

STS 51-C National Space Transportation Systems Program Mission Report

March 1985



National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas

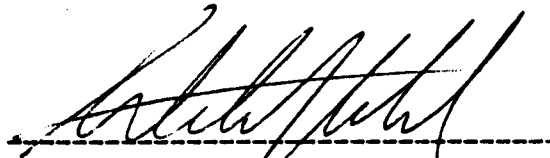
STS 51-C

NATIONAL SPACE TRANSPORTATION SYSTEMS PROGRAM

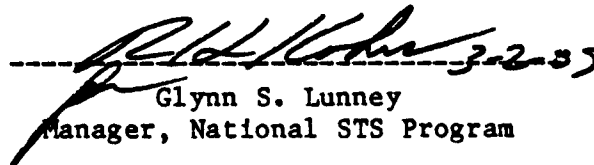
MISSION REPORT



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TABLE OF CONTENTS

<u>Title</u>	<u>Page</u>
<u>INTRODUCTION AND MISSION OBJECTIVES</u>	1
<u>MISSION SUMMARY</u>	1
<u>VEHICLE ASSESSMENT</u>	3
SOLID ROCKET BOOSTER	3
EXTERNAL TANK	3
SPACE SHUTTLE MAIN ENGINE	3
MAIN PROPULSION SYSTEM	4
ORBITER	4
Improper Moding and Timing in BFS	4
TACAN 3 Failed to Lock Up During Entry	4
Radar Altimeter 2 Was Erratic At High Altitude	4

INTRODUCTION AND MISSION OBJECTIVES

The STS 51-C National Space Transportation System Program Mission Report contains a summary of the Orbiter, ET (external tank), SRB (solid rocket booster), and SSME (Space Shuttle main engine)/MPS (main propulsion system) systems operation for the fifteenth Space Shuttle mission, which was also the third flight of the Orbiter vehicle, Discovery (OV-103). Because of the security classification assigned to this mission, this report contains no discussion of any of the mission activities or accomplishments.

Table I contains a partial sequence of events, including only those activities that are unclassified. Additionally, this report contains a discussion of the most significant Orbiter problems/anomalies. Table II is a listing of all unclassified Orbiter problems/anomalies. Table III is the Marshall Space Flight Center problem tracking list.

MISSION SUMMARY

The STS 51-C mission was launched on January 24, 1985, at 19:50:00 G.m.t., 1 hour and 35 minutes into the 3-hour launch window. The flight was originally scheduled to be launched on January 23, 1985, but because the expected cold temperatures might cause ice formations on the vehicle, the launch was delayed until January 24, 1985.

The crew for the STS 51-C mission were Thomas K. Mattingly, Capt., U.S. Navy, Commander; Loren J. Shiver, Maj., U.S. Air Force, Pilot; Ellison S. Onizuka, Maj., U.S. Air Force, and James F. Buchli, Maj., U.S. Air Force, Mission Specialist; and Gary E. Payton, Maj., U.S. Air Force, Payload Specialist.

The countdown phase was completed satisfactorily, however, two minor Orbiter problems were noted during that period. The first occurred during the T-3 hour hold and involved a force fight in the right inboard elevon actuator between channel 4 and channels 1, 2, and 3. The condition corrected itself within 22 seconds after APU (auxiliary power unit) start up at T-5 minutes. A similar problem with the same channels in the same actuator occurred on STS 41-D (first flight of this vehicle).

The second problem that was noted during the countdown phase was the high helium concentration in the Orbiter mid-body. A pressure decay test showed no significant system leakage. The high helium concentration disappeared when the MPS (main propulsion system) gaseous helium system was pressurized to the flight level.

System operations were all nominal during the ascent phase. SRB motor performance was near the predicted levels and well within the allowed envelopes. External tank and MPS performance was excellent with MECO (main engine cutoff) near the predicted time.

TABLE I. - STS 51-C SEQUENCE OF EVENT

Parameter	G.m.t., hr:min:sec
APU Activation (1)	024:19:45:08
(2)	024:19:45:09
(3)	024:19:45:10
SRB HPU activation command (LH-A2)	024:19:49:32.14
MPS start command sequence (engine 3)	024:19:49:53.44
SRB ignition command from GPC (lift-off)	024:19:50:00
MPS throttle-down to 92-percent (engine 3)	024:19:50:15.48
MPS throttle-down to 65-percent (engine 3)	024:19:50:29.4
Maximum dynamic pressure	024:19:50:52
MPS throttle-up to 104-percent (engine 3)	024:19:51:01.08
SRB separation command from GPC	024:19:52:07
MPS throttle-down from 3g acceleration (engine 3)	024:19:57:34.54
Main engine cutoff (MECO)	024:19:58:32
External tank separation	024:19:58:49
APU deactivation (1)	024:20:06:15
(2)	024:20:06:17
(3)	024:20:06:14
Flight control system checkout APU 2 start	026:22:15:02
APU 2 shutdown	026:22:20:20
APU 3 activation	027:20:11:03
APU activation (1)	027:20:39:29
(2)	027:20:39:28
Entry Interface	027:20:52:29
End blackout	027:21:08:16
Terminal area energy management (TAEM)	027:21:16:45
Main landing gear contact	027:21:23:23
Nose landing gear contact	027:21:23:35
Wheels stop	027:21:24:13
APU deactivation complete (3)	027:21:43:41

At external tank separation, the BFS (backup flight system) did not automatically proceed to major mode 104. The crew performed the necessary manual procedures, and the BFS operated satisfactorily until the deorbit maneuver when the BFS time for deorbit maneuver ignition was 8 seconds late. However, the BFS operated satisfactorily for entry.

The entry phase systems operations were satisfactory with the Orbiter landing on runway 15 at Kennedy Space Center at 027:21:23:23 G.m.t. (4:23 p.m.e.s.t.) on January 27, 1985. The rollout distance was 7352 ft. An inspection of the Orbiter after landing showed the vehicle to be in excellent condition.

VEHICLE ASSESSMENT

SOLID ROCKET BOOSTER

All SRB systems performed as expected. The SRB prelaunch countdown was nominal with no problems noted. Performance of both SRM's (solid rocket motors) was close to predicted values and well within the allowable envelopes.

The average head pressures during the first 20 seconds as well as the propellant burn rates were approximately 1.0-percent below predicted values, thus resulting in longer than predicted web and action times. Preliminary indications are that the SRB separation occurred approximately 1.7 seconds later than predicted. The SRB recovery system performed nominally, with both SRB's reported floating in the normal manner.

EXTERNAL TANK

All ET systems performed as expected. There were no ET preflight or flight anomalies. There was some ice/frost buildup observed as predicted, however, the vehicle was clean at lift-off.

SPACE SHUTTLE MAIN ENGINE

The SSME performance data during prelaunch, mainstage, shutdown and propellant dump looked good, following trends which were similar to those observed during previous flights. Predicted data for engines 1 and 3 were very good, however, engine 2 HPOTP (high pressure oxidizer turbopump) turbine discharge temperatures during mainstage were slightly higher than the predicted values.

MAIN PROPULSION SYSTEM

Overall performance of the MPS was excellent. Liquid oxygen and liquid hydrogen loading was accomplished as planned. Ascent performance appeared to be normal with MECO near the predicted time.

ORBITER

All Orbiter systems operated very satisfactorily with only two minor anomalies occurring during the flight. A discussion of each of these is contained in the following paragraphs, and a complete listing of all problems and anomalies is contained in Table II.

Improper Moding and Timing in BFS

The BFS did not automatically proceed to major mode 104 after ET separation. The condition was noted, and the crew manually made the mode change. The criteria for the mode change is a 3.6 ft/sec velocity change after receiving the ET separation indication. Assuming worst case timing and maximum acceleration in the early portion of the separation maneuver, analysis indicates that the BFS sensed only 3.5 of the required 3.6 ft/sec velocity change. For STS 51-E, no change will be made to the software and the crew will be instructed to manually proceed to the major mode 104, if the same problem recurs.

Also, the BFS TIG (ignition time) for the deorbit maneuver was 8 seconds later than the PASS (primary avionics software system). The TIG for the deorbit maneuver ended on an even minute and the zero seconds were not entered by the crew. As a result, the burn time for a previous maneuver which occurred 8 seconds after the even minute was still present in the register. The crew will be instructed to enter all digits of maneuver times.

TACAN 3 Failed to Lock Up During Entry

During entry, TACAN 3 was operating in the search mode, but failed to lock up on the selected ground station. Postflight tests at Kennedy Space Center revealed reduced receiver sensitivity.

Radar Altimeter 2 Was Erratic At High Altitude

During the descent phase, RA (radar altimeter) 2 did not lock on the ground until the vehicle reached an altitude of 2300 feet. Normally, ground-lock occurs at about 5000 feet. Between 2300 and 1400 feet, ground-lock was intermittent. From 1400 feet through landing, ground-lock was solid and the difference in the RA 1 and RA 2 altitude readings was within acceptable limits. Postflight troubleshooting indicated that the unit was marginal with the lock-loop sensitivity being 3 to 4 dB less than that observed for RA 1. RA 2 was removed, replaced, and returned to the vendor for a loop sensitivity (far range) checks and possible re-adjustment. For the next flight of OV-103, RA 1 will be flown in slot 2 and the spare RA will be flown in slot 1.

TABLE II.- JSC OV-103 STS 51-C PROBLEM TRACKING LIST

JSC OV-103 STS 51-C PROBLEM TRACKING LIST		FEB 25, 1985	
NO.	TITLE	TIME, G.M.T.	COMMENTS
1	RIGHT INBOARD ELEVON CHANNEL & SECONDARY DELTA PRESSURE FORCE FIGHT.	PRELAUNCH	FORCE FIGHT CLEARED DURING PRELAUNCH PROFILE. SAME CHANNEL AND SAME ACTUATOR HAD A FORCE FIGHT PRELAUNCH ON FIRST FLIGHT OF OV-103, BUT IT CLEARED JUST PRIOR TO PRELAUNCH PROFILE. R&R ACTUATOR. CAUSE UNKNOWN.
2	HELIUM LEAK IN MID-BODY FROM UNKNOWN SOURCE.	PRELAUNCH	MASS SPEC IN MID-BODY INDICATED 11,200 PPM OR ABOUT 0.36 #/MIN. MPS PRESSURE DECAY TEST SHOWED NO LEAK. MPS PRESSURES NORMAL DURING LAUNCH. PROBABLE INTERFACE SEAL LEAK AT GHE QD ON LH2 T-40 UNBILICAL.
3	INSTRUMENTATION FAILURES		
A	APU 1 EXHAUST GAS TEMPERATURE 2 (V46T0140A) FAILED.	LAUNCH APU START	READ OFF SCALE HIGH AND THEN FAILED LOW. SAME MEASUREMENT FAILED OFF SCALE LOW LAST FLIGHT 5 MINUTES BEFORE TOUCHDOWN. SENSOR WAS REPLACED PRIOR TO 51+C. REMOVED AND REPLACED.
B	SSHE 2 CH2 OUTLET TEMPERATURE (V41T1261A) FAILED.	LAUNCH	READ OFF SCALE HIGH A FEW MINUTES AFTER LIFTOFF. TRANSDUCER FAILED. REMOVED AND REPLACED.
C	MAIN BUS "B" FORWARD POWER CONTROLLER AMMETER (V76C3076A) VERY NOISY.	FLIGHT DAY 1	READ BETWEEN 105 AND 155 AMPS FOR 3 MINUTES. FUEL CELL AND OTHER FORWARD POWER CONTROLLER AMPS NORMAL. CAUSE UNKNOWN. FLY AS IS.
D	ET LH2 100 PERCENT LIQUID LEVEL POINT SENSOR (T41X1718E) ERRATIC.	LAUNCH	READING WAS ERRATIC. PROBABLE TRANSDUCER FAILURE.
4	STS 41+D CARRYOVER:		
A	LEFT OMS FUEL TOTAL QUANTITY (V43Q4331C) FAILED.	LAUNCH STS 41D+8	STOPPED AT INTERMEDIATE POSITION AFTER OMS+1 SIMILAR TO THE LAST FLIGHT WHEN PROBE ELECTRONICS WERE REPLACED POSTFLIGHT. FLY AS IS.

TABLE II.- JSC OV-103 STS 51-C PROBLEM TRACKING LIST

NO.	TITLE	TIME, G.M.T.	COMMENTS	RESP. MGR.
JSC OV-103 STS 51-C PROBLEM TRACKING LIST				
FEB 25, 1985				
B	RIGHT OMS FUEL TOTAL QUANTITY (V43Q5331C) FAILED.	PRELAUNCH STS+41D	FAILED PRIOR TO FIRST FLIGHT ON OV-103 AND HAS NEVER BEEN REPAIRED. FLY AS IS.	J. HOOPER CAR 19F013
C	RIGHT OMS OXIDIZER TOTAL QUANTITY (V43Q5231C) READ LOW.	PRELAUNCH STS+41D	MEASUREMENT HAS HAD A SMALL NEGATIVE SCALE FACTOR ERROR OF ABOUT 2% FULL SCALE FOR ALL OV-103 FLIGHTS. FLY AS IS.	J. HOOPER
5A	BACKUP FLIGHT SYSTEM DID NOT PROCEED TO MAJOR MODE 104 AFTER ET SEPARATION.	LAUNCH	CREW MODDED MANUALLY. WORST-CASE TIMING DELAYS WITH ACCELERATION VARIATIONS COULD CAUSE LOW BFS SEPARATION VELOCITY INTEGRATION. CHANGE INTEGRATION CONSTANT. FLY AS IS FOR 51+E.	S. MURRAY CLOSURE IN PROCESS
5B	BACKUP FLIGHT SYSTEM DEORBIT IGNITION TIME WAS 8 SECONDS LATE.	DEORBIT	BFS WAS OPERATIONAL FOR ENTRY. CREW DID NOT ENTER 00 SECONDS FOR DEORBIT TIC LEAVING 08 SECONDS FROM LAST ENTRY. CHIT J+1507.	S. MURRAY CLOSURE IN PROCESS
6	AC 1 PHASES "A" AND "B" LOW CURRENT TRANSIENTS ON WCS FAN SEPARATOR 1.	FLIGHT DAY 2	SIMILAR TO PROBLEM STS+51A+16 EXCEPT SIGNATURE IS ALSO ON PHASE "B". NO IMPACT ON WCS OPERATION. IN-FLIGHT TROUBLESHOOTING FOUND LOW CURRENT CORRELATED WITH OPERATION OF PANEL LIGHTS. NO ACTION REQUIRED.	R. EGUSQUIZA CLOSED 02/20/85
7	OXYGEN TANK 2 HEATER CONTROL PRESSURE (V45P1210A) FAILED MOMENTARILY.	FLIGHT DAY 2	READ OFF SCALE LOW FOR A MINUTE CAUSING AN ONBOARD FSM. RETURNED TO NORMAL. SET LOW LIMIT AT 500 PSI TO PREVENT ALARMS. CHIT J+1506. T/S NO JOY. UNEXPLAINED ANOMALY. FLY AS IS.	T. DAVIES CLOSURE IN PROCESS
8	STAR TRACKER +Y AND +Z SHUTTER CLOSURES.	FLIGHT DAY 1, 2, AND 3 (+Y) FLIGHT DAY 3 (+Z)	TARGET SUPPRESS BIT WAS SET SEVERAL TIMES WITHOUT BRIGHT OBJECT SENSOR RESPONDING. CREW DID NOT OPEN SHUTTERS AND ST OPERATION CONTINUED. ST +Z SHUTTER LATCHED UP LAST FLIGHT. SEE STS+51A+21. FOUND CONTAMINATION ON LIGHT SHADES.	I. SAULIETIS CLOSURE IN PROCESS

TABLE II.- JSC OV-103 STS 51-C PROBLEM TRACKING LIST

JSC OV+103 STS 51+C PROBLEM TRACKING LIST		FEB 25, 1985	
NO.	TITLE	TIME, G.M.T.	COMMENTS
9	TACAN 3 DID NOT LOCK UP.	ENTRY	USED TACANS 1 AND 2. KSC FOUND LOW RECEIVER SENSITIVITY. R&R. RESP. MGR.
10	THERMAL PROTECTION SYSTEM HAD A LONG GOUGE UNDER THE LEFT WING.	LAUNCH	GOUGE WAS ABOUT 5 FEET LONG, 3/8 INCH WIDE AND 1/4 INCH DEEP AND LOCATED OUTBOARD OF LEFT MAIN LANDING GEAR DOOR. CAUSE UNKNOWN. TILE REPAIRED. J. SMITH CLOSURE IN PROCESS
11	RADAR ALTIMETER 2 ERRATIC AT HIGH ALTITUDE.	ENTRY	JSC DATA ANALYSIS. INTERMITTENT GROUND LOCK FROM 2300 TO 1400 FEET. T/S FOUND MARGINAL LOOP SENSITIVITY ON FAR RANGE. R&R WITH RA 1. PLACED SPARE IN RA 1. D. RHOADES CAR 20F005 CLOSED 02/20/85
12	RIGHT OMS FUEL AND OXIDIZER QUANTITY GAGES WENT TO ZERO DURING ENTRY.	ENTRY	FOUND FUSES BLOWN AND AN INTERNAL SHORT ON BOTH BUSES. TRACED TO TOTALIZER INPUT POWER CIRCUITRY. R&R TOTALIZER. J. HOOPER CAR 20F006 CLOSED 02/20/85
13	FORWARD RCS DILEMMA DURING DEORBIT.	DEORBIT	PREFLIGHT WAIVER DUE TO SLOW ACTIVATION OF AC MOTOR VALVE MANIFOLD 4 OX PRELAUNCH. T/S SNIFFED OX FUMES. R&R MANIFOLD 4 OX VALVE. G. GRUSH CAR AC 9013 CLOSURE IN PROCESS
14	AC PHOTO FLOODLIGHT FAILED.	ON ORBIT	FUSE BLOWN IN OLD FLOODLIGHT. SEE PROBLEM STS+41D+19. WILL USE NEW TWO-TUBE COLOR BALANCED FLORESCENT FLOODLIGHT ON STS 51+E AND SUBS. D. YEATES CLOSURE IN PROCESS
15	FORWARD DAP PANEL (C3) ROTATION PULSE PITCH PBI LIGHT FAILED.	ON ORBIT	CREW REPORTED LIGHT FAILED BUT DAP MODE WORKED PROPERLY. POSTFLIGHT T/S FOUND ACA 1 LIGHT CONTROL CIRCUIT INTERMITTENT. R&R WITH ACA FROM OV+102. SEE PROBLEM STS+41D+29. R. BURGDUFF CAR 14F024 CLOSURE IN PROCESS

PREPARED BY: /s/RJW ROBERT J. WARD
 APPROVED BY: /s/JEM JOSEPH E. MECHELAY
 02/25/85 DATE
 02/25/85 DATE

TABLE III.- MSFC ANOMALY AND FAILURE LIST

NO.	TITLE	GMT D: H: M	COMMENTS	PROJECT CONTACT
1	HPFTP Discharge Temperature Failure	24:19:52	<p>ME-2 (2018) HPFTP discharge temperature (Channel B) drifted below the lower limit at approximately 137 seconds after liftoff and became erratic for the rest of the flight. Failure analysis revealed a crack of the coax tube. Sensor has been replaced. A design process change will be incorporated on a later flight for this sensor. Controller software disqualifies a failed sensor. <u>CLOSED for STS-51E</u></p>	SSME R. Bledsoe/EE21
2	Controller MFY Servoactuator Self Test Failure	24:19:54	<p>ME-2 controller (F9) failed MFY servoactuator self test (Channel B) at approximately 331 seconds after liftoff. Controller has been returned to Honeywell for testing. The problem was isolated to an intermittent hang up of a DG 140 solid state switch. No other failures of this nature have been observed in the history of the SSME program. This problem is considered a random piece part failure. <u>CLOSED</u></p>	SSME R. Bledsoe/EE21