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STS 61-A National Space Transportation System Mission Report

March 1986

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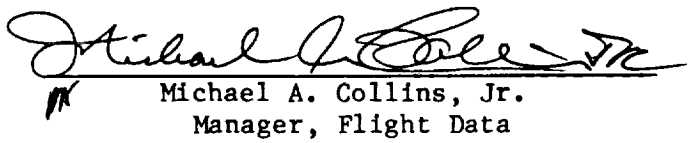
Lyndon B. Johnson Space Center
Houston, Texas

JSC-20956

STS 61-A
NATIONAL SPACE TRANSPORTATION SYSTEM
MISSION REPORT



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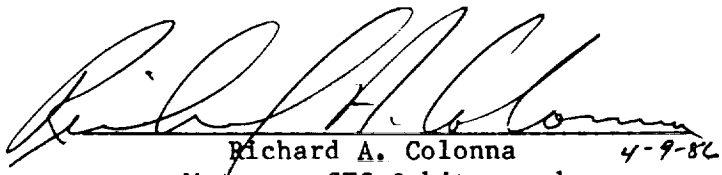

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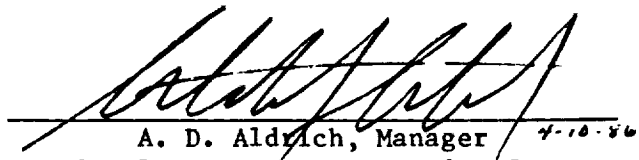

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INTRODUCTION AND MISSION OBJECTIVES

The STS 61-A National Space Transportation System (STS) Mission Report contains a summary of the major activities and accomplishments of the twenty-second Space Shuttle mission and the ninth flight of the OV-099 vehicle, Challenger.

The primary objective of the STS 61-A flight was to successfully operate and return the German Spacelab D-1 payload. The sequence of events for this mission is shown in Table I, and the Orbiter problem tracking list is presented in Table II.

The crew for this twenty-second flight ot the Space Shuttle was Henry W. Hartsfield, Jr., Commander; Steven R. Nagel, Lt. Col., U. S. Air Force, Pilot; James F. Buchli, Col., U. S. Marine Corp., Guion S. Bluford, Jr., Col., U. S. Air Force, and Bonnie J. Dunbar, Ph.D., Mission Specialists; and Reinhard Furrer, Ph.D., Ernest Messerschmidt, Ph.D., and Wubbo J. Ockels, Ph.D., Payload Specialists.

MISSION SUMMARY

The STS 61-A countdown proceeded very smoothly with no unplanned holds. Lift-off occurred at 303:17:02:00 G.m.t. (11:02 a.m. e.s.t. on October 30, 1985) from launch complex 39A at Kennedy Space Center (KSC). The launch phase was normal and the vehicle was inserted into a 170- by 174-nmi. orbit at the conclusion of the second orbital maneuvering system (OMS) maneuver.

Spacelab D-1 activation was begun about 3 hours after orbital insertion and was completed 2 hours later. Seventy-three of the 76 D-1 experiments were successfully activated; however, the furnace in the Materials Science Experiment Double rack for Experiment Modules and Apparatus (MEDEA) material processing rack malfunctioned.

The Orbiter fuel cell 1 condenser exit temperature cycled between 147 deg and 160 deg F throughout launch and during the mission. This oscillation had no effect of fuel cell operation or impact on the mission.

At external tank (ET) separation, the right aft reaction control system (RCS) experienced two anomalies. Initial indications showed a failure of the B-leg regulator. As a result, the right RCS provided propellants for all aft RCS thrusters. Aside from the minor RCS and fuel cell problems, all Orbiter subsystems operated satisfactorily.

The Global Low Orbiting Mission Relay (GLOMR) satellite was launched at a mission elapsed time of 12 hours 34 minutes.

Spacelab D-1 payload activities during the second day continued satisfactorily with better results in the areas of life sciences than materials science. The Orbiter subsystems and Spacelab experiments continued to operate in a satisfactory manner during the third day. Spacelab power usage was about 1.5 kW below predictions for this point in the mission. A successful inflight maintenance (IFM) procedure was performed on the MEDEA furnace pressure sensors, and a lamp change-out was also made. As a result, the MEDEA facility was fully recovered and processing of samples was initiated; however, many hours of run-time on various samples were lost because of the furnace malfunction.

Orbiter subsystems continued to operate satisfactorily for the remainder of the 7-day mission. All Spacelab experiment subsystems also operated satisfactorily for the remainder of the mission.

Because of the temporary malfunction of the MEDEA furnace facility during the early part of the mission, discussions were held with the Science community on lengthening the mission one day to obtain additional materials processing data. Spacelab power-usage levels could not be reduced enough to provide the required extension day; therefore, the decision was made to not extend the mission, and instead, to conduct simultaneous materials processing and vestibular sled operations.

After completing the final entry preparations, including deactivation of the Spacelab, the 171-second deorbit maneuver was performed. Entry was normal in all respects. A 207-degree heading alignment circle (HAC) maneuver was performed and the Orbiter landed at 310:17:44:51 G.m.t., on runway 17 at Edwards AFB, California. Rollout required 8304 feet and was completed 49 seconds after landing.

All Orbiter detailed test objectives (DTO's) assigned to STS 61-A were completed. In addition, seven special-test-condition DTO's were accomplished either completely, or to a very high degree. Data were also collected on seven data-only DTO's.

TABLE I. - STS 61-A SEQUENCE OF EVENTS

Event	Actual time, G.m.t.
APU activation (1)	303:16:55:09
(2)	303:16:55:10
(3)	303:16:55:11
SRB HPU activation command	303:16:55:29.4
MPS start command sequence (engine 3)	303:16:59:53.5
SRB ignition command from GPC (lift-off)	303:17:00:00
MPS throttle down to 89-percent thrust (engine 3)	303:17:00:18.5
MPS throttle down to 65-percent thrust (engine 3)	303:17:00:27.1
Maximum dynamic pressure	303:17:00:50
MPS throttle up to 104-percent thrust (engine 3)	303:17:00:59.9
SRB separation command	303:17:02:05
MPS throttle down for 3g acceleration (engine 3)	303:17:08:28.5
Main engine cutoff (MECO)	303:17:08:36
External tank separation	303:17:08:54
OMS-1 ignition	303:17:10:35
OMS-1 cutoff	303:17:12:37
APU deactivation (3)	303:17:18:53
OMS-2 ignition	303:17:44:44
OMS-2 cutoff	303:17:46:56
FCS (flight control system) checkout - APU 1 activation	309:17:31:03
APU 1 deactivation	309:17:35:12
APU 2 activation	310:16:35:31
Deorbit maneuver ignition	310:16:40:30
Deorbit maneuver cutoff	310:16:43:21
APU 1 activation	310:17:00:25
APU 3 activation	310:17:00:26
Entry interface (400,000 ft)	310:17:13:32
End blackout	310:17:31:33*
Terminal Area Energy Management (TAEM)	310:17:38:26
Main landing gear contact (LH)	310:17:44:51
Nose landing gear contact	310:17:44:59
Wheel stop	310:17:45:50
APU deactivation complete	310:18:01:59

*Engineering approximation

VEHICLE ASSESSMENT

SOLID ROCKET BOOSTERS

All solid rocket booster (SRB) systems performed as expected. The SRB prelaunch countdown was nominal with no problems noted. Performance of both solid rocket motors (SRM's) was near predicted values, and well within the allowed envelopes. Propellant burn rates were near predicted values. Preliminary data indicate that the SRB separations occurred 0.2-second early. The SRB recovery system was reported to have performed nominally. Both SRB's and frustums were floating and recovered.

EXTERNAL TANK

All ET systems performed as expected. No launch commit criteria (LCC) or Operational Maintenance Requirements and Specifications Document (OMRSD) violations occurred. Propellant loading was accomplished as planned. Some normal frost was observed, but weather conditions were not conducive to any appreciable ice/frost formation. No known ET preflight or flight anomalies were noted.

Liquid oxygen ullage pressure transducer no. 1 experienced a momentary 10-second control band dropout approximately 7.5 minutes after lift-off, and this anomaly had no impact on the flight. All instrumentation performed satisfactorily during the countdown.

SPACE SHUTTLE MAIN ENGINES

All Space Shuttle main engine (SSME) parameters appeared to be normal during the prelaunch countdown and compared well with prelaunch parameters that have been observed on previous flights. Preliminary data indicate that SSME performance at start, mainstage, shutdown, and propellant dump was satisfactory.

One anomaly was recorded for main engine-1 at 5 minutes 13 seconds after lift-off. The high pressure oxidizer turbopump (HPOTP) discharge pressure measurement, which is only a maintenance parameter, failed the reasonableness test. This had no effect on engine performance.

MAIN PROPULSION SYSTEM

Overall performance of the main propulsion system (MPS) was excellent. Liquid oxygen and liquid hydrogen loads were very close to the inventory loads. There were no MPS-related leaks of any significance. Ascent performance appeared to be normal.

ORBITER

Right Reaction Control System Helium Regulators Failed

During the prelaunch reaction control system (RCS) pressurization operations, the right-RCS A-leg fuel regulators failed in the open position, and this resulted in a rupture of the downstream burst disc. A retest of the A and B fuel-regulator legs verified acceptable performance, although the A-leg regulators were operating sluggishly.

At 303:19:00 G.m.t. after ET separation, the right RCS fuel-tank pressure was reading 274 psia, indicating that a primary regulator had failed in the open position. The crew closed the right RCS helium pressure A-leg to prevent a possible overpressure condition. After the right RCS helium pressure A-leg was closed, the fuel ullage pressure decayed to about 215 psia, thus indicating that the right RCS regulator B-leg had failed closed. The crew reopened the right RCS regulator A-leg to repressurize the system. The right fuel-tank pressure rose above secondary lockup pressure, reaching 290 psia.

A special on-orbit test of the right RCS fuel regulator A-leg was conducted to simulate the entry propellant flow rates and obtain the main poppit valve opening characteristics. The test was performed at 309:18:53 G.m.t., and the capability of the right RCS fuel regulators to support entry primary flow requirements was verified.

Fuel Cell 1 Condenser Exit Temperature Cycling

The fuel cell 1 condenser exit temperature cycled beyond the normal control range of 145 deg F to 160 deg F during prelaunch high-load operations. Analysis showed this condition was acceptable for launch and flight. The cycles damped during ascent and temperature cycling returned to the normal control band during flight.

This was the first flight for this fuel cell since it was rebuilt and stored dry for approximately 1 year. A records review showed that the coolant flow control cartridge was marginally acceptable based on flow/gain characteristics during component-level bench testing. However, other valves with similar flow/gain characteristics have not shown a tendency to become unstable. Postflight acceptance test procedure operations for this fuel cell showed behavior similar to flight performance, with a tendency toward minor cycling of 3 to 4 deg F with load changes, indicative of marginally high coolant flow control valve gain. The fuel cell has been removed and replaced.

SPACELAB D-1

The Spacelab D-1 had 76 experiments of which 73 operated properly and the data received was well beyond the experimenters' expectations. The Germans' response to the success was stated as "an extremely challenging mission with outstanding results." Data reduction and evaluation is in progress. Five minor problems occurred in addition to the three experiments that were lost. None of these five problems had a significant impact on the conduct of inflight experiments. Overall, the Spacelab D-1 mission must be viewed as an outstanding success.

DETAILED TEST OBJECTIVES

All Shuttle DTO's assigned to this flight were accomplished. The following DTO's required special test conditions or crew activity.

External Tank Thermal Protection System Performance (DTO 0312) - This DTO required a +X translation after ET separation to photograph the ET thermal protection system.

Waste and Supply Water Dumps (DTO 0325) - Three test conditions were performed from the DTO's set of required tests. All tests were waste water dumps, starting at a nozzle temperature of 100 degrees. The first was a warm-attitude dump which was stopped at 50 percent. The second and third test conditions were combined into a single dump at a cold attitude, which was stopped at 66-percent remaining.

MPS Vacuum Dump Test (DTO 0411) - This test required dumping MPS oxygen through the fill and drain valves. It was a repeat of the test performed on STS 51-J and was completed as planned.

Nose Wheel Steering Evaluation (DTO 0515) - This test was performed during the landing rollout. Real-time data and physical track data indicated nominal system performance. Crew comments and evaluation are required.

Cabin Air Monitoring (DTO 0623) - This test required sampling the cabin air with a solid sorbent sampler. This DTO is required on all Spacelab flights.

Radiator Performance (DTO 0624) - One test condition was performed from this DTO's set of required tests. This was an evaluation of radiator performance in a -ZLV attitude with the radiators stowed followed by an evaluation of performance with the radiators deployed.

Gravity Gradient Attitude Control (DTO 0816) - Five test conditions were performed from this DTO's set of required tests. Each test required entry into gravity-gradient mode using vernier reaction control system thrusters and all appear to have been successful.

The following DTO's required no special test or crew activity other than the functioning of operational instrumentation/modular auxiliary data system (OI/MADS) instrumentation and recorders.

DTO No.	Title
0301	Ascent Structural Capability Evaluation
0303	Reinforced Carbon Carbon Life Evaluation
0307	Entry Structural Capability
0308	Vibration and Acoustic Evaluation
0311	Longitudinal Oscillation (POGO) Stability Performance
0319	Shuttle/Payload Low Frequency Environment
0758	Payload Flight Control System (FCS) Dynamics Measurements

Postflight analysis of data from these DTO's will be required. A MADS pulse code modulation (PCM) master built-in test equipment (BITE) failed inflight and this may indicate problems with the PCM data.

ACIP data were recorded during OMS maneuvers to gather data on what the crew call "rough starts". Also, data were taken for DTO 0327, Waste Control System Airflow Measurements, although the DTO itself was not assigned to this flight.

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