This operation did not impact ET tank pressurization. Planned postflight insp of valves. <u>Corrective Action:</u> Three valves were removed from OV-103, cleaned, and their clearances increased to 0.0010 - 0.0012 inches from flight. The clearances on OV-102 and OV-104 valves will be increased. This problem is closed. Track through CAR #26RF03.	BOOSTER-03	P. Cota
STS-26-8	COAS adapter plate could not be mounted properly.	275:11:02 CAR #26RF02 Criticality 3	During COAS alignment at forward station, crew could not secure adapter plate with the hold down screw. Nut plate may be missing on panel 01. <u>Corrective Action:</u> The COAS is being returned to JSC for further analysis. The OV-104 COAS installation has been fit checked. This problem is closed. Track through CAR #26RF02.	GNC-02	F. McAllister

JSC Form 318 (Feb 81)

NASA-JSC

PROBLEM TRACKING LIST		STS-26 OV103 FINAL REPORT		DATE 11-18-88	PAGE 6
NO.	TITLE	TIME	COMMENTS	MOD NO.	RESP. MGR.
STS-26-9	WSB Sys 1 GN ₂ Relief Valve Leak	273:15:11 No CAR # Criticality 1R2	GN ₂ pressure showed a 3 psi decay over the first 15 hours on-orbit. Decay then stopped. Indicates that GN ₂ relief valve did not fully seat for the first 15 hours on-orbit. Corrective Action: The water spray boiler #1 Relief Valve will be leak-tested during turnaround operations. Relief Valve out of specification leakage will result in the removal & replacement of the valve. This problem is closed pending results of OMI V1017/V1018.	MMACS-5	W. Tuthill
STS-26-10	Waste collection system fan separator 1 showed indications of flooding	276:18:51 CAR #26RF06 Criticality 2R3	WCS fan separator 1 exhibited stall currents for 80 seconds. Inverter bus 1 current and voltage measurements verify WCS switch to fan separator 2 which is operating normally. Corrective Action: The WCS & Fan Separator have been removed and sent to the vendor for analysis. Fan separator redesign is in work. A demonstration unit may be flown as early as STS-28 with the new design. The OV104 Fan Separator has been flow checked. This problem is closed, track through CAR #26RF06.	EECOM-6	E. Winkler

NASA JSC

JSC Form 318 (Feb 81)

PROBLEM TRACKING LIST		STS-26 OV103 FINAL REPORT		DATE 11-18-88	PAGE 7
NO.	TITLE	TIME	COMMENTS	MOD NO.	RESP. MGR.
STS-26 -11	Starboard payload bay door forward ready to latch indicator 'A' talkback did not function.	277:13:07 CAR # 26RF05 Criticality 1R2	During payload bay door closing the starboard forward ready to latch indicator did not work. <u>Corrective Action:</u> Remove & replace the switch assembly and reinstall the Module, this problem is closed. Track through CAR #26RF05.	MMACS-08	L. Moore
STS-26 -12	APU-3 low chamber press/high fuel usage	273:15:37 CAR # 26RF04 Criticality 1R2	APU #3 performance indicated low chamber pressure during all APU runs. <u>Corrective Action:</u> Analysis of the performance of APU-3 during STS-26 mission has shown that it will continue to perform within specifications for the next flight of OV-103. It will not be removed from the vehicle. Both the OMRSD and the Launch Commit Criteria are being revised to reflect the minimum acceptable chamber pressure. This problem is closed. Track through CAR #26RF04.	MMACS-4	W. Scott
STS-26 -13	Rt wing TPS damage	CAR #26RF13	Approx. 6" x 18" x 1 1/2" TPS damage on Rt wing lower surface noted post flight. Possible debris during ascent. <u>Corrective Action:</u> MSFC has taken the following steps to minimize SRB debris:		J. Smith

PROBLEM TRACKING LIST		STS-26 OV103 FINAL REPORT		DATE	PAGE
NO.	TITLE	TIME	COMMENTS	MOD NO.	RESP. MGR.
STS-26 -13 Con't			<p>a.) All DFI, ground instrumentation, and heater cable cork will be inspected for voids (or debonding) using a tap technique in the areas that could damage the Orbiter or External Tank.</p> <p>b.) All voids detected to be greater than 1.6" x 1/4" will be vented by drilling a .125 inch hole angling forward at 40 degrees from the cork surface. For large voids, holes will be drilled every 1.6 inches. A small amount of HD-2 grease will be applied in each hole as a moisture barrier. Where voids are detected at the cork edges, the cork will be removed and replaced with K5NA material.</p> <p>c.) Tests will be conducted to assure that cork will not be blown off due to increasing atmospheric-induced pressure changes and that grease applied to the drilled areas will not produce adverse debris effects. For STS-29 and subsequent SRM's, the cork bonded to the motor will be tested and repaired if necessary, and all cap cork will be replaced with K5NA. Where cap cork has already been installed, the STS-27 inspection will be repeated. This problem is closed. Track through CAR #26RF13.</p>		

NASA-JSC

JSC Form 318 (Feb 81)

PROBLEM TRACKING LIST		STS-26 OV103 FINAL REPORT		DATE	PAGE
NO.	TITLE	TIME	COMMENTS	MOD NO.	RESP. MGR.
STS-26-14	4" LH2 ET/Orbiter disconnect leak.	KB0346 Criticality 1R2	Internal leak occurred prelaunch. Audible leak reported postlanding. <u>Corrective Action:</u> The 4" flapper seal was removed, replaced, and returned to the vendor for failure analysis. This problem is closed. Track through KB0346.		P. Cota
STS-26-15	OPS RCDR 2 modulation anomaly	74:13:42 2F1AR B-FCE-029 #F001 Criticality 3	While repositioning OPS 2 over DKR via a rewind command DKR reported they saw modulation on the FM. <u>Corrective Action:</u> Change-out of the recorder on OV-103 will be performed when a replacement recorder is available. The operational workaround will be to prohibit winding/rewinding the -0005 tape recorders when the parallel dump mode is in use. This problem is closed. Track through FIAR #B-FCE-029-F001.	INCO-3	Edmiston
STS-26-16	Radar altimeter failed off at landing	CAR #26RF09 Criticality 1R2	Pilot reported "off" flag on pilot and commander's radar altimeter at about 30 ft. <u>Corrective Action:</u> The radar altimeter units for OV-103 & OV-104 were returned to the vendor to test & readjust the low-altitude receiver gain sensitivity settings. This problem is closed. Track through CAR #26RF09.		R. Nuss

PROBLEM TRACKING LIST		STS-26 OV103 FINAL REPORT		DATE	PAGE
NO.	TITLE	TIME	COMMENTS	MOD NO.	RESP. MGR.
STS-26-17	<p>Government furnished equipment.</p> <p>a) Video cassette tapes jammed (4 tapes)</p> <p>b) Vacuum cleaner flapper failed open</p> <p>c) Seat back would not fold with parachutes attached</p> <p>d) ORB AFT fuselage gas sampling system failed.</p> <p>e) Dossimeter reads high.</p>		<p>a) Four tapes jammed in VCR, one required cutting tape to effect removal.</p> <p>b) Vacuum cleaner flapper would not close, rendering vacuum cleaner unusable.</p> <p>c) Seat back would not fold with parachutes attached.</p> <p>d) - PYROS in LH 2nd & 3rd bottle did not fire. - Valve on LH 1st bottle did not close - RH 2nd bottle leaked up to atmos.</p> <p>e) One dossimeter read unusually high. This is considered a common failure to this part. They are off the shelf items, some quite old. Spares readily available.</p> <p><u>Corrective Action:</u></p> <p>a) Crew will tension tape by hand prior to inserting into VCR. Closed.</p> <p>b) Vacuum cleaner with best flapper to fly on STS-27. New flappers ordered. Closed.</p> <p>c) Remove parachutes prior to seat folding as designed. Closed.</p> <p>d) System will be replaced. Closed.</p> <p>e) Dossimeter will be replaced. Closed.</p>		F. McAllister

PROBLEM TRACKING LIST		STS-26 OV103 FINAL REPORT		DATE 11-18-88	PAGE 11
NO.	TITLE	TIME	COMMENTS	MOD NO.	RESP. MGR.
STS-26 -18	Contractor furnished equipment (a) Fwd port floodlight failed off (b) Fwd bulkhead floodlight failed, flickering		a) Crew reported forward port floodlight was failed off b) Crew reported forward bulkhead floodlight was flickering at low intensities. <u>Corrective Action:</u> a) Port floodlight removed & replaced. Closed. b) Flickering expected for up to 15 minutes for start after previous use. This case considered nominal. Closed.		F. McAllister
STS-26 -19	WSB system 1 GN2 tank leak	CAR # 26RF12 Criticality 1R2	System 1 had a slow GN2 leak of approximately 0.85 psi/hr throughout the mission. <u>Corrective Action:</u> Based upon results of analysis at KSC, the unit may be repaired at KSC or removed & replaced. Problem closed. Track through CAR # 26F12.		W. Tuthill
STS-26 -20	Dedicated display OPS 8 checkout discrepancies	Car #26RF22 Criticality 1R2	During FCS checkout the CDR's dedicated displays showed minor discrepancies in readings as high as 20% on the ADI. Suspect LH units out of spec. Suggest using G & C OPS # 8 instead of OPS #9 for C/O. <u>Corrective Action:</u> There was no evidence of any discrepancies during the operational modes. No corrective action required. Problem closed. Track through CAR # 26RF22.		E. Dickinson

PROBLEM TRACKING LIST		STS-26 OV103 FINAL REPORT		DATE	PAGE
NO.	TITLE	TIME	COMMENTS	MOD NO.	RESP. MGR.
			11-18-88 David W. Camp David W. Camp, Manager, Flight Evaluation Office		

NASA-JSC

JSC Form 318 (Feb 81)

NASA-JSC