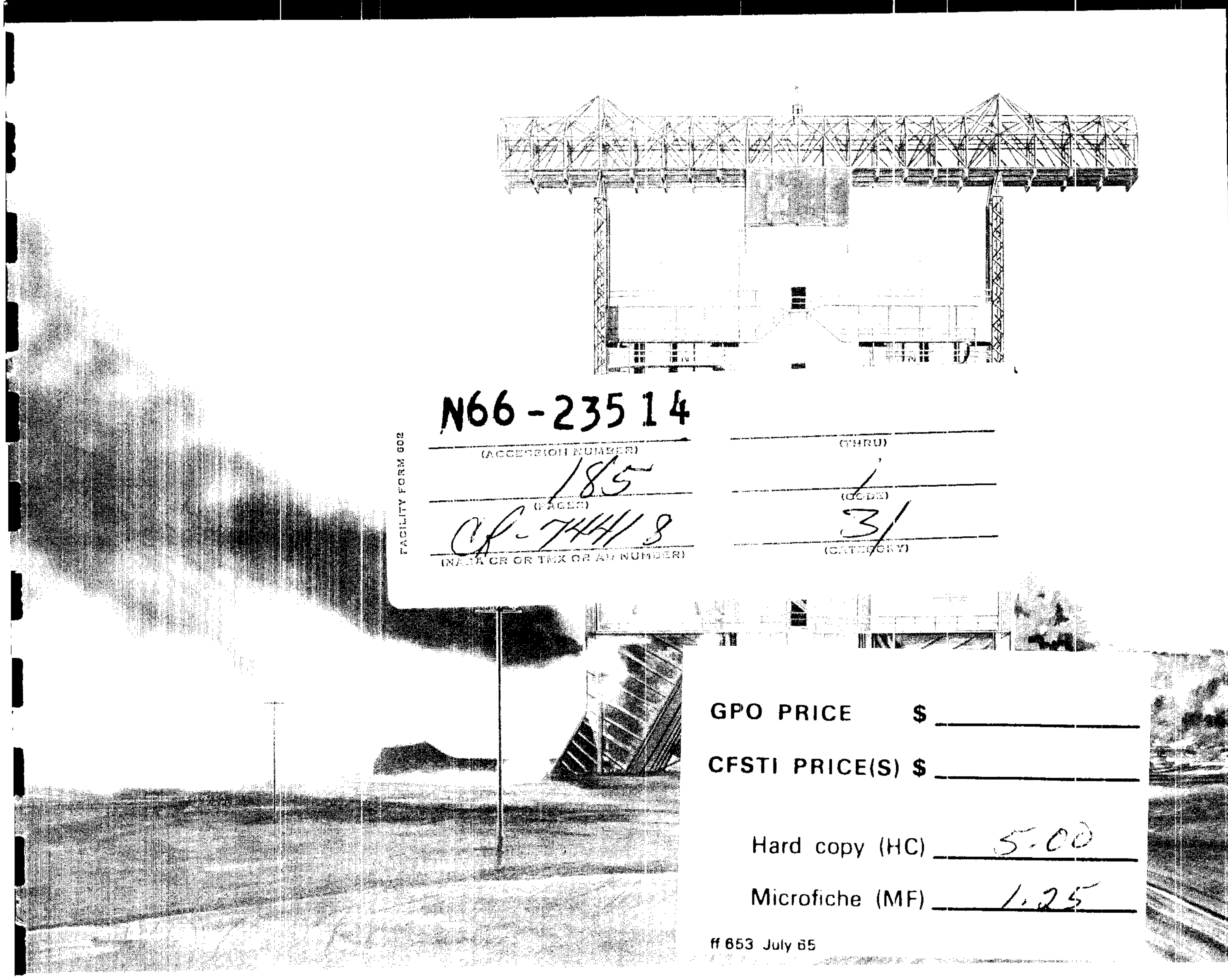
SATURN S-IB STAGE FINAL STATIC TEST REPORT



STAGE S-IB-4

SPACE DIVISION CHRYSLER CORPORATION

SATURN S-IB STAGE

FINAL STATIC TEST REPORT

STAGE S-IB-4

FEBRUARY 25, 1966

Don Adams, III
SYSTEMS STATIC TEST BRANCH

J. V. Wible, Test Engineering

R. D. Cox, Test Operations

Approved by: J. H. Wood, Jr., Manager
Systems Static Test Branch

CHRYSLER CORPORATION SPACE DIVISION

HUNTSVILLE, ALABAMA

FOREWORD

This report, prepared by Chrysler Corporation Space Division, Systems Static Test Branch, presents the results of acceptance test firing of the Saturn flight stage S-IB-4. Acceptance firings of Saturn S-IB stages are performed by Chrysler's Space Division for the National Aeronautics and Space Administration at the George C. Marshall Space Flight Center under Contract NAS 8-4016, Item No. 1, Static Test Operations.

TABLE OF CONTENTS

APPENDIX

TABLE OF CONTENTS (CONTINUED)

LIST OF ILLUSTRATIONS

TABLE OF CONTENTS (CONTINUED)

LIST OF TABLES

TABLE OF CONTENTS (CONTINUED)

LIST OF TABLES (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

LIST OF GRAPHS

TABLE OF CONTENTS (CONTINUED)

LIST OF GRAPHS (CONTINUED)

SUMMARY

This report describes the acceptance test firings of the Saturn flight stage S-IB-4, which were conducted at the Static Test Tower East, Marshall Space Flight Center, Huntsville, Alabama, during the period of December 13, 1965 to January 28, 1966.

Test SA-32 was originally scheduled for January 14, 1966, but was cancelled because the yaw actuator on engine 3 was not controllable from the blockhouse. A new yaw actuator was installed on engine 3 prior to the rescheduled test.

The short duration test SA-32 was successfully conducted on January 17, 1966. Test duration was 35.227 seconds from ignition command to inboard engine cutoff with cutoff being initiated as planned by the firing panel operator.

The long duration test SA-33 was successfully conducted on January 21, 1966. Inboard engine cutoff was initiated by the switch selector, 3.19 seconds after the LOX low level sensor 3 in LOX tank 0-4 was uncovered. Outboard engine cutoff was by LOX depletion of engine 3. Test duration from ignition command to inboard engine cutoff was 143.934 seconds. Outboard engine cutoff occurred at 147.110 seconds after ignition command.

Engine operation and performance were satisfactory during tests SA-32 and SA-33. All engines produced thrust within the limits of 200K$\pm$3 percent.

All stage systems performed satisfactorily during tests SA-32 and SA-33 with the exception of the engine 3 hydraulic system during test SA-33. This system was disabled pretest due to a leakage of the GN_2 precharge into the oil system during the firing day functional checks. The hydraulic system was removed from this engine and the actuators locked in the midstroke position.

A hold in the test SA-32 automatic sequence was called at X-6 seconds for a redline verification. No problem existed, and the count was resumed after approximately 20 seconds of hold.

Due to a defective headset being used by the person calling the countdown times, the recorder room personnel did not hear the countdown times after X-30 seconds. Consequently no ignition transient data were obtained.

To preclude the re-occurrence of this problem, an indicator light has been installed in the recorder room to be turned on automatically at X-13 seconds at which time all recording systems will be turned on.

The heat shield support beams were instrumented to determine if excessive strains were present. There was no indication of damage following test SA-32. Boattail cameras, installed to determine the magnitude of heat shield beam movement, failed to give any useful data during test SA-32 due to failure of the camera light sources at ignition.

Good camera coverage of heat shield beam deflection was obtained during the ignition transition of test SA-33. Heat shield beam movement was recorded on the beams which are perpendicular to fin lines II-IV nearest engines 6 and 8. Maximum deflections noted were an upward movement of 0.75 inch at X-2.03 seconds and a downward movement of 1.35 inches at X-1.81 seconds.

Slight deformation of four heat shield beams (60C30459-1) occurred during test SA-33. This deformation is considered minor.

SECTION 1

INTRODUCTION

Stage S-IB-4 was shipped by barge from the CCSD manufacturing facility at Michoud, Louisiana, on December 7, 1965, and arrived at the Marshall Space Flight Center dock on December 13, 1965. Installation of stage S-IB-4 in the STTE was performed on December 14, 1965.

Four major tests were performed in checkout and acceptance firing of stage S-IB-4: the simulated flight tests with flight pressures, performed on January 3, January 4, and January 13, 1966; the propellant loading test, performed on January 5; the short duration confidence firing conducted on January 17; and the full duration acceptance firing conducted on January 21, 1965. All tests were successfully performed.

Stage S-IB-4 was removed from the tower on January 28 and loaded on the barge on that day for return to Michoud.

Stage S-IB-4 is the fourth of the Saturn 200 series booster stages to be manufactured by Chrysler Corporation Space Division. The stage configuration is similar to that of stage S-IB-3 which incorporated light weight propellant tanks, titanium fuel pressurizing spheres, low differential pressure LOX venting system, stainless steel honeycomb heat shield panels, and chamber mounted inboard engine turbine exhaust ducts.

The primary objective of the static firing tests of the Saturn S-IB stages is to demonstrate the correct functional performance and operation of the airborne systems under simulated launch conditions. The short duration static firing constituted a confidence test to verify airborne/ground control system compatibility and to check out instrumentation. Based on data obtained from the short duration firing, corrections were made prior to the long duration static firing, as required. The specific test objectives are further outlined as follows:

SHORT DURATION TEST

1. Performance check of the 200K engines.

2. Performance check of the gimbal system.

3. Performance check of the telemetry system.

4. Determination of LOX boiloff rate.

5. Evaluation of propellant tank pressurization transients with flight ullages.

LONG DURATION TEST

1. Verify engine performance.

2. Verify performance of the gimbal control system.

3. Verify reliability and performance of the telemetry system.

4. Evaluate performance of the airborne tank pressurizing systems.

5. Obtain fuel tank structural data to verify the effectiveness of measures taken to prevent fuel tank structural ripples.

The static test configuration of stage S-IB-4 is defined by drawing 60C10016. Deletions from the flight configuration include the following: stabilizer fins, outboard engine shrouds, instrumentation canister doors, LOX replenish valve, 3 command destruct antenna, 2 FM/FM antenna, and 2 PCM antenna. Hardware additions include the following: static test holddown brackets, auxiliary LOX dome purge manifold, three fuel fill and drain valves, and three LOX fill and drain valves. A peripheral tail skirt radiation shield is also included as a part of the static test configuration.

The following sections of this report present the results of the static test firings of stage S-IB-4.

SECTION 2

ENGINE SYSTEMS

Engine operation during tests SA-32 and SA-33 was satisfactory. All engines produced thrust values within the specified limits of 200K±3 percent. No engine reorificing was required.

Test duration for test SA-32 was 35.339 seconds from ignition command to outboard engine cutoff signal, with cutoff being initiated as planned by the firing panel operator.

Inboard engine cutoff signal for test SA-33 was initiated by the switch selector at 143.934 seconds after ignition command, 3.19 seconds after LOX low level sensor 3 in tank 0-4 was uncovered. Outboard engine cutoff was initiated by dropout of engine 3 Thrust OK pressure switches (147.110 seconds after ignition command) as a result of LOX depletion. There was no decay in thrust of the other outboard engines prior to outboard engine cutoff signal.

H-1 engine schematics can be found in FIGURES 2-1 and 2-2. Engine static test data for tests SA-32 and SA-33 can be found in TABLES 2-1 and 2-2, respectively. Ignition and cutoff sequence times for each engine are listed in TABLES 2-3 and 2-4 for tests SA-32 and SA-33, respectively. GRAPHS 2-1 through 2-8 show the oscillograph traces during the ignition and cutoff transitions of each engine during test SA-33. Engine orifice sizes may be found in Item 14, APPENDIX C, Stage and Ground Support Test Data Sheets, Stage S-IB-4.

The "Confidential Supplement", for stage S-IB-4, contains the following additional information for tests SA-32 and SA-33: site and sea level engine thrust, sea level combustion chamber pressures, a comparison of telemetry and hardwire site values of combustion chamber pressures, sea level engine specific impulse, and run-to-run sea level turbopump speeds versus chamber pressures.

Engine 4 chamber pressure measurement *PP103 was erratic during test SA-32. This failure was traced to a loose connection in a stand junction box and was corrected prior to test SA-33. Measurement *PP108 provided a valid reading.

Prior to test SA-32, Rocketdyne personnel installed orificed Thrust OK pressure switch supply manifolds on all engines (reference ECP H1-288). These manifolds contain an 0.041-inch diameter orifice in each line to eliminate Thrust OK pressure switch "chatter" during the cutoff transition or if combustion instability should occur. No Thrust OK pressure switch "chatter" was noted during either test SA-32 or SA-33.

Thermocouples were installed on the thrust chamber bands of engines 3 and 8 and nine strain measurements were installed on engine 3 to determine maximum temperatures and stresses occurring during static firing.

During test SA-32, a maximum value of 500 μ in./in. tension was obtained on strain measurement PS107-3. Data obtained on the other eight measurements were questionable due to a gage ground problem caused by moisture. Measurements PS102-3 through PS105-3 were dropped for test SA-33. The maximum strain values recorded during test SA-33 are listed in TABLE 2-5. The maximum temperatures obtained at each band position are shown in FIGURE 2-3.

Graphs depicting temperature trends for each thrust chamber band measurement can be found by referring to GRAPHS 2-1 through 2-8 of the "Preliminary Static Test Reports for Tests SA-32 and SA-33".

Additional LOX seal drain lines were installed on each engine turbopump due to recent failures of the LOX pump seals at Rocketdyne (reference ECP H1-290). A thermocouple, PT156, and a pressure transducer, PP117, were installed in the primary LOX seal drain line on each engine. The temperature measurement was given a redline value and monitored on recorders during test SA-32 and test SA-33. A comparison of drain line temperatures recorded during the Rocketdyne acceptance test, test SA-32, and test SA-33 is shown in TABLE 2-6. GRAPHS 2-9 and 2-10 show LOX seal drain line temperatures for test SA-32. LOX seal drain line temperatures for test SA-33 may be found in GRAPHS 2-11 through 2-14.

Thermal insulation plates, P/N R209772, located at the inboard engines' aspirator exits, were installed per ECP FEB R-65-50.

PRETEST LEAK AND HARDWARE CHECKS

Initial inspection of the engine systems revealed that tube assembly P/N 60C20242-1 for LOX pump inlet pressure measurement D13-2 was cracked. The tube assembly was replaced.

Engine clearance checks were performed on all engines. The outboard engines were gimbaled and clearances were measured. The following measurement locations were not within the specified limits:

ENGINE	CLEARANCE	MEASURED VALUE (INCH)	MIN. ALLOWABLE VALUE (INCH)
2	GOX Line Bellows to Gimbal Block	0.15	0.25
4	GOX Line Bellows to LOX Manifold Bellows	Interference	0.09
7	GOX Manifold to Turnbuckle	1.35	1.80

The GOX line at engine 4 was repositioned to correct the interference problem. The corrected clearance was 0.16 inch.

A turbine exhaust leak check revealed the following leaks:

ENGINE	LOCATION OF LEAKAGE	CORRECTIVE ACTION
5	Turbine Inlet Flange	None
6	Turbine Inlet Instrumentation Boss	Replaced Seal

Following the propellant loading test, the screens in the LOX and fuel pump inlets were removed. A piece of white tape, approximately 2 inches by 1 inch, was found in engine 8 LOX pump inlet screen. The tape appeared to be the type used to cover the ends of lines following LOX cleaning.

Inspection of engine 5 revealed a dent on the exterior of the thrust chamber. The dent was on tube 259 and was measured to be approximately 3/4-inch long and 0.090 inch deep. Repair was made by filling the dent with silver solder.

During the removal of engine 1 thrust chamber covers for external leak check, it was noted that the first foam rubber thrust chamber protective cover, P/N T-8100786-J, below the throat was damaged. The major portion of a blind nut assembly sleeve was imbedded in the cover, nearly in contact with the thrust chamber tubes (reference UCR 02934).

The following tests and checks were performed on the engine systems with no discrepancies other than those previously mentioned:

1. Gas generator control valve functional check.
2. Gas generator and exhaust system leak check.
3. Fuel control system leak check.
4. Igniter fuel system and thrust chamber fuel injector purge.
5. Main fuel valve leak check.
6. Ignition monitor valve leakage and functional test.
7. Thrust chamber leak test (gas and fuel).
8. Engine pressure switches functional check.
9. Fuel lube blowdown.
10. LOX pump seal cavity contamination check.

A LOX seal swab check was performed with no contamination noted.

POST TEST SA-32 HARDWARE INSPECTION AND LEAK CHECKS

Gas generator and turbine exhaust system leak checks were performed indicating leakages which were corrected as noted:

ENGINE	LOCATION OF LEAKAGE	CORRECTIVE ACTION
2	Turbine to Turbine Inlet Flange	Replaced Gasket
3	Turbine Inlet Instrumentation Boss	Replaced Seal
4	Turbine Inlet Instrumentation Boss	Replaced Seal
5	Turbine Inlet Instrumentation Boss	Replaced Seal
6	Turbine Inlet Instrumentation Boss	Replaced Seal
7	Turbine Inlet Instrumentation Boss	Replaced Seal

The turbopumps were not preserved due to the short time interval between tests SA-32 and SA-33. The turbopumps were torque checked and the following values recorded:

ENGINE	INITIAL BREAKAWAY TORQUE (IN.-LBS)	RUNNING TORQUE (IN.-LBS)
1 ⚠1	70	60
2	90	80
3	80	70
4	90	80
5	60	50
6	60	55
7	60	50
8	60	55

⚠1 Main hydraulic pump not installed.

Thrust chamber leak checks with gas were performed with no leakage discovered. While performing these checks, a crack was found in the return manifold on engine 6 in line with tube 94 on the inside of the thrust chamber. Although only a seep leak was evident, a decision was made to weld the crack prior to test SA-33 due to its location. The repair consisted of welding over the 0.020-inch hole with an alloy of 85 percent gold and 15 percent nickel. A leak check was performed with fuel following this repair, and no leakage was noted.

During the thrust chamber leak check with fuel, a slight internal leak was noted at engine 6 between tube number 6 and the return manifold. No repair action was taken prior to test SA-33.

During the thrust chamber jacket flushing operation following test SA-33, the engine thrust chambers were leak checked with trichloroethylene. Engine 6 had two slight seep leaks, one at tube 6 where it attaches to the return manifold and one at the previously repaired area just below tube 94. The Material Review Board and Rocketdyne should decide what repair action, if any, is necessary on return of the stage to Michoud.

After tanking fuel for test SA-33, a leak was discovered at the FABU inlet at engine 5. An investigation revealed that the threads were damaged on the FABU inlet fitting, P/N 454120. The leakage was corrected by replacing the fitting (reference UCR 02949).

Prior to test SA-33, the following pretest leak and hardware checks were performed with no discrepancies other than those previously mentioned:

1. Fuel lube blowdown.
2. LOX seal cavity contamination check.
3. Igniter fuel system and thrust chamber fuel injector purge.
4. Thrust chamber leak check (gas).
5. Thrust chamber leak check (fuel).

POST TEST SA-33 HARDWARE INSPECTION AND LEAK CHECKS

An inspection of engine 3 immediately following test SA-33 revealed metal erosion on the lower edge of the aspirator lip, directly below tube number 110 and the low side thrust chamber drain screw access port. The lower edge of the aspirator lip at engine 4 is also beginning to crack in the same area as the erosion at engine 3 (see FIGURE 2-4). For tests SA-32 and SA-33, calorimeters (measurements AT119-3 and AT119-4) were installed adjacent to the thrust chamber drain screw access port. The cover plates were not installed. It is concluded that hot gases were diverted and concentrated on the aspirator lip by the calorimeter support brackets. Recommendations have been made to eliminate further measurements in the area of the thrust chamber drain screw access ports. It is also recommended that no repairs be made, since the erosion of the aspirator lip does not affect engine performance for launch.

During test SA-33, the fuel pump outlet pressure measurement *PP104 at engine 8 was lost for the entire run. A post test investigation revealed that the electrical connector at the facility engine junction box came loose at ignition.

Turbopump preservation was performed at all engines. The turbopumps were torque checked, prior to and after preservation, with the following values recorded:

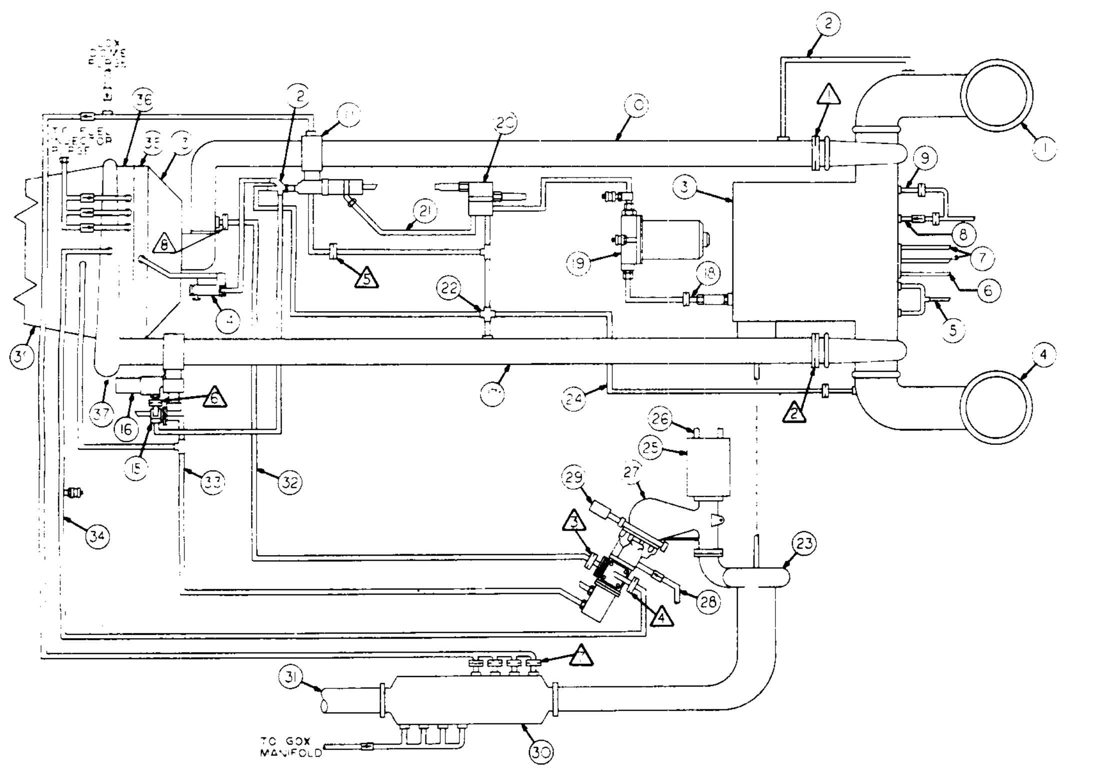
ENGINE	PRIOR TO PRESERVATION		AFTER PRESERVATION	
	BREAKAWAY TORQUE (IN.-LBS)	RUNNING TORQUE (IN.-LBS)	BREAKAWAY TORQUE (IN.-LBS)	RUNNING TORQUE (IN.-LBS)
1	70	60	100	90
2	75	65	90	80
3 ⚠1	65	55	60	50
4	85	70	80	70
5	⚠2 140-50	45	70	60
6	⚠2 110-60	50	70	60
7	⚠2 250-60	50	60	50
8	⚠2 225-60	50	70	60

⚠1 The hydraulic pump at engine 3 was removed pretest.
⚠2 Initial breakaway torque.

2. Turbine exhaust system leak checks were performed following test SA-33, and the results are tabulated below:

ENGINE	LOCATION OF LEAKAGE	CORRECTIVE ACTION
1	Instrumentation Bosses on Turbine Inlet (2)	Replaced Copper Crush Seal
2	Gas Generator - Turbine Inlet Flange	None
3	Gas Generator - Turbine Inlet Flange	None
5	Gas Generator - Turbine Inlet Flange	None
5	Instrumentation Boss on Turbine Inlet	Replaced Copper Crush Seal
6	Gas Generator - Turbine Inlet Flange	None
7	Gas Generator - Turbine Inlet Flange	None

It is recommended that the leaks at the turbine inlet flange not be corrected since they are minor fuzz leaks at low pressure.

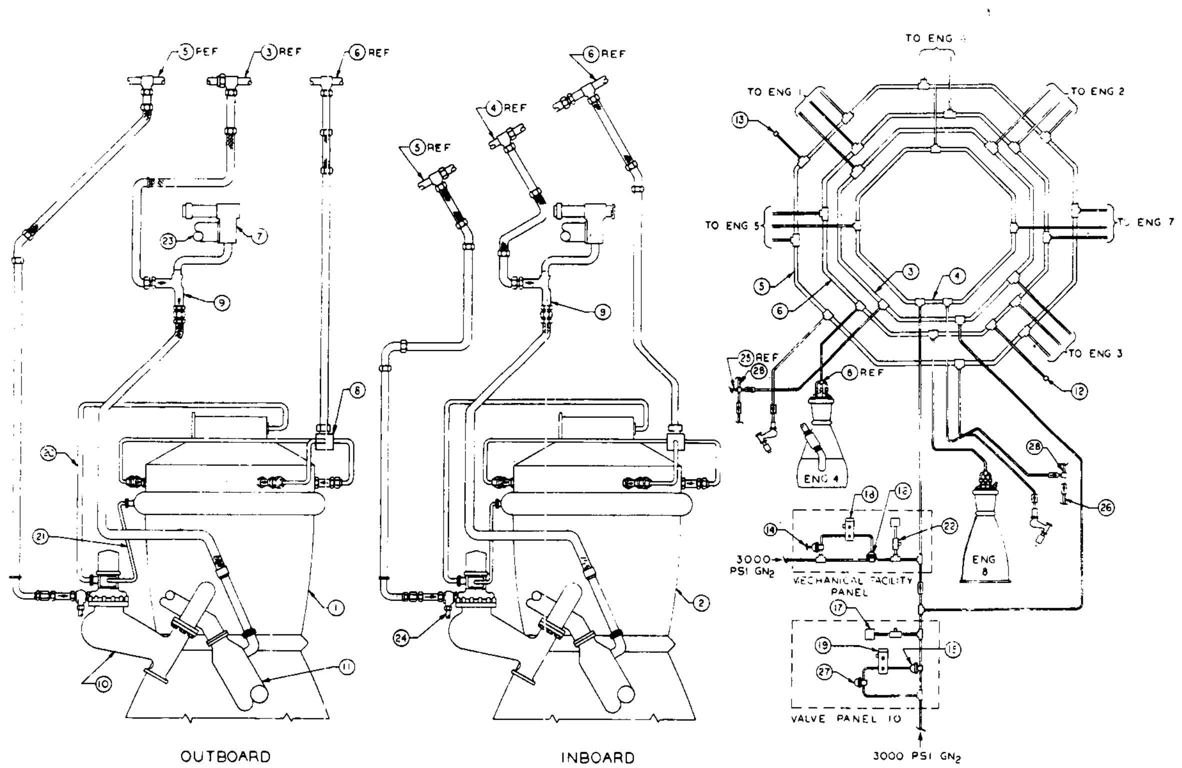


FIND NO	ITEM
1	LOX SUCTION LINE
2	LOX BLEED LINE
3	TURBO PUMP
4	FUEL SUCTION LINE
5	LUBE DRAIN
6	LUBE SEAL DRAIN
7	LOX SEAL DRAIN
8	GEAR BOX PRESS
9	LOX SEAL PURGE
10	LOX HIGH PRESS DUCT
11	MAIN LOX VALVE
12	IGNITER FUEL VALVE
13	LOX DOME
14	HYPERGOL CONTAINER
15	IGNITION MONITOR VALVE
16	MAIN FUEL VALVE
17	FUEL HIGH PRESS DUCT
18	T/P LUBE LINE
19	FABL
20	CONAX VALVE
21	MAIN LOX VALVE CLOSING CONTROL LINE
22	FUEL CONTROL CROSS
23	2-STAGE TURBINE
24	FUEL BLEED LINE
25	SOLID PROPELLENT GAS GENERATOR
26	SPGG INITIATORS
27	LIQUID PROPELLENT GAS GENERATOR
28	GG LOX INJECTOR PURGE
29	GG AUTO IGNITERS
30	HEAT EXCHANGER
31	TURBINE EXHAUST DUCT
32	LOX BOOTSTRAP LINE
33	CONTROL LINE
34	FUEL BOOTSTRAP LINE
35	LOX INJECTOR
36	FUEL INJECTOR
37	FUEL MANIFOLD
38	COMBUSTION CHAMBER

ORIFICES

1	MAIN LOX
2	MAIN FUEL
3	GG LOX
4	GG FUEL
5	MLV CONTROL
6	MFV CONTROL
7	HEAT EXCHANGER (TYP 3 PLACES)
8	FIXED GG LOX ORIFICE

FIGURE 2-1
H-1 ENGINE SCHEMATIC



FIND NO.	ITEM
1	ENGINES 1, 2, 3 & 4
2	ENGINES 5, 6, 7 & 8
3	LOX DOME PURGE MANIFOLD, OUTBOARD ENGINES
4	LOX DOME PURGE MANIFOLD, INBOARD ENGINES
5	GAS GENERATOR LOX INJECTOR PURGE MANIFOLD (TYPICAL ALL ENGINES)
6	FUEL INJECTOR PURGE (TYPICAL ALL ENGINES)
7	MAIN LOX VALVE (TYPICAL ALL ENGINES)
8	PURGE MANIFOLD (TYPICAL ALL ENGINES)
9	UNITIZED CHECK VALVE (TYPICAL ALL ENGINES)
10	LIQUID PROPELLANT GAS GENERATOR (TYPICAL ALL ENGINES)
11	HEAT EXCHANGER (TYPICAL ALL ENGINES)
12	PURGE SUPPLY, LOWER UMBILICAL, FIN II
13	PURGE SUPPLY, LOWER UMBILICAL, FIN IV
14	HAND OPERATED REGULATOR
15	DOME REGULATOR - 250 PSI
16	DOME REGULATOR - 650 PSI
17	PRESSURE SWITCH (TYPICAL 2 PLACES)
18	AUXILIARY LOX DOME PURGE SOLENOID
19	LOX DOME PURGE SOLENOID
20	LOX BOOTSTRAP LINE (TYPICAL ALL ENGINES)
21	FUEL BOOTSTRAP LINE (TYPICAL ALL ENGINES)
22	CALIBRATION VALVE (TYPICAL 2 PLACES)
23	HIGH PRESSURE LOX DUCT
24	TO MEASUREMENT PP1(6), PRESSURE GAS GENERATOR LOX INJECTOR MANIFOLD (TYPICAL ALL ENGINES)
25	DELETED
26	TO HEAT EXCHANGER (TYPICAL ALL ENGINES)
27	FIXED REGULATOR
28	TO MAIN LOX VALVE

FIGURE 2-2
H-1 ENGINE PURGE SYSTEM

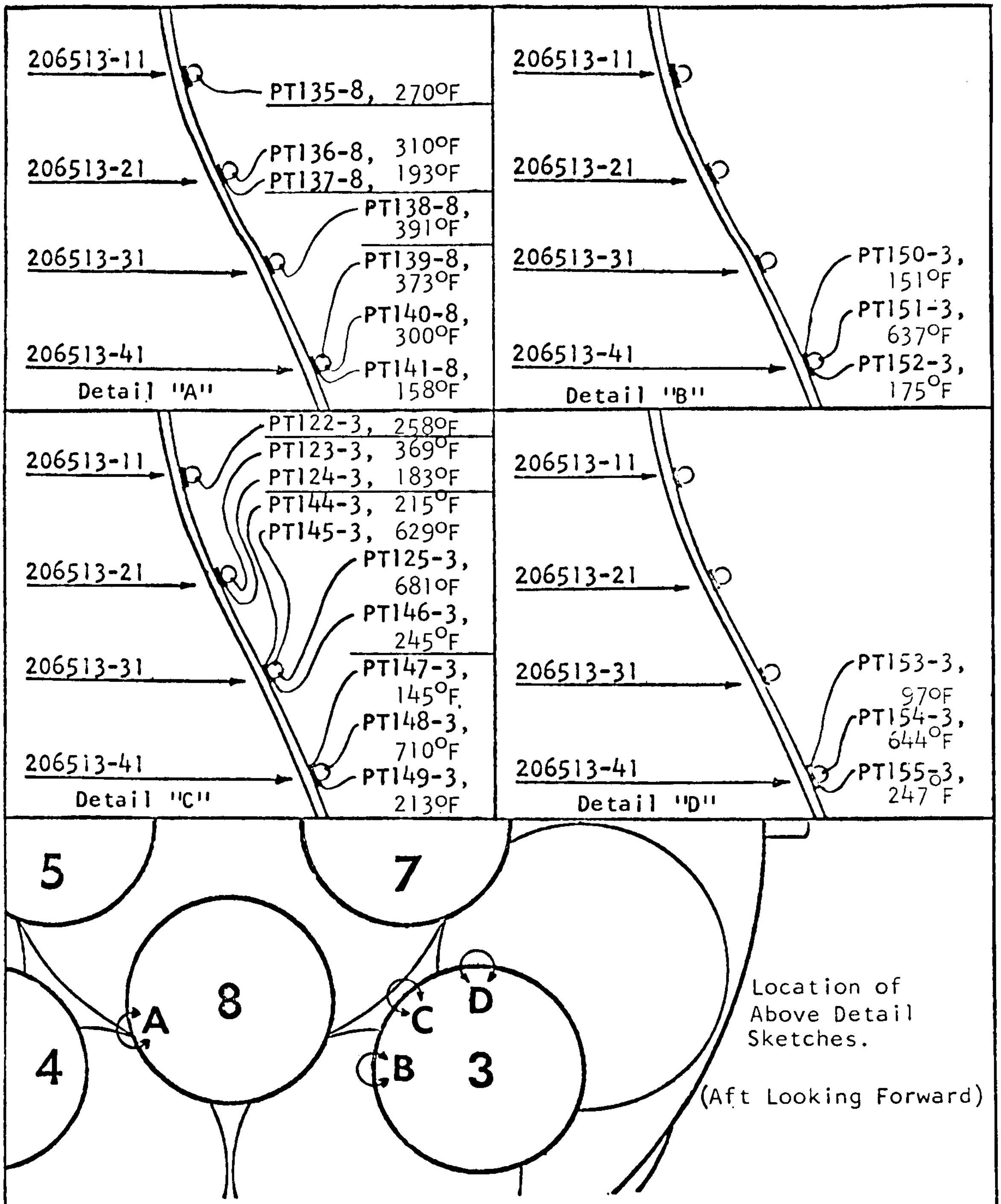


FIGURE 2-3

MAXIMUM THRUST CHAMBER BAND TEMPERATURES, TEST SA-33

FIGURE 2-4
METAL EROSION, ASPIRATOR LIP OF ENGINE 3

TABLE 2-1

ENGINE STATIC TEST DATA

Ambient Pressure (psia)	14.58
Ambient Temperature (°F)	37

TEST SA-32

MEAS. NO.	MEASUREMENT DESCRIPTION	ENGINE	VALUES AT	
			IGNITION	X+29-32 SEC.
*PT100	Temperature, Fuel Pump Inlet (°F)	8		28.2
	Density, Fuel Pump Inlet (lb/ft^3)	8		51.023
*PP113	Pressure, Fuel Pump Inlet (psig)	1	41.9	25.21
		2	41.0	25.95
		3	41.5	26.30
		4	40.7	25.71
		5	40.7	25.50
		6	40.5	25.72
		7	42.3	26.85
		8	42.5	26.15
*PP104	Pressure, Fuel Pump Outlet (psig)	1		964.0
		2		974.3
		3		948.8
		4		918.8
		5		926.8
		6		946.7
		7		946.0
		8		938.7
*PT107	Temperature, LOX Pump Inlet (°F)	1	-278.2	-292.69
		2	-278.7	-292.43
		3	-278.3	-292.83
		4	-278.3	-292.95
		5	-278.1	-293.36
		6	-277.5	-293.02
		7	-277.8	-292.88
		8	-277.1	-292.57
*PP114	Pressure, LOX Pump Inlet (psig)	1	75.5	53.01
		2	74.0	51.80
		3	74.9	52.93
		4	⚠1	⚠1
		5	76.5	53.17
		6	75.0	51.60
		7	75.5	53.72
		8	75.7	54.55

⚠1 Hardwire value not valid.

TABLE 2-1 (CONTINUED)

TEST SA-32

MEAS. NO.	MEASUREMENT DESCRIPTION	ENGINE	VALUES AT IGNITION	VALUES AT X+29-32 SEC.
PP109	Pressure, Turbine exit (psig)	5		8.5
		7		9.3
PP111	Differential Pressure, Turbine out to Exhaust Nozzle (psid)	5		6.25
		7		6.0
PT110	Temperature, Turbine exhaust at Heat Exchanger Outlet (°F)	6		897.8
		8		895.3
	Turbopump Speed (rpm), Derived From *PR100, Turbine rpm	1		6725.0
		2		6763.0
		3		6696.0
		4		6593.0
		5		6592.0
		6		6700.0
		7		6713.0
		8		6653.0
*PT701	Temperature, Oronite (°F)	1	131.0	
		2	130.5	
		3	123.5	
		4	125.5	
		5	124.0	
		6	126.0	
		7	129.9	
		8	128.0	
*PP112	Pressure, Gearcase (psig)	1		4.16
		2		4.28
		3		4.10
		4		4.67
		5		3.83
		6		4.28
		7		4.36
		8		3.98
*PT700	Temperature, LOX Pump Bearing 1 (°F)	1	105.0	114.6
		2	108.0	113.8
		3	97.5	114.5
		4	101.8	107.1
		5	113.2	119.6
		6	111.8	116.6
		7	125.0	127.6
		8	103.0	113.0

TABLE 2-1 (CONTINUED)

TEST SA-32

MEAS. NO.	MEASUREMENT DESCRIPTION	ENGINE	VALUES AT IGNITION	VALUES AT X+29-32 SEC.
*PP105	Pressure, LOX Pump Outlet (psig)	1		⚠1
		2		821.8
		3		806.2
		4		789.0
		5		802.2
		6		803.5
		7		816.3
		8		800.5
*PT101	Temperature, SPGG Surface (°F)	3	38.6	
		7	34.8	
*PT102	Temperature, Conisphere (°F)	1		1218.9
		2		1224.8
		3		1220.9
		4		1175.7
		5		1195.0
		6		1223.4
		7		1221.3
		8		1221.5
*PP100	Pressure, GG Fuel Injector Manifold (psig)	1		720.0
		2		760.0
		3		715.0
		4		710.0
		5		700.0
		6		710.0
		7		735.0
		8		720.0
*PP101	Pressure, GG LOX Injector Manifold (psig)	1		741.9
		2		770.6
		3		758.9
		4		715.5
		5		706.2
		6		735.5
		7		744.5
		8		754.9
*PP102	Pressure, Turbine Inlet (psig)	1		498.5
		2		528.9
		3		498.9
		4		495.5
		5		495.5
		6		526.5
		7		508.3
		8		503.0

⚠1 Hardwired value not valid.

TABLE 2-1 (CONTINUED)

TEST SA-32

MEAS. NO.	MEASUREMENT DESCRIPTION	ENGINE	VALUES AT	
			IGNITION	X+29-32 SEC.
*PT105	Temperature, Turbopump Bearing 4 (^{o}F)	1		125.4
		2		122.3
		3		120.1
		4		115.7
		5		124.5
		6		122.7
		7		125.7
		8		115.5
*PT112	Temperature, Turbopump Bearing 6 (^{o}F)	1		147.5
		2		146.7
		3		130.4
		4		138.5
		5		145.7
		6		160.3
		7		△1
		8		142.6
*PT113	Temperature, Turbopump Bearing 7 (^{o}F)	1	54.0	165.8
		2	56.0	157.9
		3	57.8	152.1
		4	51.0	147.6
		5	55.0	151.8
		6	61.8	160.3
		7	57.8	160.0
		8	53.8	151.4
*PP115	Pressure, Lube Oil, Bearing 1 (psig)	1		126.0
		2		114.0
		3		103.0
		4		104.0
		5		99.0
		6		115.0
		7		127.5
		8		102.5

△1 Hardwire value not valid.

TABLE 2-2

ENGINE STATIC TEST DATA

Ambient Pressure (psia)	14.455
Ambient Temperature (^{o}F)	41

TEST SA-33

MEAS. NO.	MEASUREMENT DESCRIPTION	ENGINE	VALUES AT		
			IGNITION	X+29-32 SEC.	CUTOFF
*PT100	Temperature, Fuel Pump Inlet (^{o}F)	8	38.4	35.0	35.8
	Density, Fuel Pump Inlet (lb/ft^3)	8		50.875	
*PP113	Pressure, Fuel Pump Inlet (psig)	1	41.50	22.96	12.24
		2	40.60	24.48	12.43
		3	40.57	24.37	12.15
		4	40.26	24.24	12.09
		5	40.22	24.21	12.35
		6	40.31	24.31	12.49
		7	40.74	24.71	12.54
		8	40.52	23.62	12.35
*PP104	Pressure, Fuel Pump Outlet (psig)	1	40.3	964.6	934.8
		2	41.7	985.5	956.4
		3	38.9	957.6	929.8
		4	43.0	934.5	905.8
		5	37.2	930.5	902.0
		6	42.0	965.3	943.4
		7	41.3	962.0	942.4
		8	39.0	945.3	935 ⚠1
*PT107	Temperature, LOX Pump Inlet (^{o}F)	1	-278.9	-293.0	-292.5
		2	-278.7	-293.4	-292.6
		3	-279.1	-294.0	-292.5
		4	-279.5	-293.5	-292.3
		5	-278.6	-293.9	-293.0
		6	-278.4	-293.6	-293.0
		7	-278.2	-293.8	-293.0
		8	-277.9	-293.6	-292.3
*PP114	Pressure, LOX Pump Inlet (psig)	1	75.04	52.46	29.04
		2	74.99	52.31	29.02
		3	75.09	52.19	29.10
		4	75.04	44.45	21.57
		5	77.30	53.55	29.14
		6	74.84	50.80	28.40
		7	74.79	52.50	29.90
		8	74.84	52.92	30.80

⚠1 Oscillograph value. Value corrected from that listed in the "Preliminary Static Test Report for test SA-33".

TABLE 2-2 (CONTINUED)

TEST SA-33

MEAS. NO.	MEASUREMENT DESCRIPTION	ENGINE	VALUES AT IGNITION	X+29-32 SEC.	CUTOFF
*PP105	Pressure, LOX Pump Outlet (psig)	1	74.00	810.7	782.6
		2	74.00	830.5	802.8
		3	72.00	815.7	785.7
		4	75.00	800.6	772.7
		5	75.00	808.65	780.1
		6	73.58	814.8	792.7
		7	75.04	825.0	802.3
		8	71.00	810.8	786.9
*PT101	Temperature, SPGG Surface (^oF)	3	43.9		
		7	38.2		
*PT102	Temperature, Conisphere (^oF)	1		1230.7	1210.3
		2		1230.7	1221.0
		3		1236.4	1215.3
		4		1188.35	1180.7
		5		1196.7	1189.4
		6		1234.5	1229.1
		7		1222.6	1216.3
		8		1230.0	1220.6
*PP100	Pressure, GG Fuel Injector Manifold (psig)	1		715.0	695.0
		2		760.0	750.0
		3		740.0	725.0
		4		725.0	705.0
		5		710.0	695.0
		6		715.0	715.0
		7		745.0	710.0
		8		750.0	720.0
*PP101	Pressure, GG LOX Injector Manifold (psig)	1		741.8	722.8
		2		780.8	762.1
		3		785.5	761.2
		4		725.3	703.7
		5		709.8	688.1
		6		749.2	729.9
		7		751.8	733.3
		8		765.6	743.8
*PP102	Pressure, Turbine Inlet (psig)	1		504.7	485.2
		2		541.5	538.0
		3		514.8	509.1
		4		509.6	504.9
		5		500.6	472.2
		6		533.3	519.1
		7		506.6	496.4
		8		504.5	496.3

TABLE 2-2 (CONTINUED)

TEST SA-33

MEAS. NO.	MEASUREMENT DESCRIPTION	ENGINE	VALUES AT IGNITION	VALUES AT X+29-32 SEC.	VALUES AT CUTOFF
PP109	Pressure, Turbine Exit (psig)	5		8.4	7.9
		7		9.3	8.6
PP111	Differential Pressure, Turbine out to Exhaust Nozzle (psid)	5		6.4	5.4
		7		6.1	5.3
PT110	Temperature, Turbine Exhaust at Heat Exchanger Outlet (°F)	6		908.8	896.6
		8		907.4	894.0
	Turbopump Speed (rpm), Derived From *PR100, Turbine rpm	1		6737.0	
		2		6804.0	
		3		6734.0	
		4		6634.0	
		5		6612.0	
		6		6750.0	
		7		6736.0	
		8		6690.0	
*PT701	Temperature, Oronite (°F)	1	126.0		
		2	121.0		
		3	138.0		
		4	123.5		
		5	125.0		
		6	134.0		
		7	129.0		
		8	125.5		
*PP112	Pressure, Gearcase (psig)	1	4.2	4.2	4.1
		2	4.3	4.3	4.15
		3	4.2	4.1	4.0
		4	4.7	4.6	4.45
		5	4.1	4.0	4.0
		6	4.2	4.2	4.1
		7	4.5	4.4	4.25
		8	4.0	4.0	4.05
*PT700	Temperature, LOX Pump Bearing 1 (°F)	1	102.5	118.4	195.0
		2	105.3	117.5	198.0
		3	97.7	120.0	198.0
		4	99.5	110.7	191.0
		5	114.4	124.5	197.4
		6	107.4	120.8	191.9
		7	127.6	132.8	198.0
		8	108.5	119.6	192.0

TABLE 2-2 (CONTINUED)

TEST SA-33

MEAS. NO.	MEASUREMENT DESCRIPTION	ENGINE	VALUES AT		
			IGNITION	X+29-32 SEC.	CUTOFF
*PT105	Temperature, Turbopump Bearing 4 (°F)	1	58.0	130.0	200.3
		2	56.9	129.5	207.0
		3	58.5	127.1	192.0
		4	55.1	122.8	192.8
		5	65.2	130.1	186.0
		6	62.2	130.1	194.0
		7	67.7	132.6	181.7
		8	61.1	124.1	180.3
*PT112	Temperature, Turbopump Bearing 6 (°F)	1	56.9	149.2	217.0
		2	58.2	150.5	221.0
		3	56.5	136.7	201.9
		4	56.2	144.3	220.5
		5	68.7	150.6	210.0
		6	68.0	160.1	251.0
		7	71.2	154.9	207.1
		8	62.7	150.2	218.0
*PT113	Temperature, Turbopump Bearing 7 (°F)	1	62.1	224.5	254.0
		2	62.5	213.7	246.0
		3	62.7	213.8	250.0
		4	62.0	202.1	236.0
		5	67.6	202.2	224.0
		6	61.9	201.9	226.0
		7	68.2	215.2	232.0
		8	64.4	204.8	234.0
*PP115	Pressure, Lube Oil, Bearing 1 (psig)	1		129.0	126.0
		2		116.5	114.5
		3		107.0	104.5
		4		103.5	102.0
		5		100.5	99.0
		6		115.0	113.5
		7		128.0	126.5
		8		107.0	106.0

TABLE 2-3

CUTOFF SEQUENCE TIMES (1)

TEST SA-32

ENGINE	1	2	3	4	5	6	7	8
Conax Firing Signal (Seconds From Commit)	32.370	32.370	32.370	32.371	32.253	32.253	32.252	32.253
TIMES FROM CONAX FIRING SIGNAL OF EACH IN MILLISECONDS								
MLV Starts Closing	66	68	68	68	74	81	74	78
MLV Full Closed	289	288	303	310	316	335	296	318
MLV Closing Time	223	220	235	242	242	254	222	240
P_c Leaves Mainstage	94	99	100	97	104	112	98	110
P_c Decays to 90% of Final Mainstage Value	140	145	144	149	151	162	157	157
P_c Decays to 10% of Final Mainstage Value	325	307	342	317	328	344	345	327

(1) Ignition sequence times are not presented because no data were obtained prior to commit.

TABLE 2-4

IGNITION AND CUTOFF SEQUENCE TIMES

TEST SA-33

ENGINE	1	2	3	4	5	6	7	8
IGNITION SIGNAL FROM IGNITION COMMAND (MILLISECONDS)	326	225	326	225	25	125	25	126
TIMES FROM THE IGNITION SIGNAL OF EACH ENGINE IN MILLISECONDS								
MLV Starts Opening	212	217	240	213	230	232	212	224
MLV Full Open	532	524	563	535	530	534	532	530
MLV Opening Time	320	307	323	313	300	302	320	306
Thrust Chamber Ignition	572	586	615	573	590	587	577	581
Pc Prime	887	882	938	893	904	892	896	886
Pc Reaches 90% Of Slice Time Value	1070	1049	1122	1073	1100	1076	1082	1074

TABLE 2-4 (CONTINUED)

TEST SA-33

ENGINE	1	2	3	4	5	6	7	8
Turbopump Prime Speed (RPM)	5263	5322	5288	5210	5279	5287	5339	5263
Conax Firing Signal (Seconds From Commit)	144.158	144.158	144.132	144.159	140.974	140.974	140.973	140.974
TIME FROM CONAX FIRING SIGNAL OF EACH ENGINE IN MILLISECONDS								
MLV Starts Closing	78	77	87	76	74	74	73	76
MLV Full Closed	325	305	365	318	321	344	303	311
MLV Closing Time	247	228	278	242	247	270	230	235
P_c Leaves Mainstage	65 △1	59 △1	-98 △2	101	98	117	110	112
P_c Decays to 90% Of Final Mainstage Value	98 △1	119 △1	-75 △2	154	151	162	156	148
P_c Decays to 10% Of Final Mainstage Value	380 △1	342 △1	449 △2	336	333	352	343	333

△1 Engines 1 and 2 experienced LOX depletion following the Conax firing signal, but prior to engine shutdown.

△2 TOP switch dropout from LOX depletion at engine 3 triggered outboard engine cutoff.

TABLE 2-5

THRUST CHAMBER BAND STRAINS
MAXIMUM VALUES, SA-33
(μ in/in)

MEASUREMENT NUMBER △1	IGNITION	30 SEC.	CUTOFF
PS100-3	0	+76	+114
PS101-3	0	-80	-120
PS106-3	+109	+218	+290
PS107-3	-40	-40	-40
PS108-3	0	0	+89

△1 Measurements PS102-3 through PS105-3 were dropped prior to test SA-33.

TABLE 2-6

COMPARISON OF LOX SEAL DRAIN LINE TEMPERATURES
ROCKETDYNE, TEST SA-32 AND TEST SA-33

ENGINE	PREIGNITION TEMPERATURE - °F			MINIMUM SPIKE TEMPERATURE - °F		
	RKDN (1)	SA-32 (2)	SA-33 (3)	RKDN (1)	SA-32 (2)	SA-33 (3)
1	-152	(4)	-54	-268	-136	-163
2	-165	-98.5	-67	-260	-155	-123
3	-171	(4)	-106	-261	-129	(5)
4	-176	-95.5	-77	-264	-182	-119
5	-154	(4)	-97	-269	-152	-149
6	-173	-92.5	-87	-273	-165	-223
7	-170	(4)	-84	-275	-251	-133
8	-157	(4)	-88	-269	-146	-113

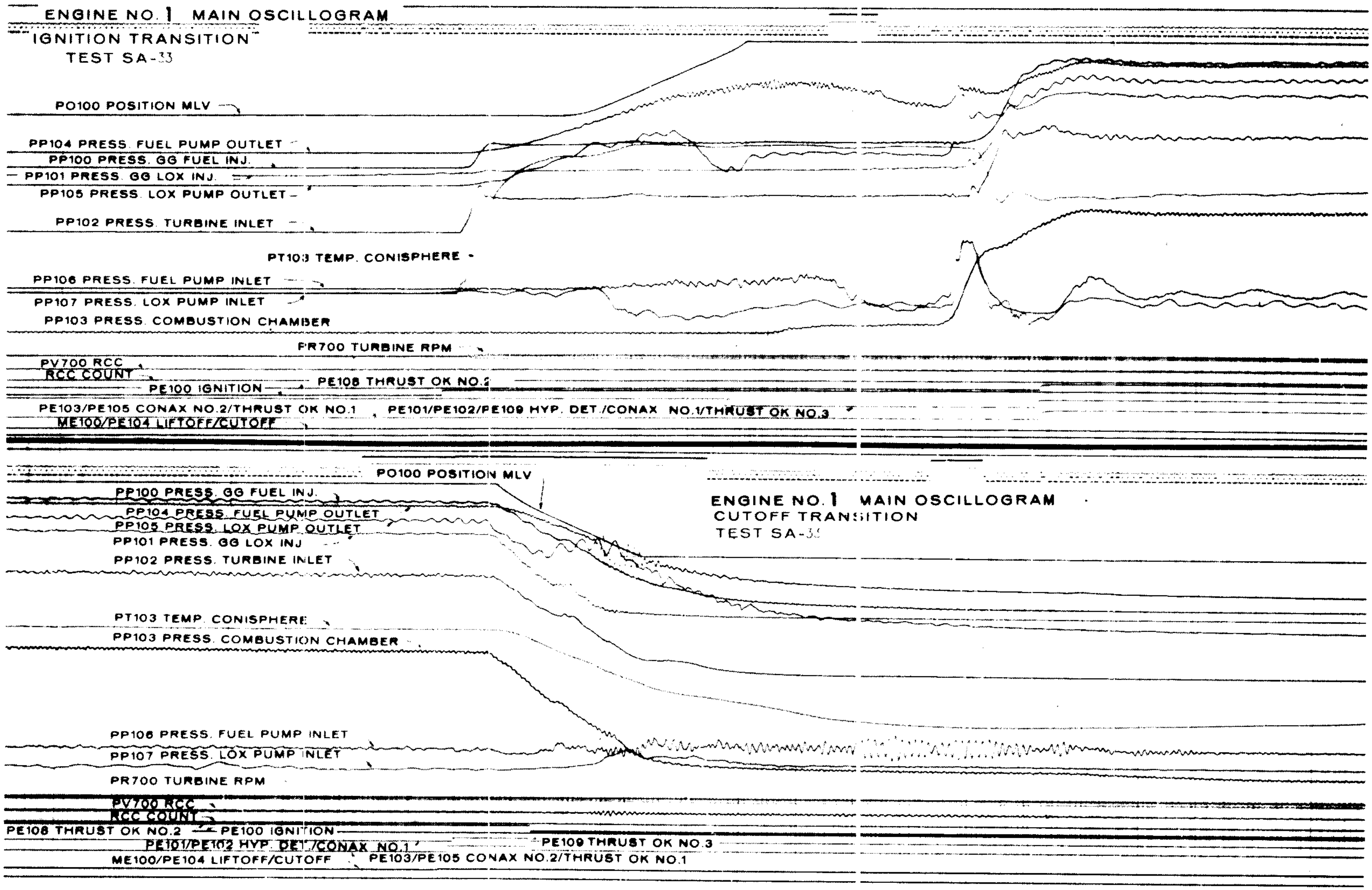
(1) Rocketdyne Program Office Letter 648, dated 20 December 1965.

(2) Strip chart data.

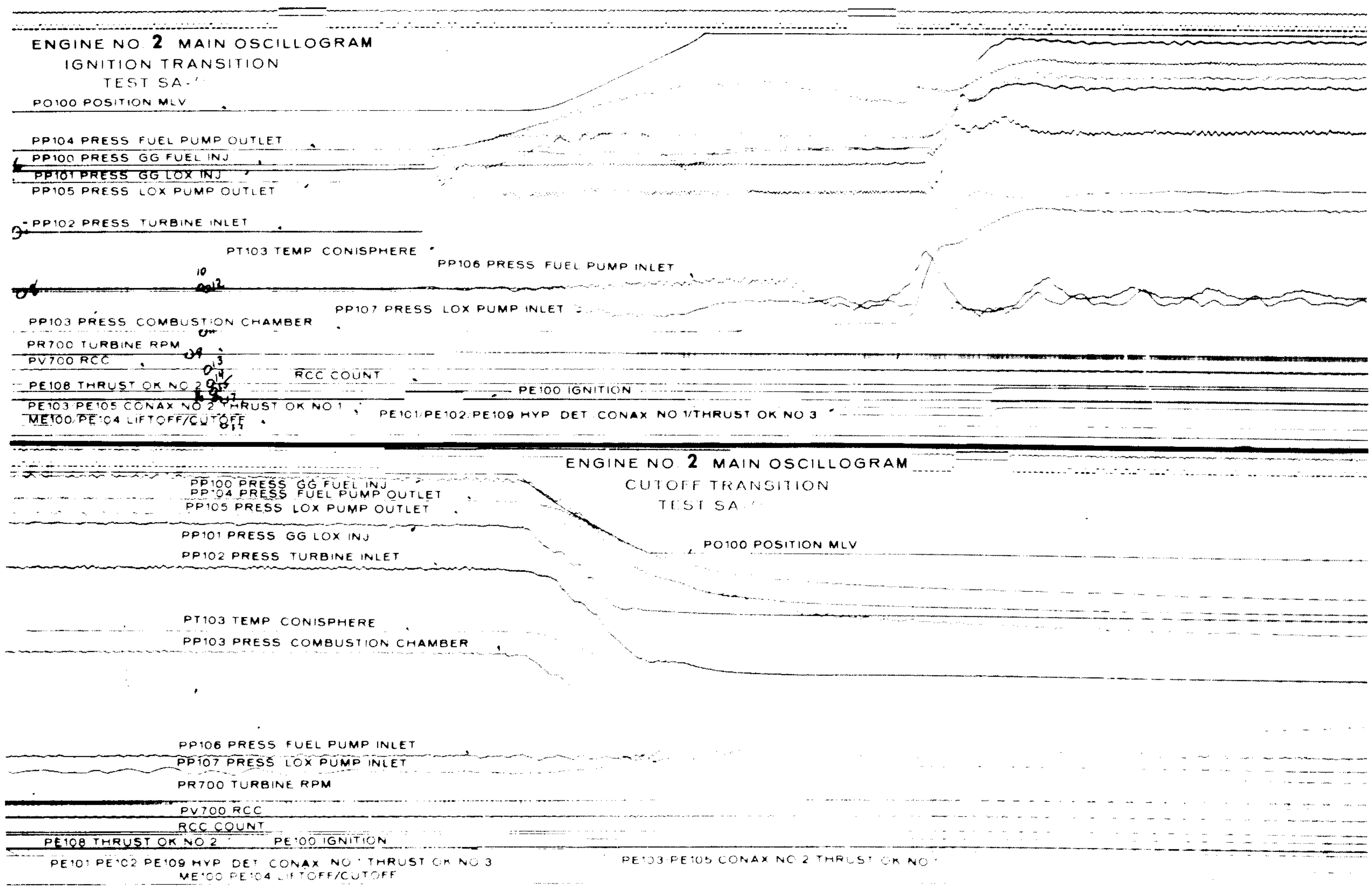
(3) Beckman digital data.

(4) Value above maximum recorder calibration range of -100°F.

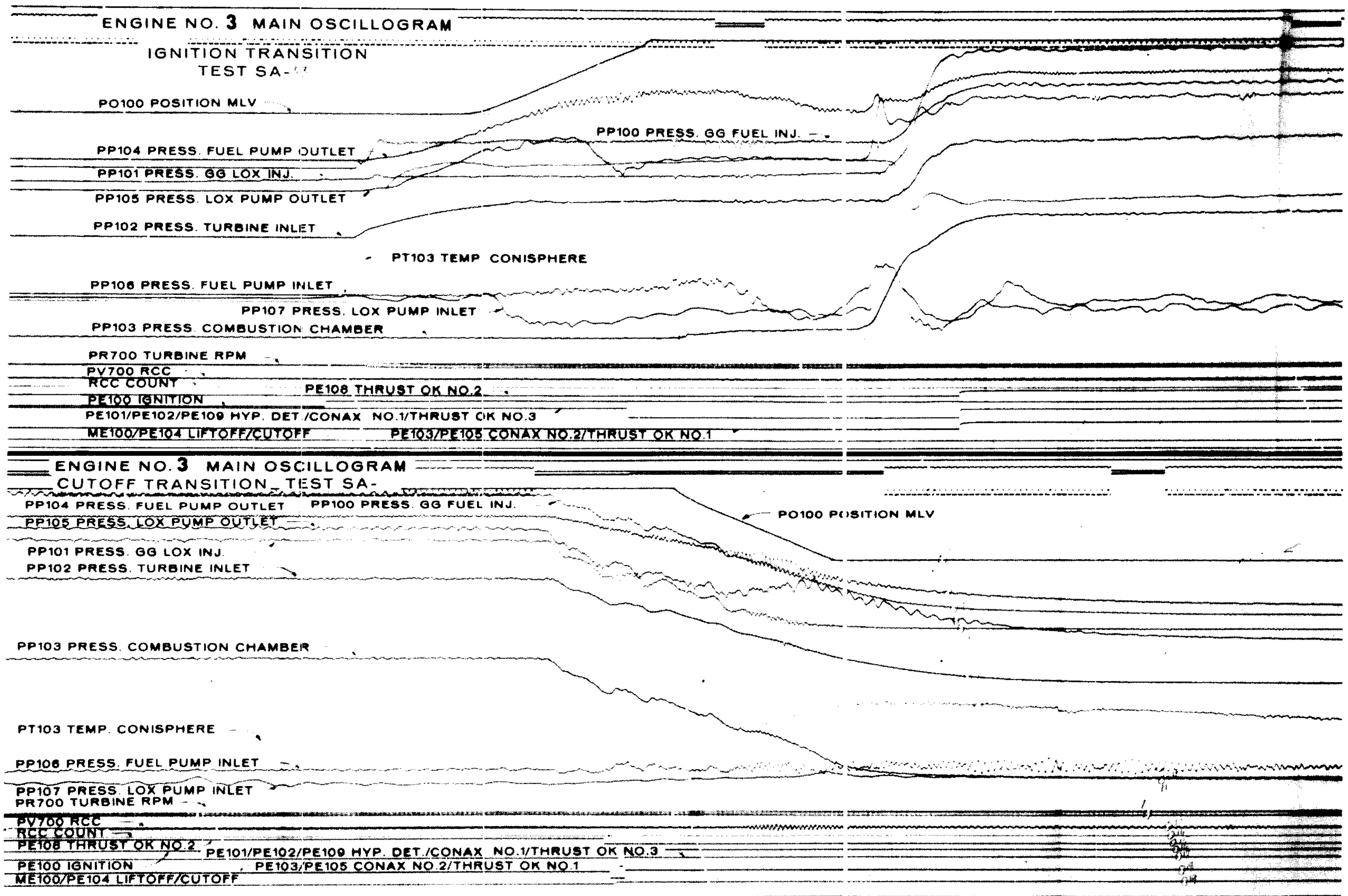
(5) Engine 3 did not experience a negative temperature spike during test SA-33.



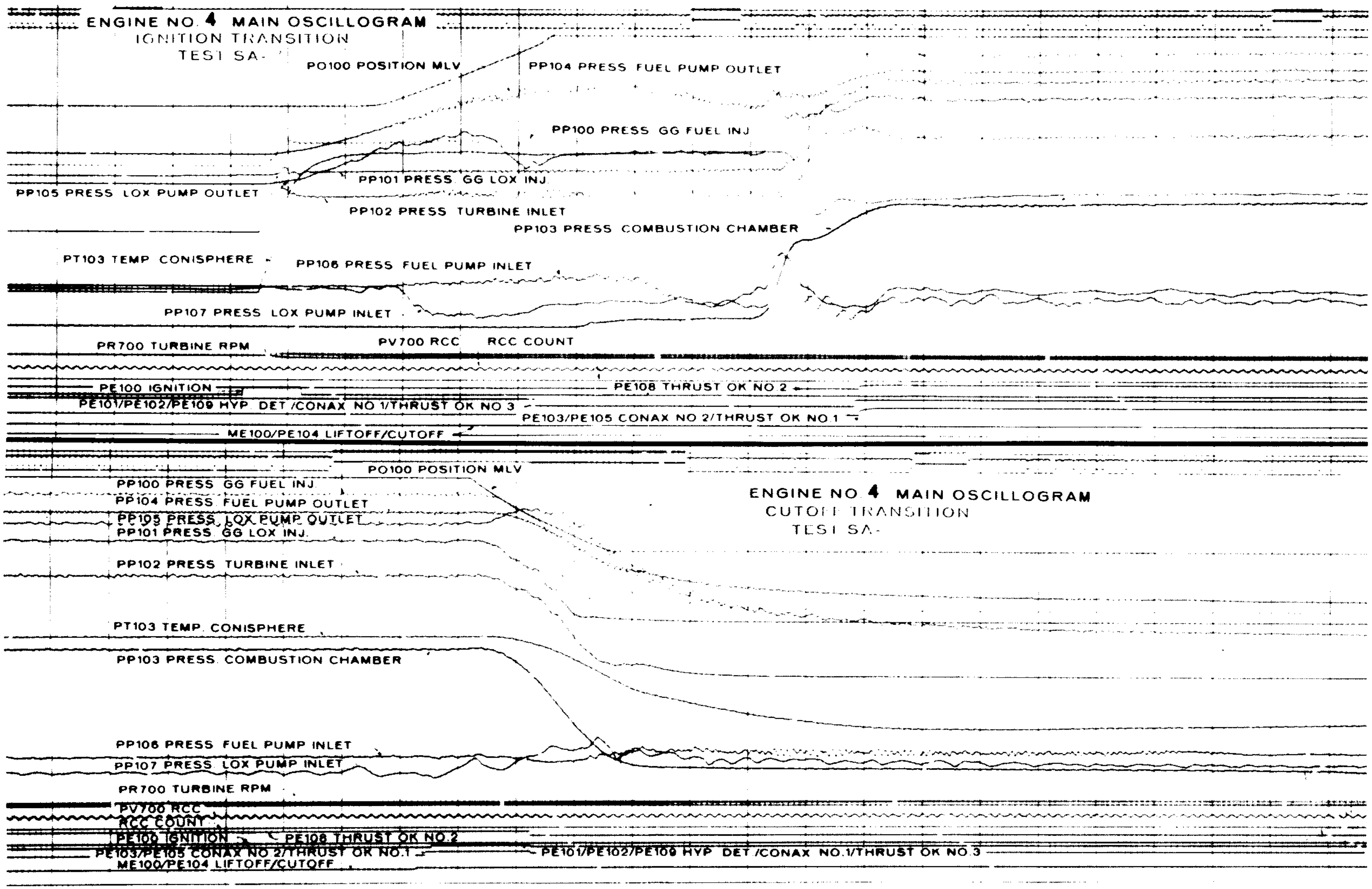
GRAPH 2-1
ENGINE 1 IGNITION AND CUTOFF TRANSITIONS - TEST SA-33



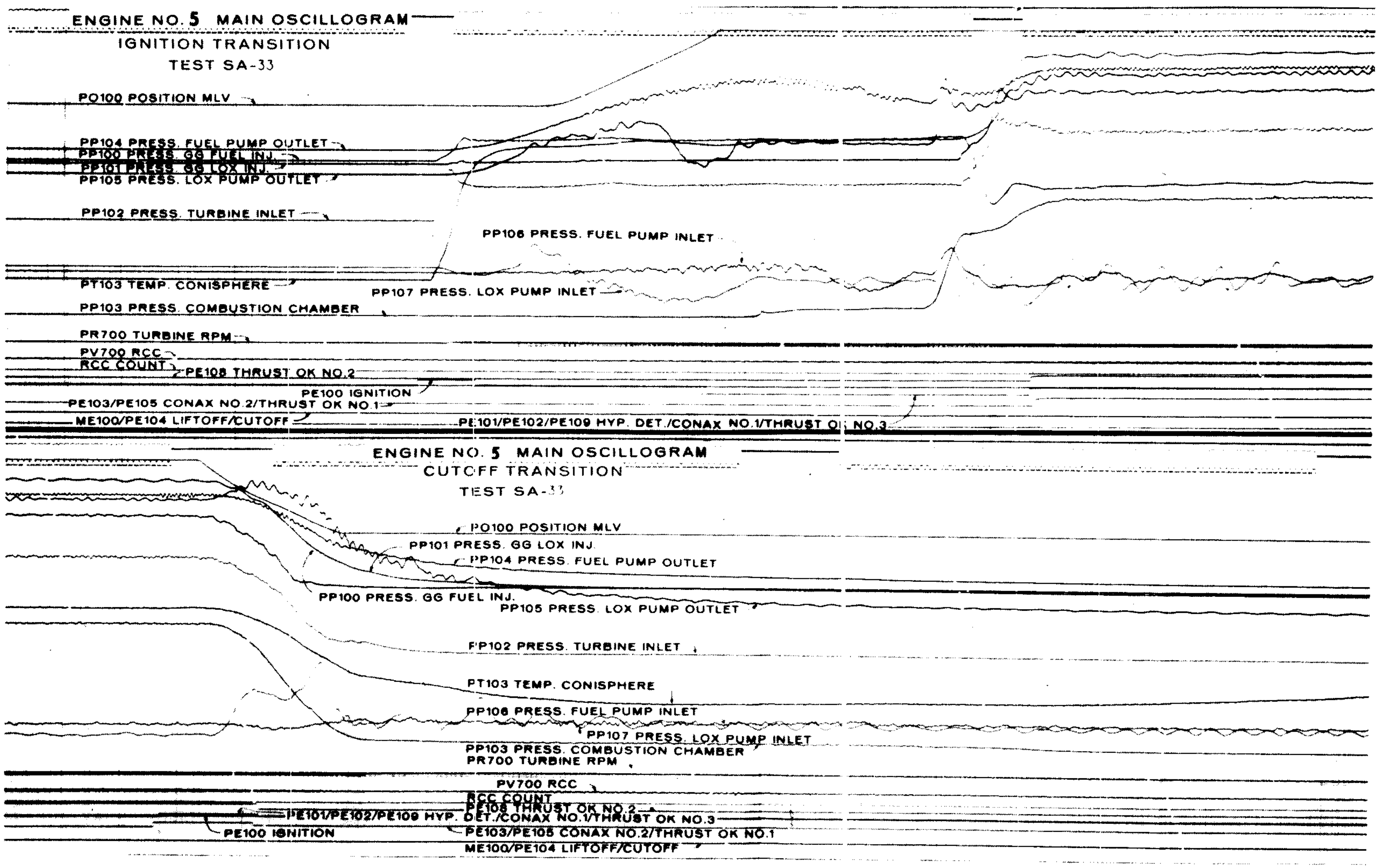
GRAPH 2-2
ENGINE 2 IGNITION AND CUTOFF TRANSITIONS - TEST SA-33



GRAPH 2-3
ENGINE 3 IGNITION AND CUTOFF TRANSITIONS - TEST SA-33

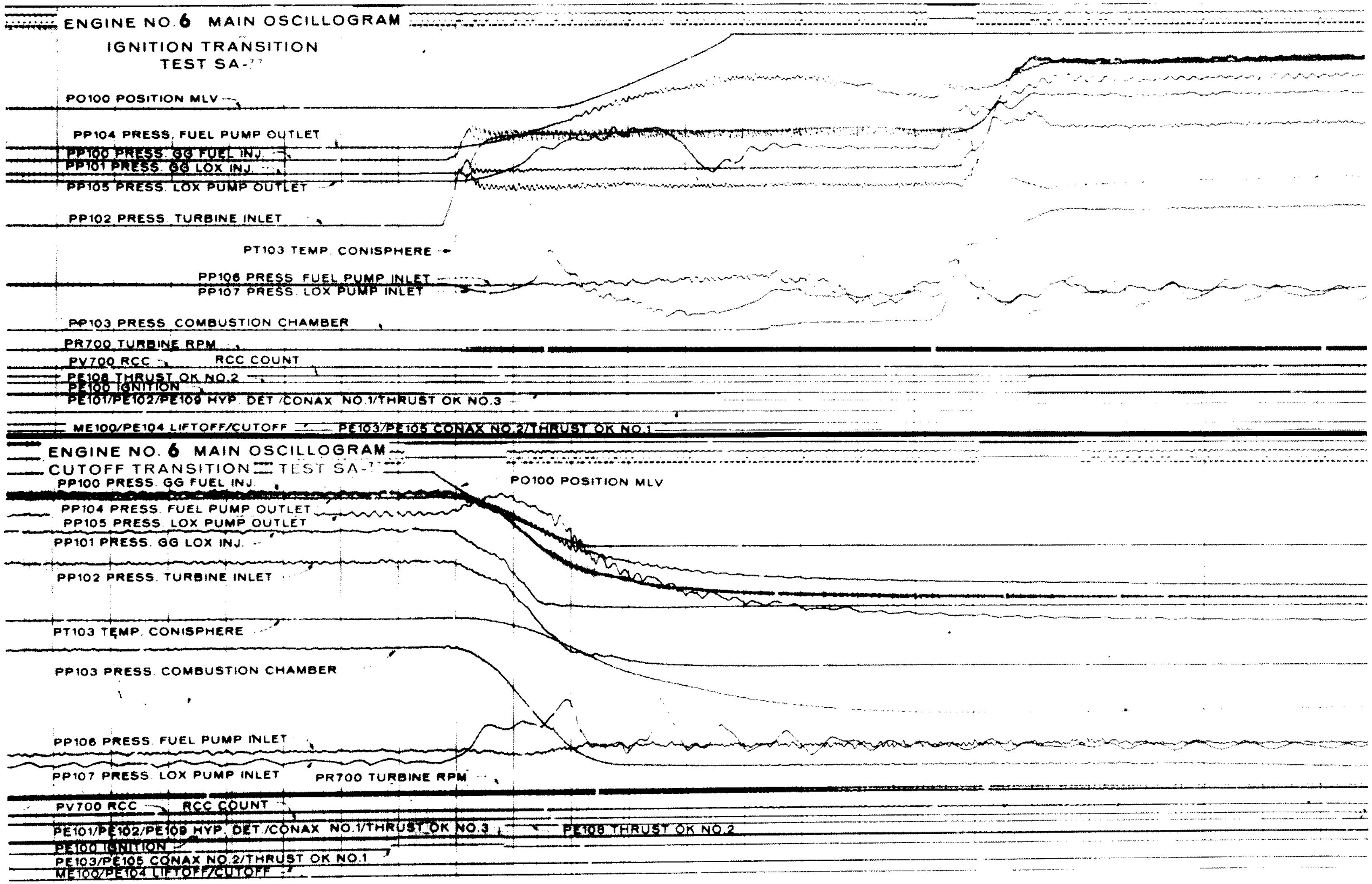


GRAPH 2-4
ENGINE 4 IGNITION AND CUTOFF TRANSITIONS - TEST SA-33



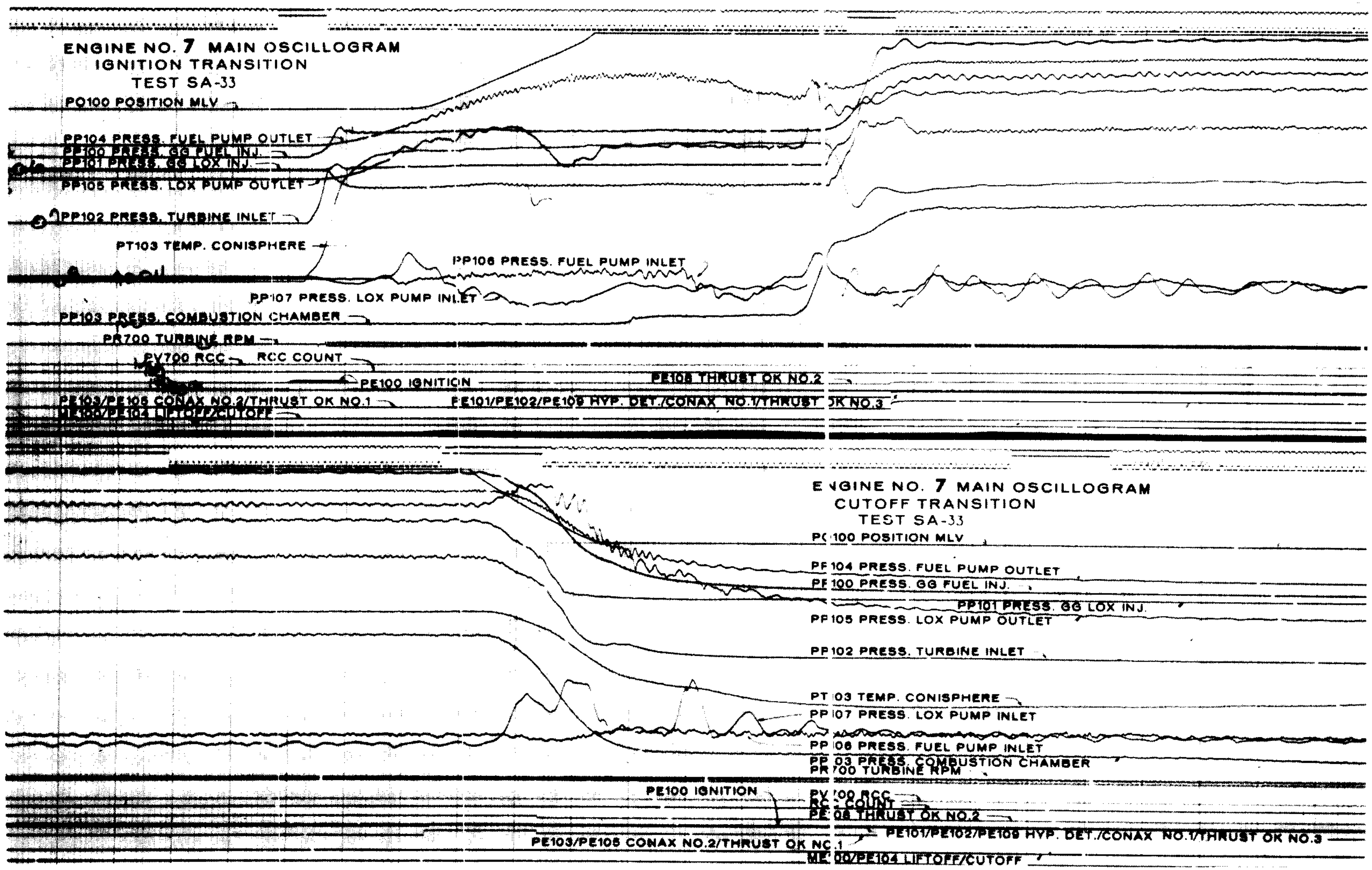
GRAPH 2-5

ENGINE 5 IGNITION AND CUTOFF TRANSITIONS - TEST SA-33



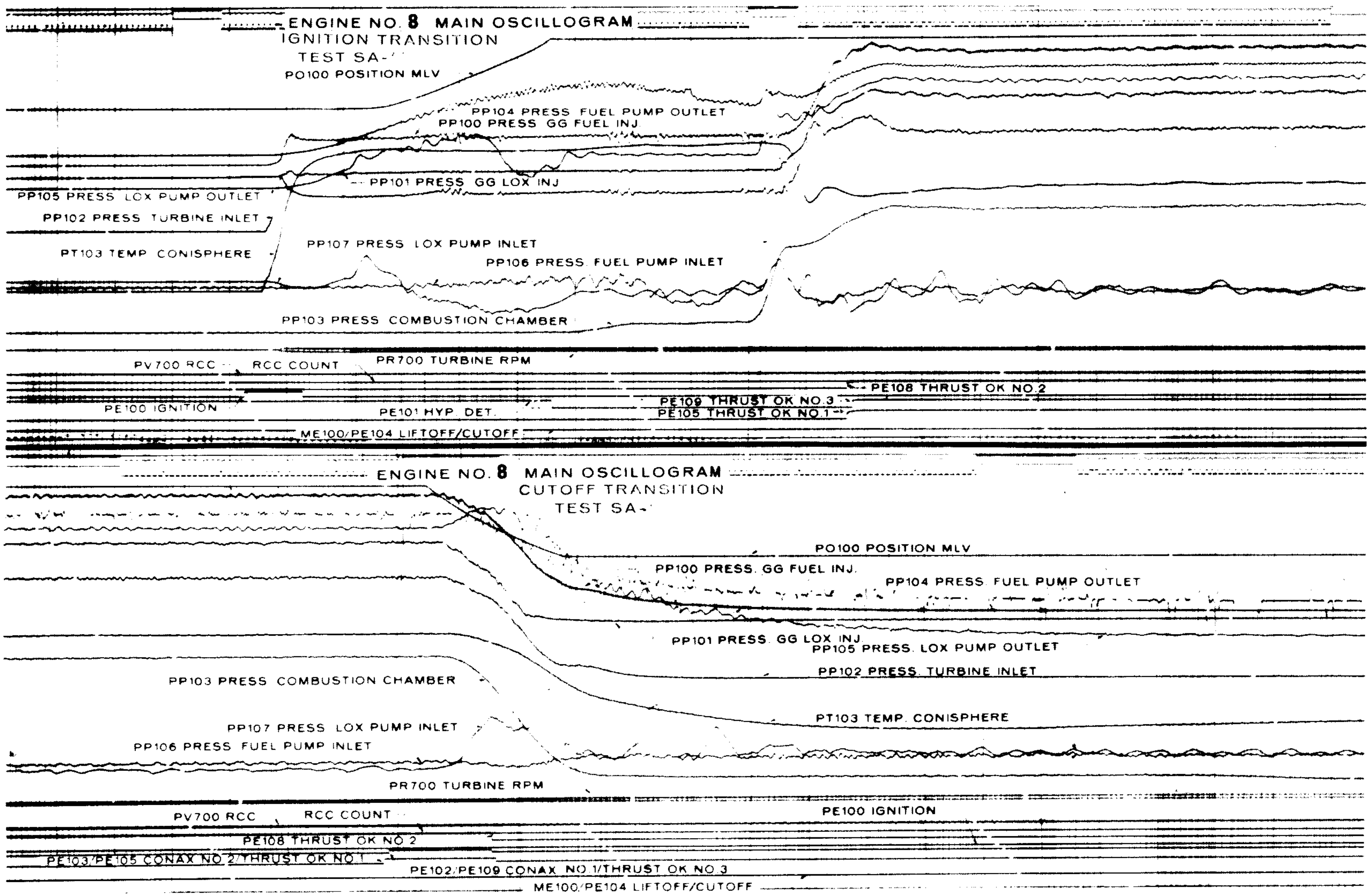
GRAPH 2-6

ENGINE 6 IGNITION AND CUTOFF TRANSITIONS - TEST SA-33

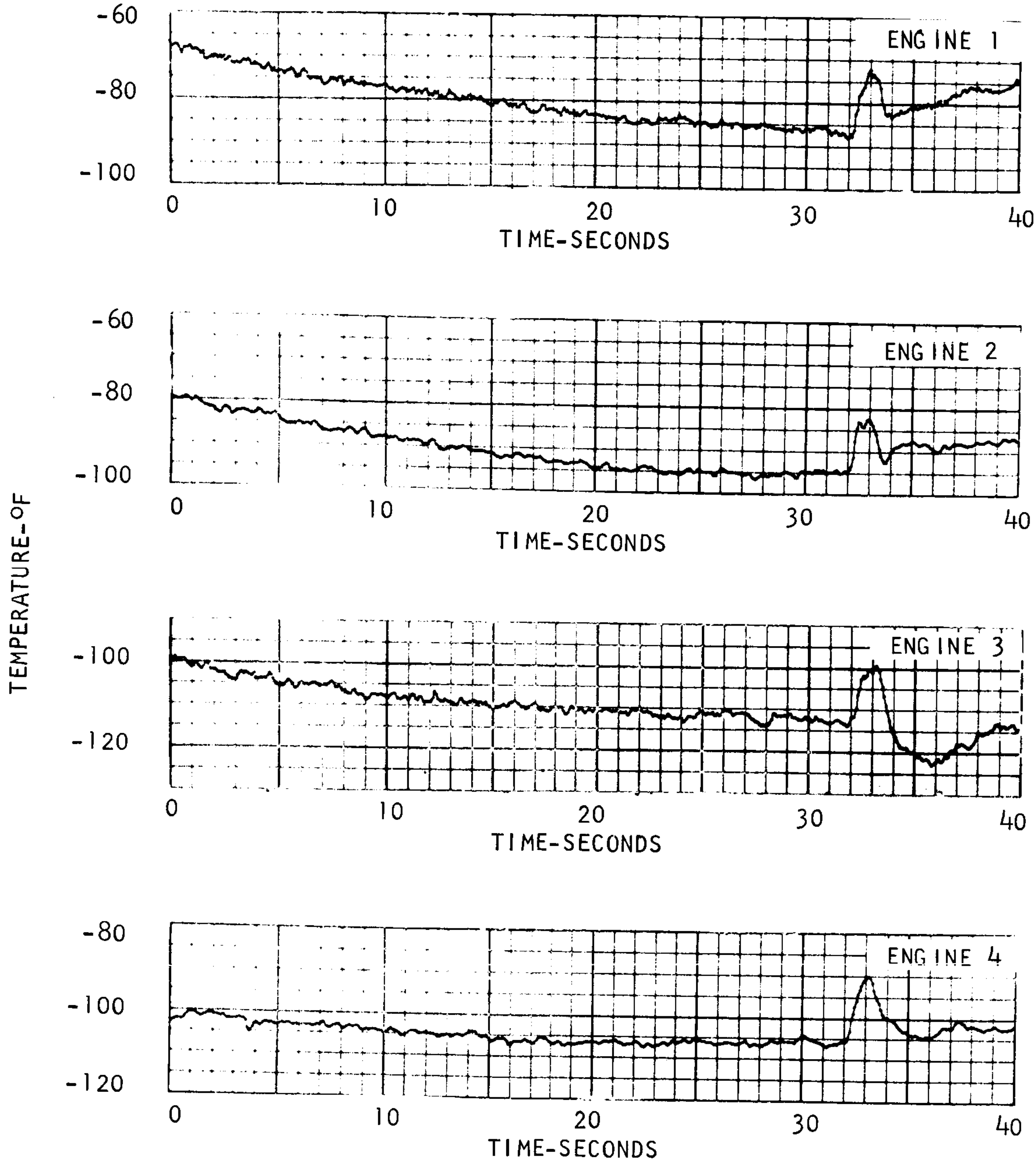


GRAPH 2-7

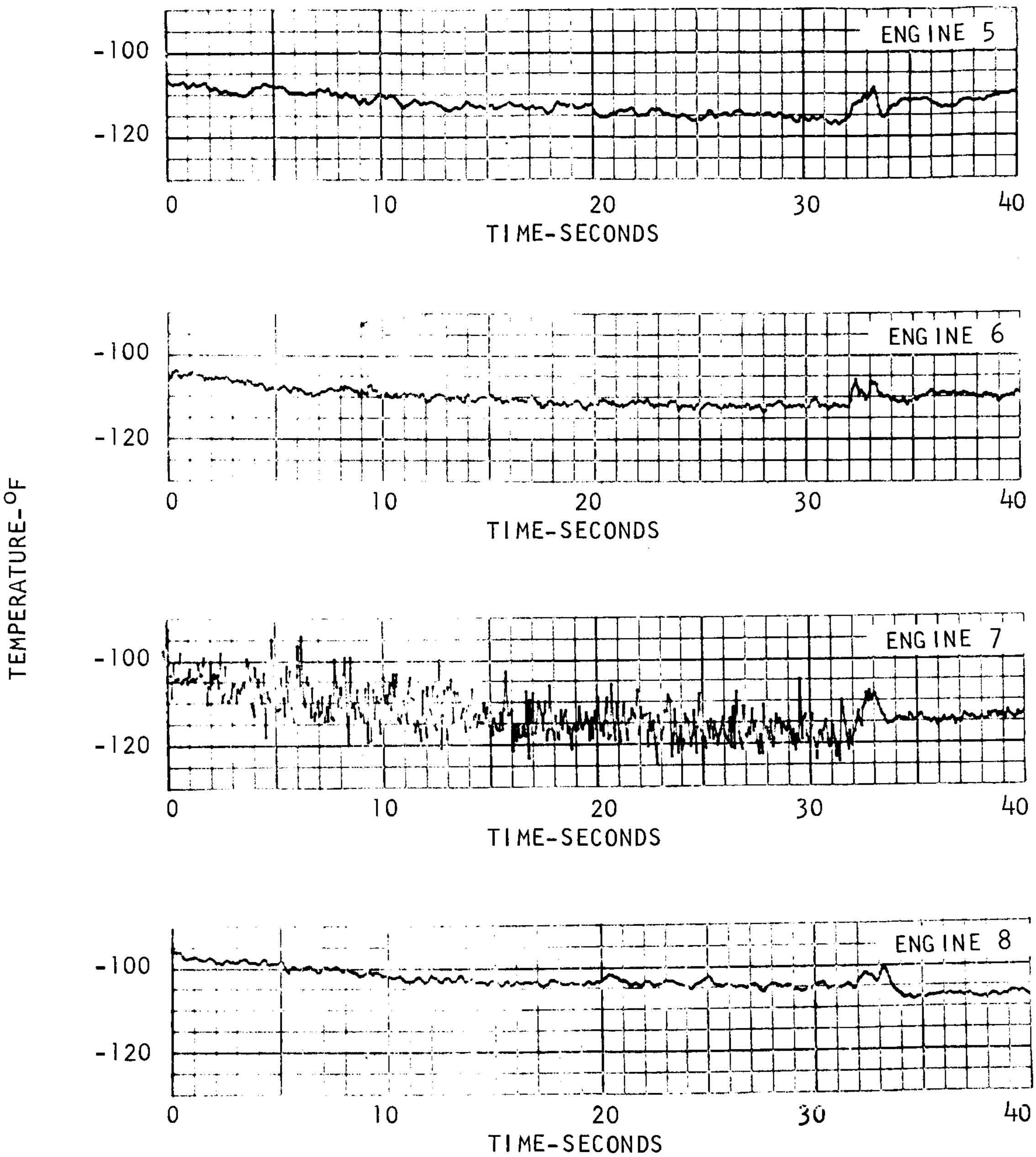
ENGINE 7 IGNITION AND CUTOFF TRANSITIONS - TEST SA-33



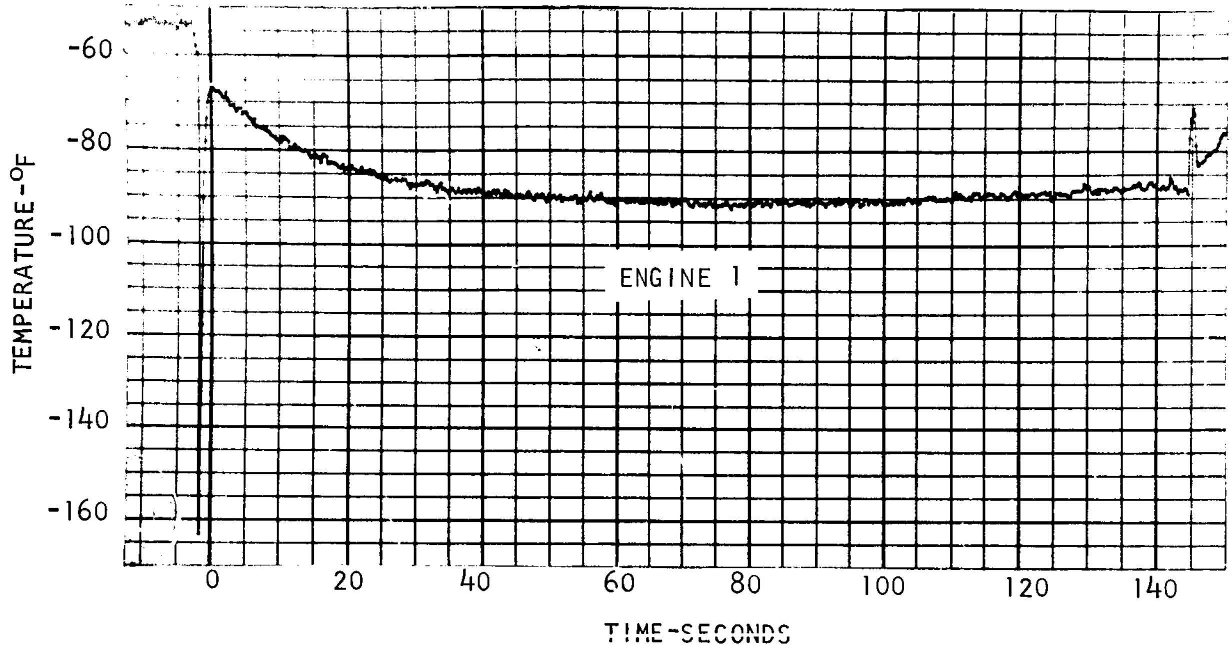
GRAPH 2-8
ENGINE 8 IGNITION AND CUTOFF TRANSITIONS - TEST SA-33

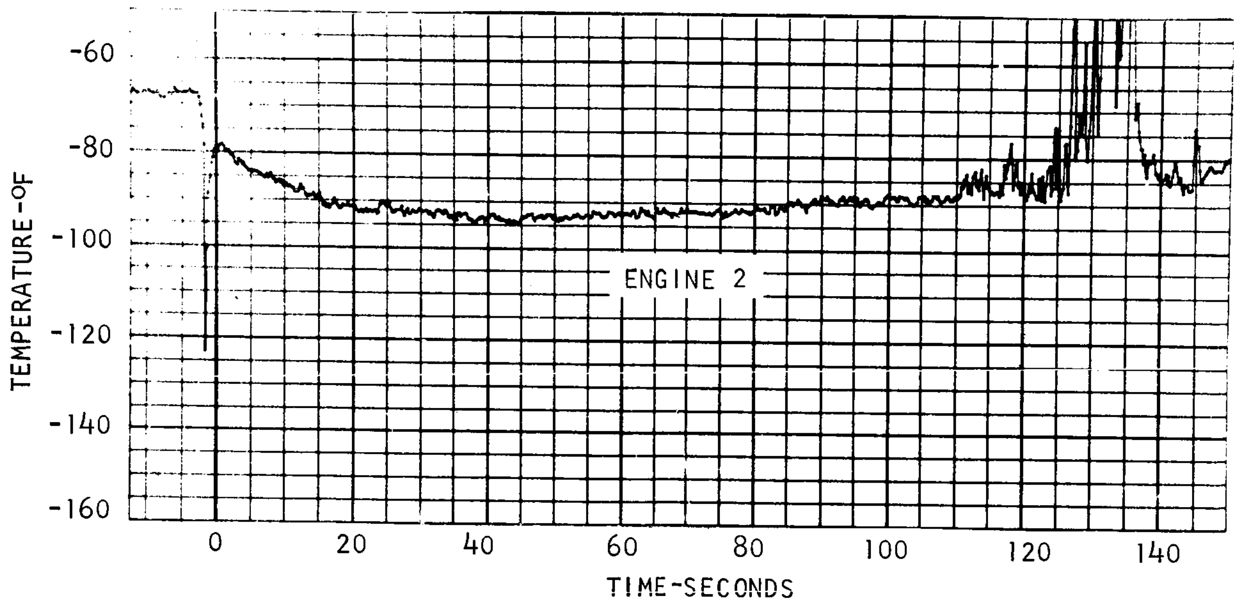


GRAPH 2-9
LOX SEAL DRAIN LINE TEMPERATURES VS TIME
MEASUREMENT PT 156
TEST SA-32

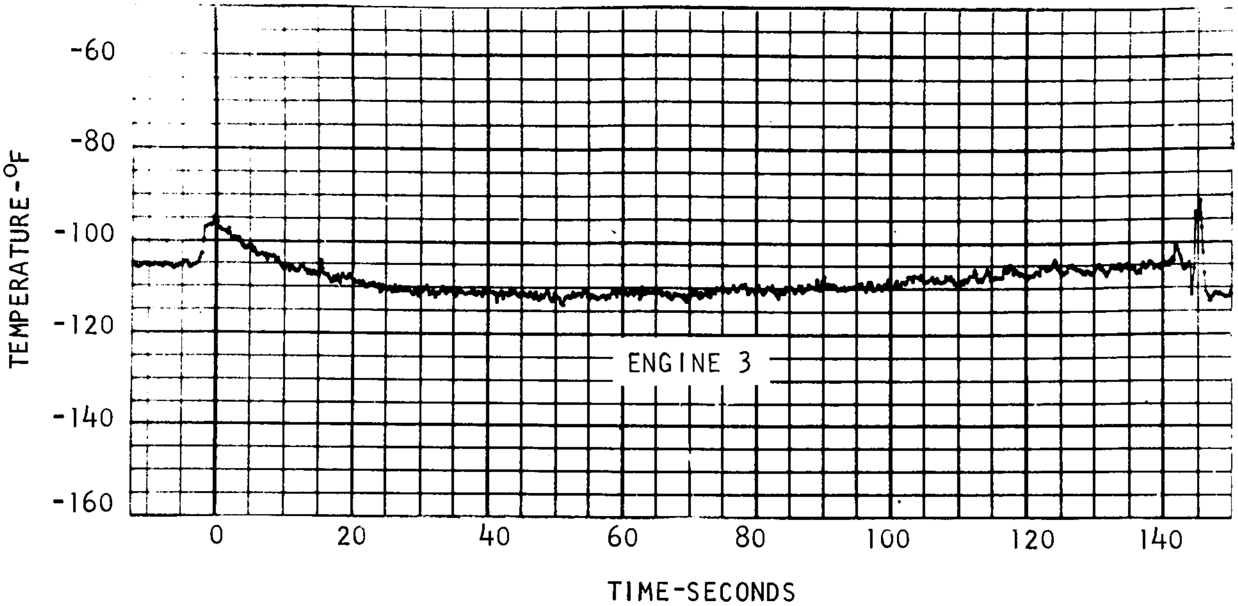


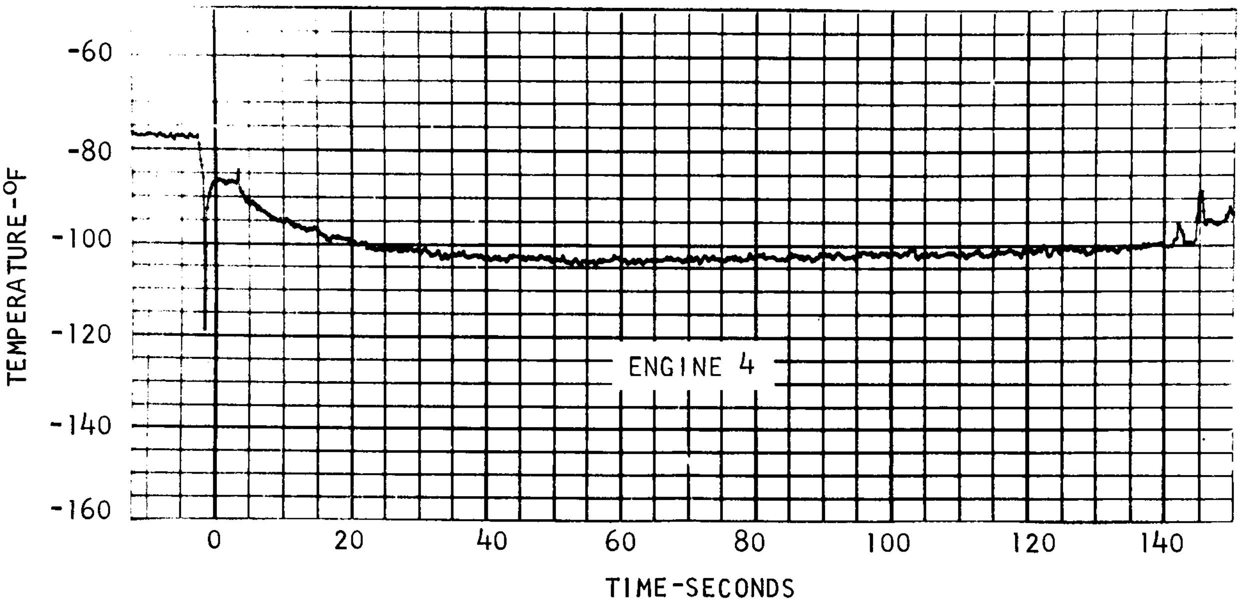
GRAPH 2-10
LOX SEAL DRAIN LINE TEMPERATURES VS TIME
MEASUREMENT PT 156
TEST SA-32



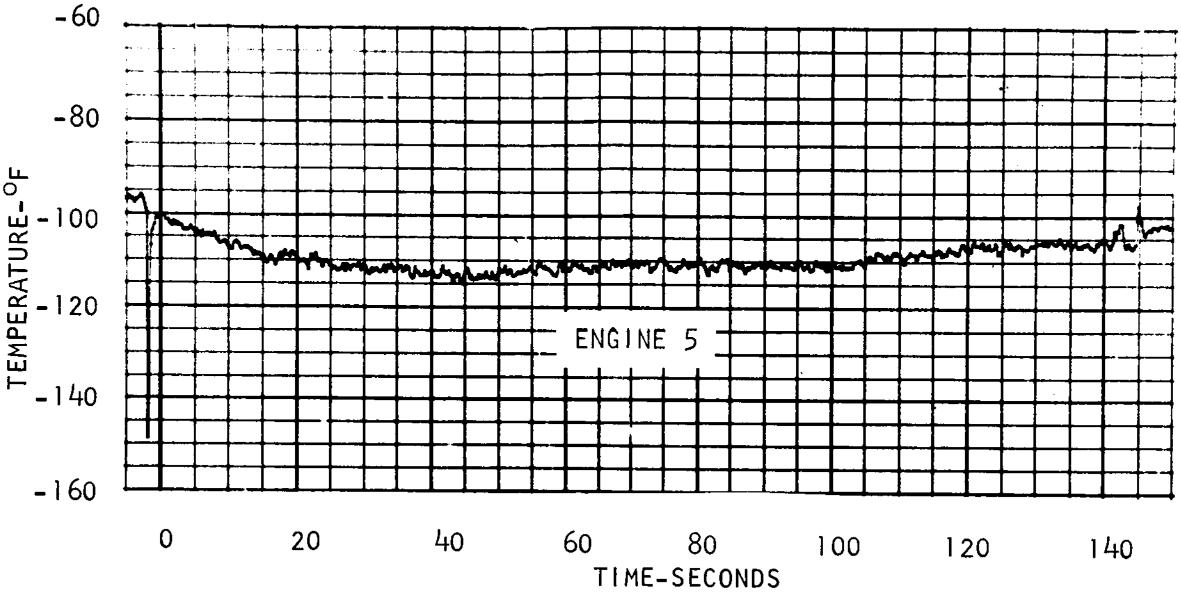


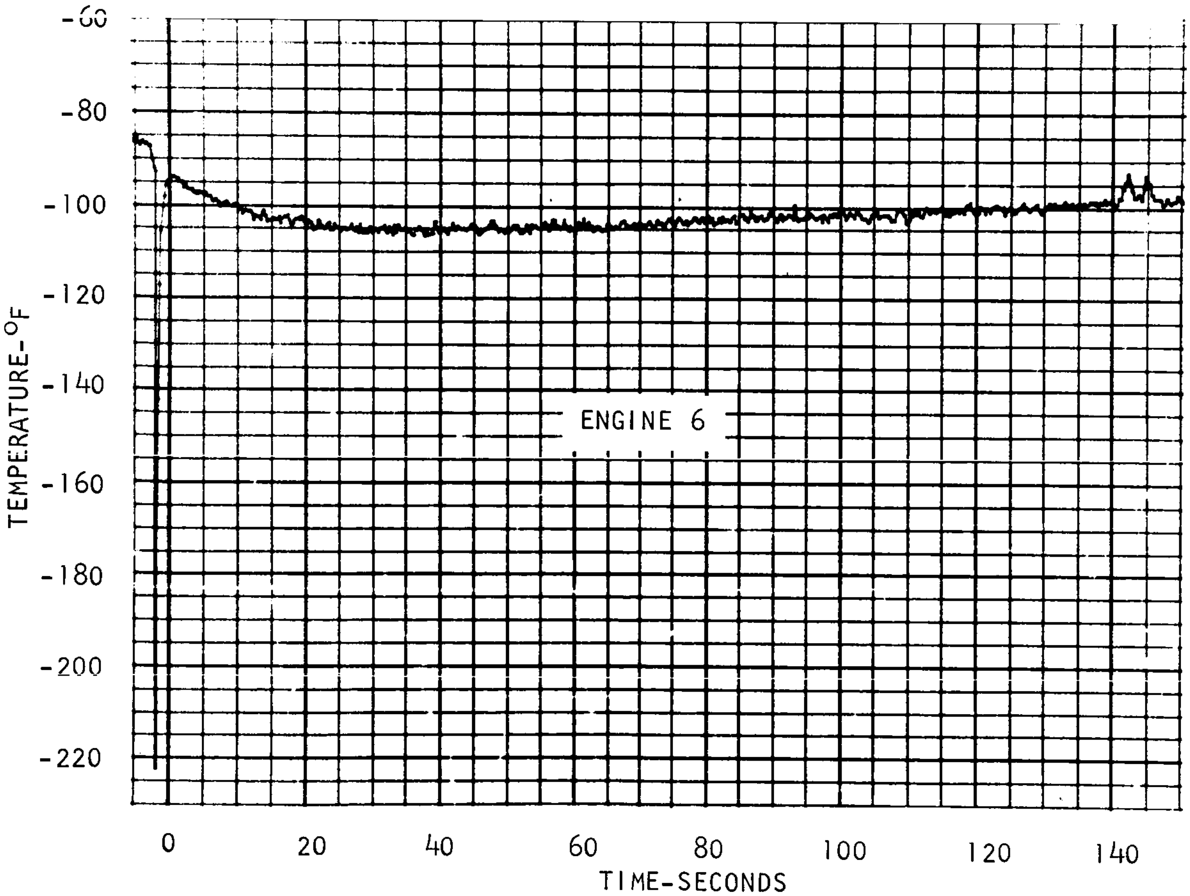
GRAPH 2-11
LOX SEAL DRAIN LINE TEMPERATURE VS TIME
MEAS. PT156
TEST SA-33



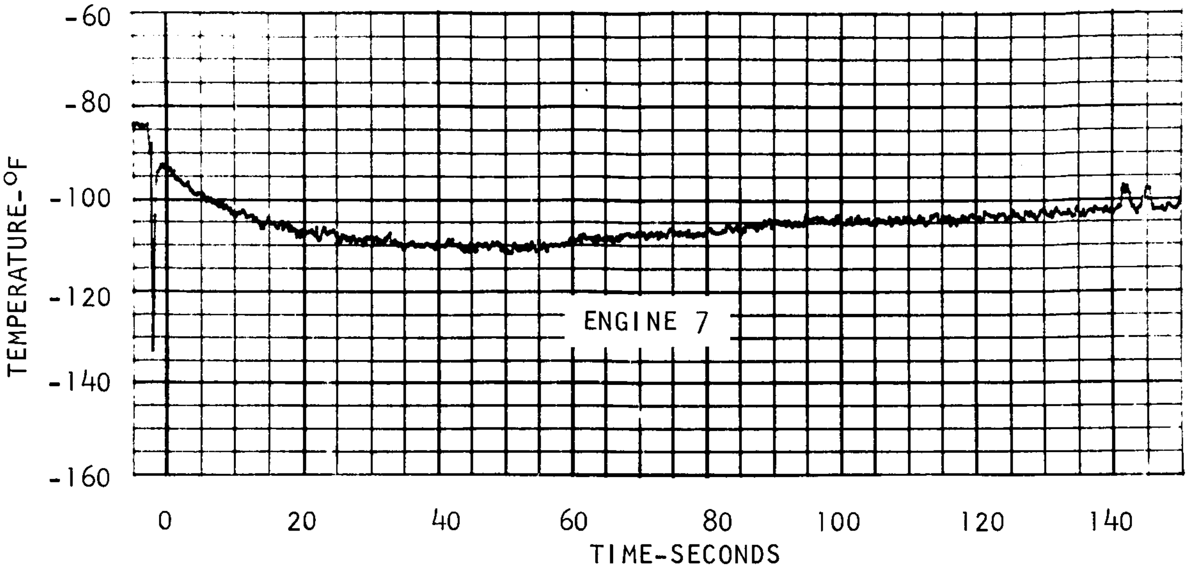


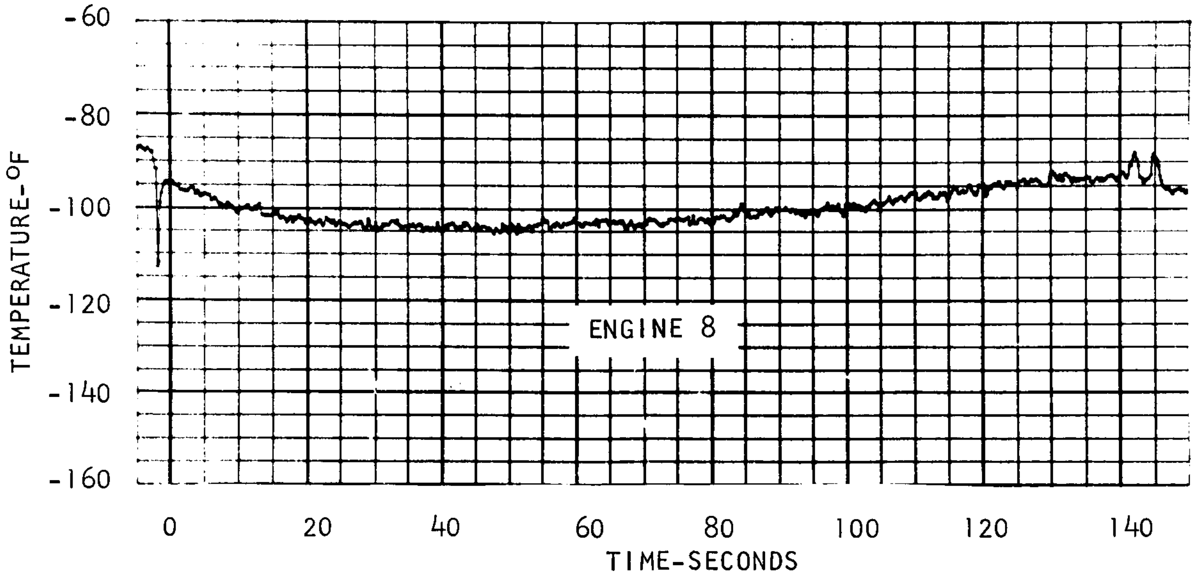
GRAPH 2-12
LOX SEAL DRAIN LINE TEMPERATURE VS TIME
MEAS. PT156
TEST SA-33





GRAPH 2-13
LOX SEAL DRAIN LINE TEMPERATURE VS TIME
MEAS. PT156
TEST SA-33





GRAPH 2-14
LOX SEAL DRAIN LINE TEMPERATURE VS TIME
MEAS. PT156
TEST SA-33

SECTION 3

ENGINE HYDRAULIC SYSTEMS

The engine hydraulic systems performed satisfactorily during test SA-32 and SA-33 with the exception of the engine 3 hydraulic system during test SA-33. The hydraulic system was removed from this engine pretest and the engine was not gimbaled. All functional requirements were accomplished as outlined by the gimbal program in TABLES 3-1 and 3-2. The engine hydraulic system schematics are shown in FIGURE 3-1. Post test inspections were performed with no evidence of damage to system components observed.

When performing prefunctional checks on engine 1 hydraulic system, prior to test SA-32, the fluid level (measurement *H0700-1) was observed to be at 41 percent with the auxiliary pump running and at 97 percent with the auxiliary pump off. Since this condition indicates the presence of gas in the oil system, the hydraulic system was bled from the bleed valve on top of the accumulator from the 41 percent fluid level down to 28 percent fluid level with only gas emission. From 28 percent fluid level down to 18 percent, the presence of oil and gas was observed. A sample was taken from the high-pressure bleed valve on the accumulator manifold, and the oil was found to be extremely contaminated. The GN_2 precharge was checked and found to be 140 psi low. The GN_2 precharge was then bled off with approximately 10 milliliters of oil being observed along with the GN_2. As a result of this investigation, galling of the accumulator piston sleeve and failure of the piston O-rings were suspected. A new hydraulic system was installed at engine 1 and filled, cleaned, and purged.

Upon completion of the cleaning operations at engine 1, a functional check was performed on all engine hydraulic systems. Hydraulic oil leaks were observed between the high-pressure flex hose assembly and the pitch actuator at engine 2, and at the auxiliary pump outlet bleed valve on engine 3. Both of these connections were torqued to the maximum specified value. Another functional check was performed on all engine hydraulic systems with no leakage observed.

Prior to starting the auxiliary pump at engine 4, the fluid level was observed to be erratic. The recorder for this measurement, *H0700-4, was periodically pegging upscale from 85.2 percent fluid level. The fluid level potentiometer was then checked with an ohmmeter. The ohmmeter revealed a periodic open circuit between pins A and B and between pins B and C, and a steady reading of over 1,900 ohms was obtained between pins A and C of the potentiometer. Following this investigation, a new hydraulic package was installed at engine 4, and the hydraulic system was filled, cleaned, and purged.

A third functional check was performed on all engine hydraulic systems upon completion of the cleaning operations at engine 4. During this functional check, the fluid level at engine 1 dropped from 41 percent at auxiliary pump starting to 18.8 percent at auxiliary pump cutoff. Investigation revealed that leakage existed between the accumulator low-pressure reservoir and vent cavity. Since replacement of this hydraulic package would have delayed test SA-32, a decision was made to fire without engine 1 hydraulic system. The main hydraulic pump and hydraulic package assembly were removed from engine 1, and the actuators were locked in the null position.

At X-10 minutes in the countdown of test SA-32, it was noted that engine 3 was not controllable in the yaw plane. Because of this, test SA-32 was cancelled and rescheduled for January 17, 1966. Investigation upon returning to the test stand revealed an excessive resistance in the beta (feedback) potentiometer on engine 3 yaw actuator.

A new yaw actuator was installed at engine 3 and a new hydraulic package assembly was installed at engine 1. Engines 1 and 3 hydraulic systems were then filled, cleaned, and purged.

Upon completion of the cleaning operations at engines 1 and 3, another functional check was performed on all engine hydraulic systems. All systems performed satisfactorily except for engine 3. Engine 3 fluid level was observed to be erratic at 76.5 percent fluid level. This problem was identical to the problem experienced at engine 4 and is believed to be caused by a bad spot on the potentiometer. Since this problem did not occur in the range of potentiometer operation during hydraulic system operation, no action was taken prior to test SA-32.

Test SA-32 was conducted as rescheduled, and all engine hydraulic systems performed satisfactorily with no unusual or adverse conditions being observed.

Post test inspections revealed four slight hydraulic oil leaks at engine 1, and five slight hydraulic oil leaks at engine 3. The connections involved were all torqued to the maximum value. All leaks were stopped with the exception of two slight seep leaks at the engine 1 auxiliary pump inlet and outlet bleed valves.

When performing firing day pretest functional checks for test SA-33, the fluid level at engine 3 was observed to be at 100 percent with the auxiliary pump off and at 79.5 percent with the pump running. Investigation revealed that GN_2 precharge had leaked into the high-pressure oil cavity. Also, an oil sample analysis revealed that the system was contaminated with rubber, metallic, and lubricant particles. The main hydraulic pump was removed from engine 3 and the actuators were locked in the midstroke position for test SA-33.

A review of the records for test SA-33 revealed that the hydraulic system of engines 1, 2, and 4 performed satisfactorily during the test with no unusual or adverse conditions being observed.

The problem experienced by the hydraulic package assembly (S/N 114) at engine 3 is believed to be identical to the problem experienced by S/N 140 hydraulic package assembly on engine 1 prior to test SA-32. Subsequent investigation at Michoud and at Cadillac Gage Company revealed that leakage had occurred past the static seal which is located between the accumulator sleeve and housing (see FIGURE 3-2). During these investigations, this type of leakage was duplicated on another hydraulic package assembly (S/N 116) by maintaining the package at 20°F for several hours and then precharging it rapidly (7 seconds) to 1,470 psig with GN_2. This leakage did not occur when this procedure was repeated with the precharge being applied slowly (several minutes). In light of this investigation, it is recommended that the accumulator sleeve be incorporated as an integral part of the housing, thus eliminating the static seal between the GN_2 and oil cavities (reference FIGURE 3-2) and that additional hydraulic system evaluation be conducted in an attempt to isolate causative malfunction factors.

The contamination in engines 1 and 3 hydraulic package assemblies (S/N 140 and 114, respectively) was found to be caused by the introduction of metallic particles to the system by the Vickers Auxiliary pump, by normal accumulator piston O-ring wear, and by MIL-I-8660 lubricant used when installing the accumulator piston into the sleeve. Because of the addition of metallic particles to the system by the Vickers auxiliary pumps an Engineering Order has been initiated to replace the Vickers pumps with Kellogg pumps on stages S-IB-9 and subsequent. If the effectivity of this Engineering Order cannot be changed to include earlier stages, an investigation of the result of such system contamination on performance and reliability should be instituted. Also, investigations should be conducted to determine if contamination caused by O-ring wear is detrimental to system operation, and to determine if the MIL-I-8660 lubricant can be eliminated by chamfering the accumulator housing (reference FIGURE 3-2).

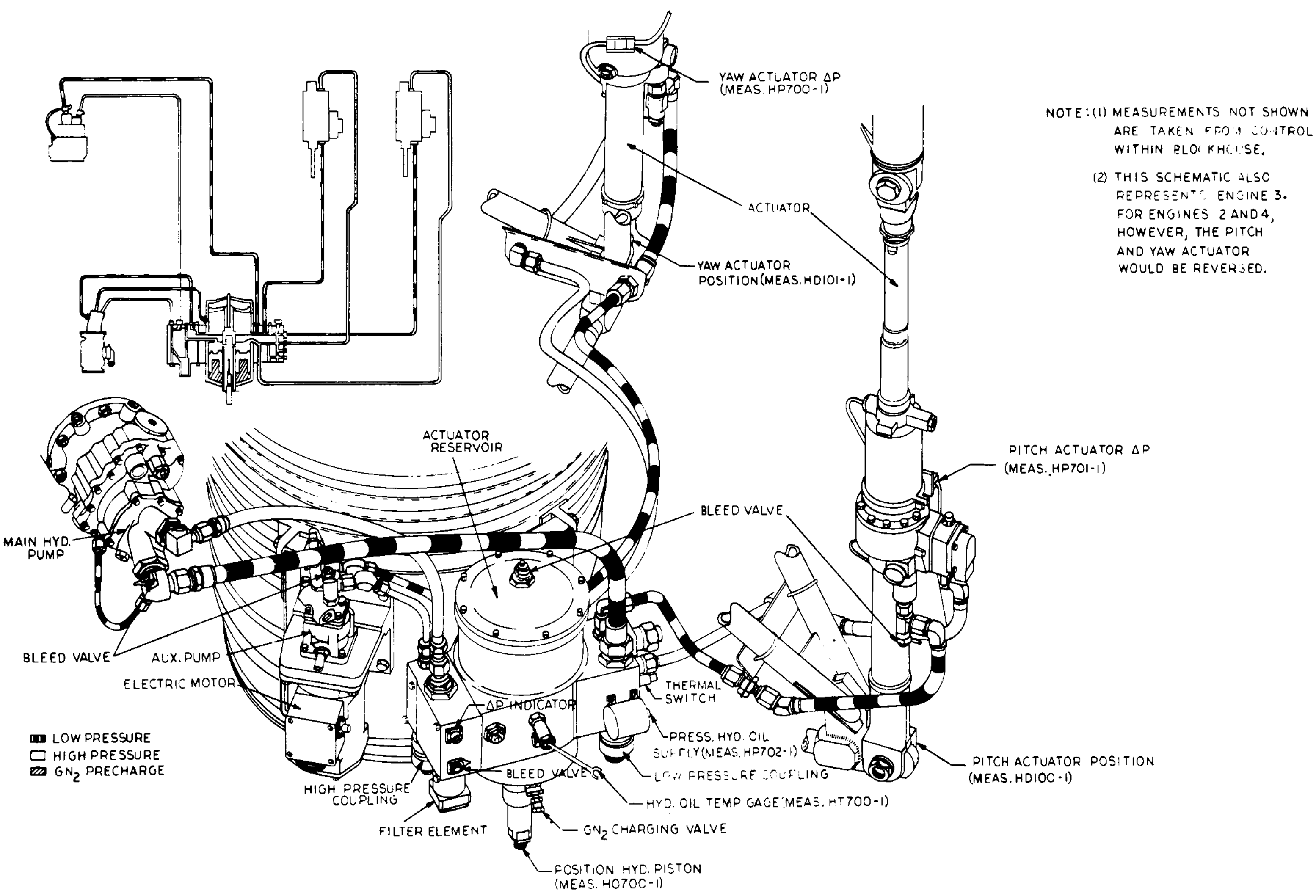
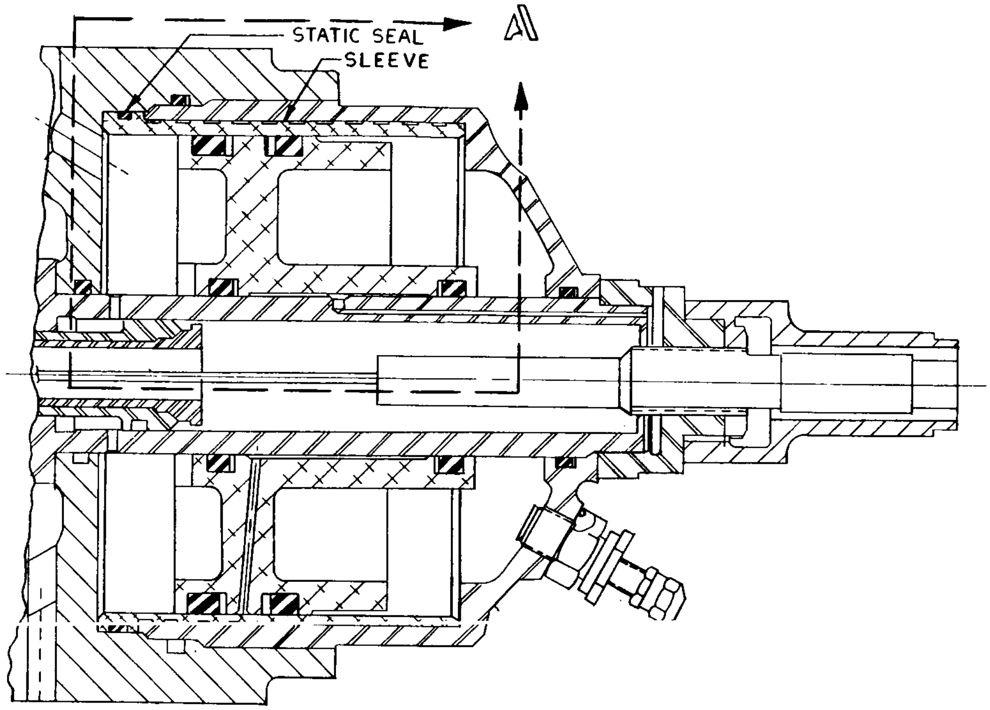
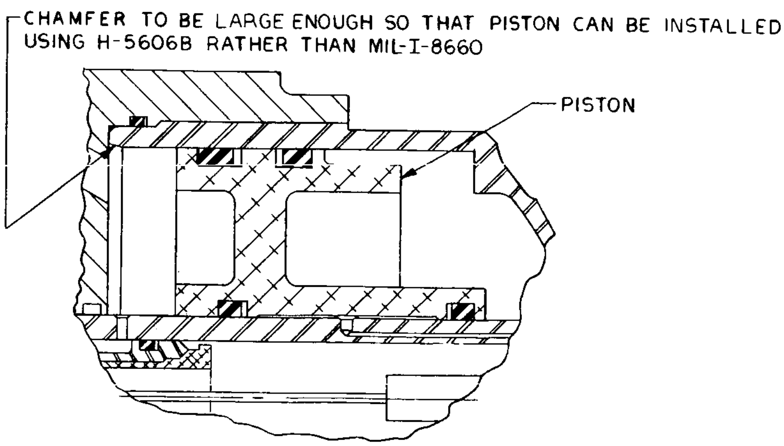


FIGURE 3-1
HYDRAULIC SYSTEM SCHEMATIC



EXISTING CONFIGURATION



DETAIL A

PROPOSED CONFIGURATION

FIGURE 3-2

HYDRAULIC PACKAGE MODIFICATION

TABLE 3-1

GIMBAL PROGRAM

TEST SA-32

ENGINES	TIME ⚠1 (SECONDS)	FREQUENCY (CPS)	INPUT (DEGREES)
1, 2, 3, & 4	0 to 3	0	0
1, 2, 3, & 4	3 to 5.5	2	±2 Roll
1, 2, 3, & 4	7 to 12	1	±3 Yaw
1, 2, 3, & 4	14 to 19	1	±3 Pitch
1, 2, 3, & 4	21 to 22	Step	+2 Yaw
1, 2, 3, & 4	23 to 24	Step	-2 Yaw
1, 2, 3, & 4	25 to 26	Step	+2 Pitch
1, 2, 3, & 4	27 to 28	Step	-2 Pitch
1, 2, 3, & 4	28 to Cutoff	0	0

⚠1 All times are referenced to simulated liftoff, X+0.28 second.

TABLE 3-2

GIMBAL PROGRAM

TEST SA-33

ENGINES	TIME ⚠1 (SECONDS)	FREQUENCY (CPS)	INPUT (DEGREES)
1, 2, & 4	0 to 5	0	0
1, 2, & 4	5 to 35	1 - 20	±0.5 Pitch
1, 2, & 4	35 to 40	0	0
1, 2, & 4	40 to 71	1 - 20	±0.5 Yaw
1, 2, & 4	71 to 76	0	0
1, 2, & 4	76 to 77	Step	+2 Pitch
1, 2, & 4	77 to 81	0	0
1, 2, & 4	81 to 82	Step	-2 Pitch
1, 2, & 4	82 to 86	0	0
1, 2, & 4	86 to 87	Step	+2 Yaw
1, 2, & 4	87 to 91	0	0
1, 2, & 4	91 to 92	Step	-2 Yaw
1, 2, & 4	92 to 100	0	0
1, 2, & 4	100 to 130	0.5	±2 Roll
1, 2, & 4	130 to Cutoff	0	0

⚠1 All times are referenced to simulated liftoff, X+0.25 second.

SECTION 4

PROPELLANT AND PNEUMATIC SYSTEMS

The propellant and pneumatic systems performed satisfactorily during tests SA-32 and SA-33. The configuration of the LOX system is shown in FIGURES 4-1 and 4-2. The fuel system configuration is shown in FIGURE 4-3, and the GN_2 control pressure system is shown in FIGURE 4-4. Stage and ground support orifice sizes and pressure switch settings are listed in APPENDIX C of this report. Propellant loading and pressurization data for tests SA-32 and SA-33 are shown in TABLE 4-1.

LOX SYSTEM

The LOX system functioned properly during tests SA-32 and SA-33. The height of LOX on board at ignition of test SA-32 was 655.0 inches in LOX tank O-C, corresponding to the required ullage of 1.5 percent. The LOX ullage at ignition of test SA-33 was the required 4.9 percent corresponding to a liquid height of 632.0 inches in LOX tank O-C.

Test SA-32 preignition pressurization of the LOX tanks was accomplished in 74.9 seconds through a 0.099-inch diameter orifice. After the ignition transients, LOX tank pressure increased from 48.8 psia at X+2 seconds to 52.6 psia at cutoff.

Test SA-33 preignition pressurization of the LOX tanks was accomplished in 60.2 seconds utilizing a 0.149-inch diameter orifice in the ground LOX pressurizing system. The LOX tank pressure at ignition was 52.3 psia and decayed to 48.7 psia at cutoff. At X+50 seconds, the GOX flow control valve started leaving the closed position, and at cutoff it was 77 percent closed (reference GRAPH 4-1).

A total boiloff rate of 5.5 pounds per second was calculated from data taken during the propellant loading test.

Prior to test SA-32, an investigation was conducted to determine the helium flowrate in the LOX bubbling system. A lockup pressure of 394 psig on the facility regulator using S-I-10 ground support equipment configuration delivered a flowrate of 45 scfm. This same lockup pressure using S-IB ground support equipment configuration delivered a helium flowrate of 31 scfm. The facility regulator setting was adjusted to 575 psig to deliver a flowrate of 45 scfm for test SA-32. Additional data obtained during this investigation are presented in TABLE 4-2.

LOX bubbling for test SA-32 was initiated at X-173 seconds, 10 seconds after vent closure, utilizing a helium flowrate of 45 scfm. The maximum LOX pump inlet temperature at ignition was -277.1°F at engine 8. (Note: A sequence hold was made following the end of bubbling. See TABLE 4-3.) LOX bubbling for test SA-33 was initiated at X-153 seconds, 10 seconds after vent closure, utilizing a helium flowrate of 45 scfm. The maximum LOX pump inlet temperature at ignition was -278.1°F at engine 8.

A comparison of LOX pump inlet temperatures following bubbling is given in TABLE 4-3. Values are listed for the propellant loading test, LOX loading prior to the originally scheduled test SA-32, test SA-32, and test SA-33.

The results of the LOX bubbling tests show that bubbling with the LOX relief valve open provides the coldest LOX pump inlet temperatures at ignition. The tests also show that there is only a small temperature differential of approximately 0.3°F between ignition values of LOX pump inlet temperatures when bubbling at 31 scfm or 45 scfm.

An erratic closed indication was received from the LOX relief valve during the countdown for test SA-32. This valve was visually verified to be in the closed position prior to the test. The discrepant valve was replaced before test SA-33.

The maximum differential pressure noted in the GOX interconnect between tank O-C and tank O-3 was 0.46 psid and 0.66 psid for tests SA-32 and SA-33, respectively.

A 21.0-inch static test orifice was installed in the center LOX tank sump for static tests of stage S-IB-4, resulting in a 3.1-second time differential between inboard and outboard engine cutoff of test SA-33.

The LOX discrete probe actuation times for test SA-33 are shown in TABLE 4-4, and the corresponding LOX volumes below the discrete probes are presented in TABLE 4-5.

Overboard LOX dump tests were conducted to determine the feasibility of eliminating static test LOX fill and drain valves. The present configuration of the LOX fill and emergency dump system is shown in FIGURE 4-5. LOX was dumped overboard through various combinations of stage fill and drain valves and at different tank ullage pressures. Data from these tests are shown in TABLE 4-6. These tests show that, with reduced ground system pressure drop, equal flow capacity could be achieved with two fill and drain valves.

FUEL SYSTEM

The fuel system parameters indicated that the system functioned properly during tests SA-32 and SA-33. The fuel level at ignition of test SA-32 was 634.5 inches, providing an ullage of 2.0 percent. For test SA-33, the fuel level was 631.1 inches corresponding to an ullage of 2.5 percent.

The replacement of a fuel vent valve was necessitated prior to test SA-32 due to possible contamination by fuel of the pilot valve assembly of the vent valves.

To comply with a test requirement to pre-pressurize the fuel spheres to minimum prelaunch pressure, the fuel spheres were pressurized to 2,895 psig for test SA-32, and to 2,815 psig for test SA-33.

For test SA-32, the maximum temperature attained in the fuel spheres during pressurization was 81°F. The fuel tanks were pre-pressurized to 17.8 psig in 1.73 seconds. At ignition, the fuel tank pressure was 17.2 psig, and it gradually decayed to 9.5 psig at cutoff.

Maximum fuel sphere temperature prior to test SA-33 was 85°F. The fuel tanks were pre-pressurized to 17.8 psig in 2.4 seconds. Fuel tank pressure was maintained by the stage system until X+46.5 seconds, at which time the tank pressure had decreased to 5.7 psig. From X+46.5 seconds to X+61 seconds, the fuel tank pressure was maintained by both the stage and the facility pressurizing systems. At X+61 seconds, the stage pressurization system was disabled, and facility fuel tank pressurizing was locked in for the remainder of the test.

The fuel consumption characteristics from test SA-33 show that the maximum difference in fuel levels between tanks F-3 and F-1 was approximately 8 inches at X+30 seconds. These levels converged at X+54 seconds and remained approximately equal for the remainder of the test. The fuel discrete probe actuation times are shown in TABLE 4-4, and the corresponding volumes below these probes are shown in TABLE 4-5.

The maximum temperature measured on the skin of fuel tank F-4 during test SA-33 was 213°F. A radiation shield was installed on fuel tank F-3 during the test.

MISCELLANEOUS

The GN_2 control system functioned satisfactorily during tests SA-32 and SA-33. Four calorimeter purges were simulated by orifices for this test. The GN_2 control sphere pressurant usage test results are presented in GRAPH 4-2.

Data obtained from the prevalve timing tests conducted under ambient and cryogenic temperatures are listed in TABLE 4-7.

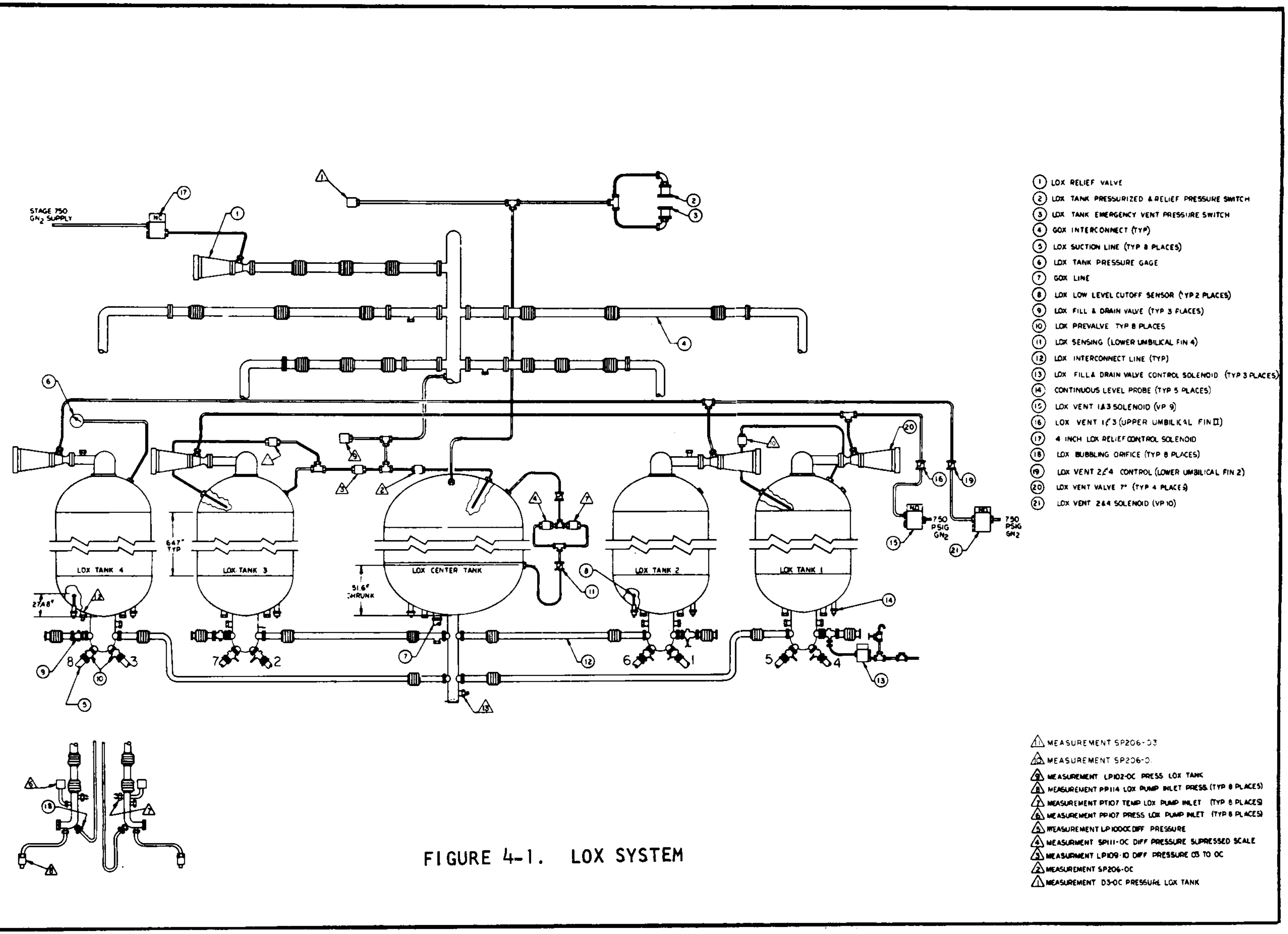


FIGURE 4-1. LOX SYSTEM

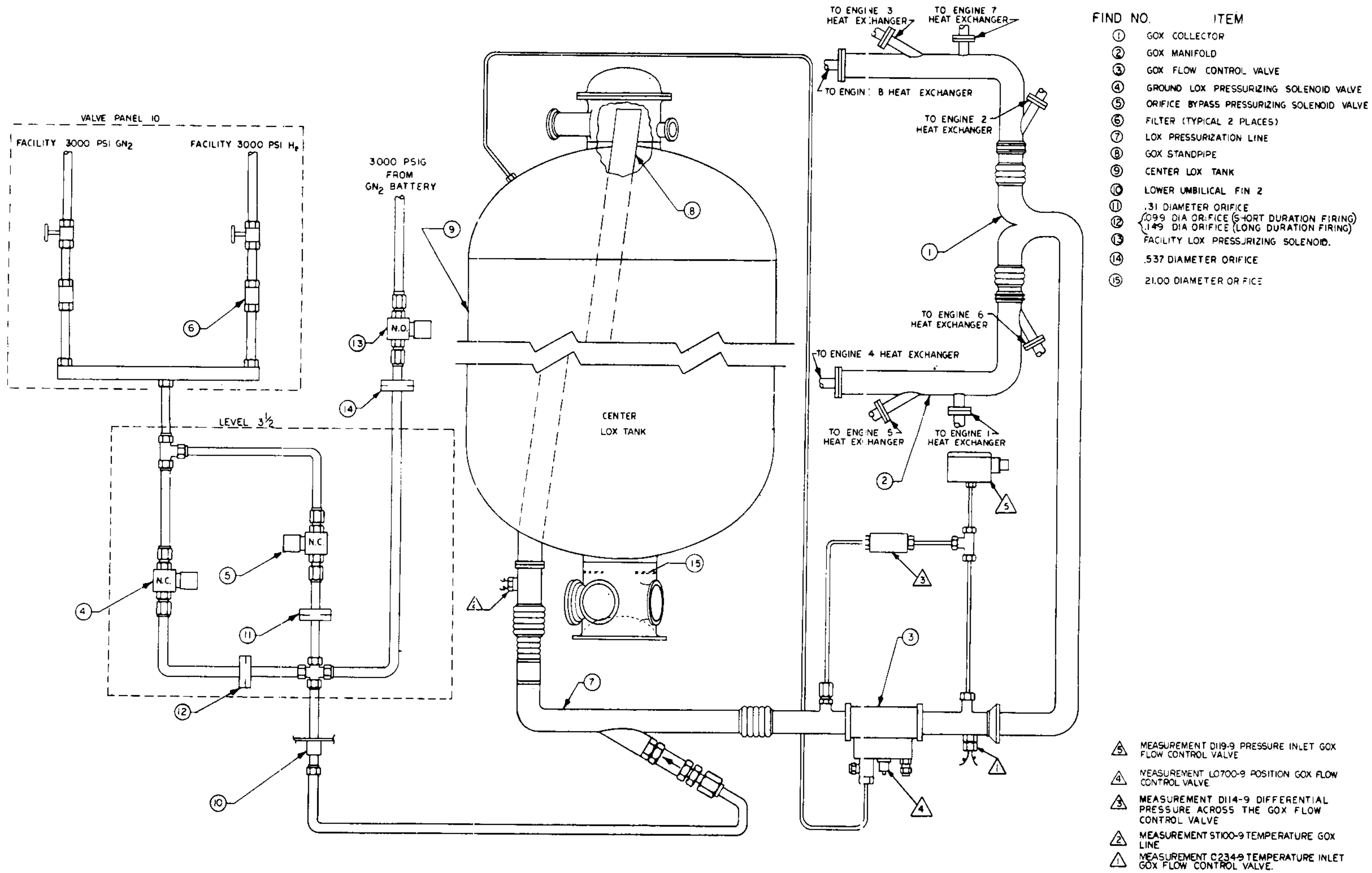
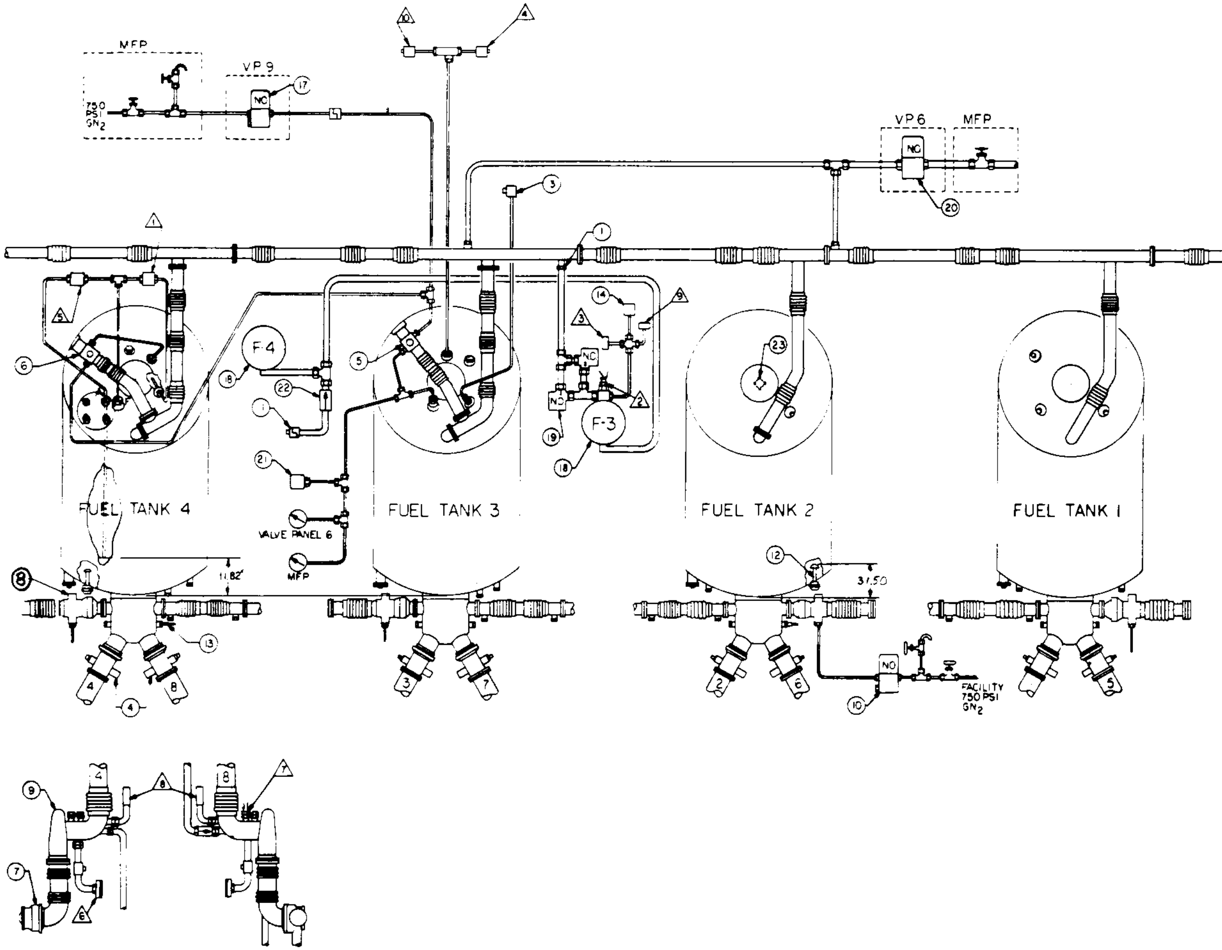


FIGURE 4-2. LOX PRESSURIZATION SYSTEM



FIND NO	ITEM
1	NOZZLE 0.210 DIA (SONIC)
2	DELETED
3	FUEL TANK PRESSURIZED PRESSURE SWITCH
4	FUEL PREVALVE (TYP 8 PLACES)
5	FUEL VENT VALVE 1
6	FUEL VENT VALVE 2
7	MAIN FUEL VALVE (TYP 8 PLACES)
8	FUEL FILL & DRAIN VALVE (TYP 4 PLACES)
9	FUEL TURBO PUMP (TYP 8 PLACES)
10	FUEL FILL & DRAIN VALVE CONTROL SOLENOID (TYP TANKS 1,2,3,4)
11	FUEL PRESSURIZING SPHERE FILL UPPER UMBILICAL FIN 2
12	ENGINE CUTOFF SENSOR (TYP 2 PLACES)
13	FUEL DEPLETION SENSOR (TYP 2 PLACES)
14	FUEL SPHERE PRESSURIZE PRESSURE SWITCH
15	DELETED
16	DELETED ,
17	FUEL VENT CONTROL SOLENOID
18	FUEL PRESSURIZING SPHERE (TYP 2 PLACES)
19	FUEL TANK PRESSURIZING VALVES 1&2
20	FACILITY FUEL TANK PRESSURIZING SOLENOID
21	PRESSURE SWITCH EMERGENCY FUEL TANK PRESSURIZING
22	CHECK VALVE
23	DISCRETE PROBE RACK
24	750 PSIG (UPPER UMBILICAL FIN II)

△10	MEAS D2-F3 PRESS. FUEL TANK NO. 3
△9	MEAS. D139-11 FUEL SPHERE PRESS.
△8	MEAS. PP113 FUEL INLET PRESSURE (TYP 8 PLACES)
△7	MEAS. PT100-8 TEMPERATURE FUEL PUMP INLET
△6	MEAS. PP106 FUEL INLET PRESS (TYP 8 PLACES)
△5	MEAS. FP109-F4 FUEL DIFF PRESS
△4	MEAS. FP101-F3 PRESSURE FUEL TANK 3
△3	MEAS. FP103-11 FUEL SPHERE PRESSURE
△2	MEAS. FT700-11 TEMPERATURE FUEL SPHERES
△1	MEAS. SP200-F4 FUEL DIFF PRESS

FIGURE 4-3. FUEL PROPELLANT AND PRESSURIZATION SYSTEMS

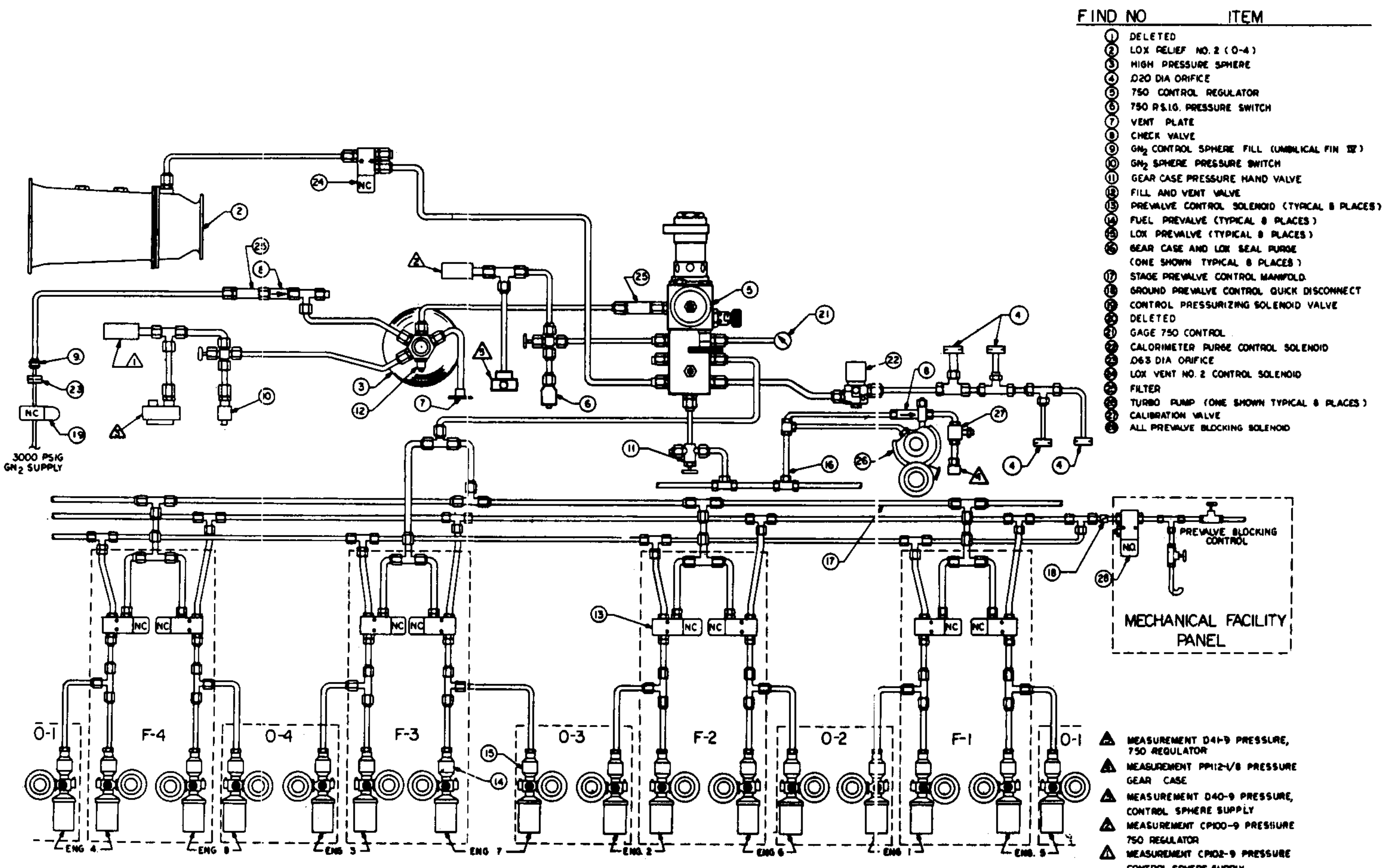


FIGURE 4-4. GN_2 CONTROL PRESSURE SYSTEM

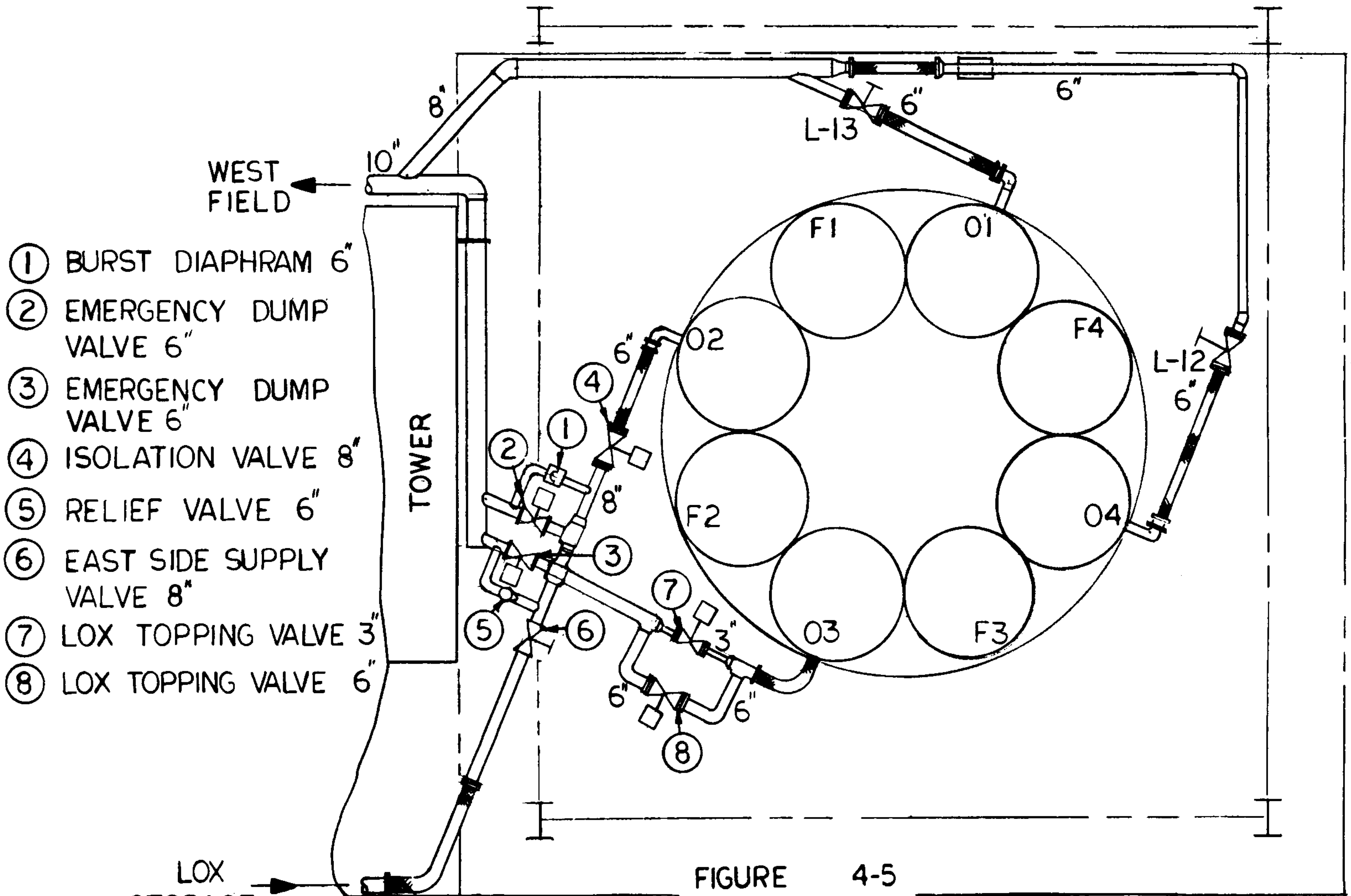


FIGURE 4-5
S-IB-4 LOX TRANSFER SYSTEM CONFIGURATION

TABLE 4-1

PROPELLANT LOADING AND PRESSURIZATION DATA

	LOX	SA-32	SA-33
1.	Tank pressurant	Helium	Helium
2.	Pressurizing time (seconds)	74.9	60.2
3.	Height from tank bottom at ignition command (inches)	655.0	632.0
4.	Ullage volume at ignition (gallons)	1,036 [1]	3,291 [1]
5.	Ullage volume at ignition (percent)	1.5 [1]	4.9 [1]
6.	Volume at ignition (gallons)	67,132	64,877
7.	LOX flow rate (gallons/second)	450.0	447.0

[1] Measured from theoretical bottom.

	FUEL	SA-32	SA-33
1.	Tank pressurant	Helium	Helium
2.	Pressurizing time (seconds)	1.7	2.4
3.	Height from tank bottom at ignition (inches)	634.5	631.1
4.	Ullage at ignition (gallons)	870.0 [1]	1,067 [1]
5.	Ullage at ignition (percent)	2.0 [1]	2.5 [1]
6.	Volume at ignition (gallons)	146.0	41,949.0
7.	Fuel flow rate (gallons/second)	275.0	277.0

[1] Measured from theoretical bottom.

TABLE 4-2

HELIUM FLOWRATE DATA
LOX BUBBLING SYSTEM

PRESSURE, FACILITY REGULATOR (PSIG)	PRESSURE, UPSTREAM OF ORIFICE (PSIG)		PRESSURE, UMBILICAL CONNECTION (PSIG)	HELIUM FLOW RATES (SCFM)	
	ENGINE 3	ENGINE 6		ENGINE 3	ENGINE 6
394	△1	△1	138	31.0	△1
500	65	90	175	39.5	43.5
575	82	105	200	45.0	50.5
610	90	112	225	47.2	53.5

△1 No values obtained

TABLE 4-3

LOX PUMP INLET TEMPERATURES, °F
MEASUREMENT *PT107-1/8

TEST	ENGINE	VALUES AT START OF BUBBLING	VALUES AT END OF BUBBLING	VALUES AT TIME FOR IGNITION
Propellant Loading Test, LOX Bubbling at X-153 Seconds at 31 scfm. All Vents Closed.	1	-273.8	-281.4	-278.8
	2	-273.6	-281.4	-279.0
	3	-274.1	-282.0	-279.6
	4	-274.3	-281.9	-279.7
	5	-274.6	-280.7	-279.4
	6	-274.6	-281.2	-279.4
	7	-274.6	-280.6	-279.2
	8	-273.1	-279.6	-277.6
Aborted Test SA-32, LOX Bubbling at X-153 Seconds at 45 scfm. 4-inch Relief Valve Open. (Data Obtained During LOX Loading Prior to Test)	1	-274.3	-283.2	-280.3
	2	-274.2	-282.4	-280.3
	3	-274.5	-283.4	-280.6
	4	-274.2	-283.3	-280.1
	5	-274.4	-282.9	-280.2
	6	-274.5	-282.7	-279.7
	7	-274.5	-283.6	-279.6
	8	-274.2	-282.1	-278.9
Test SA-32, LOX Bubbling at X-173 Seconds at 45 scfm. All Vents Closed. ⚠1	1	-274.1	-281.5	-278.9
	2	-274.0	-281.4	-278.9
	3	-274.2	-281.9	-278.7
	4	-273.8	-281.6	-279.0
	5	-274.0	-281.2	-278.4
	6	-274.1	-281.3	-277.9
	7	-274.1	-281.5	-278.2
	8	-273.8	-280.8	-277.5
Test SA-33, LOX Bubbling at X-153 Seconds at 45 scfm. All Vents Closed.	1	-274.6	-281.3	-279.0
	2	-275.0	-281.8	-278.8
	3	-274.9	-281.5	-279.3
	4	-274.4	-281.8	-279.5
	5	-274.7	-281.5	-278.7
	6	-274.9	-282.0	-278.7
	7	-274.8	-282.9	-278.4
	8	-274.5	-280.8	-278.1

⚠1 A sequence hold was made during the countdown after "End of Bubbling". Ignition values were read 100 seconds after "End of Bubbling". Time For Ignition values are corrected from those listed in the "Preliminary Static Test Report for Test SA-32".

TABLE 4-4

DISCRETE PROBE ACTUATION TIMES

LOX PROBES ⚠1

TEST SA-33

PROBE	TANK 0-C	TANK 0-1	TANK 0-3
P1	8.232	6.886	6.936
P2	17.830	16.584	16.308
P3	27.170	26.232	25.818
P4	36.728	35.865	35.350
P5	46.168	45.466	44.858
P6	55.659	55.098	54.422
P7	65.172	64.871	63.964
P8	74.682	74.378	73.712
P9	84.339	84.048	83.329
P10	93.869	93.802	92.959
P11	103.652	103.391	102.610
P12	113.077	113.141	112.432
P13	122.709	122.918	⚠2
P14	132.501	132.541	131.765
P15	141.858	142.081	141.381

⚠1 Times shown are periods in seconds after ignition command.

⚠2 Probe 13 was obscured by a calibration step.

TABLE 4-4 (CONTINUED)

FUEL PROBES [1]

TEST SA-33

PROBE	TANK F-1	TANK F-3
P1	13.445	13.230
P2	23.962	24.870
P3	32.532	34.252
P4	43.166	43.609
P5	52.010	52.482
P6	61.915	61.432
P7	71.655	70.708
P8	81.172	80.597
P9	90.780	90.321
P10	100.279	100.129
P11	109.844	109.827
P12	119.451	119.558
P13	129.109	129.344
P14	138.699	138.907
P15	[2]	[2]

[1] Times shown are periods in seconds after ignition command.

[2] Probe 15 in tanks F-1 and F-3 was not uncovered.

TABLE 4-5

PROPELLANT VOLUMES BELOW DISCRETE PROBES

LOX
(SHRUNK GALLONS)

PROBE	TANK O-C	TANKS O-1 AND O-3	TOTAL VOLUME
P1	21,904	9,803	61,117
P2	20,363	9,118	56,836
P3	18,821	8,434	52,556
P4	17,280	7,749	48,277
P5	15,739	7,065	43,997
P6	14,198	6,380	39,718
P7	12,657	5,695	35,439
P8	11,116	5,010	31,157
P9	9,575	4,325	26,876
P10	8,035	3,640	22,595
P11	6,496	2,955	18,315
P12	4,957	2,270	14,036
P13	3,418	1,586	9,760
P14	1,880	901	5,485
P15	394	222	1,284

TABLE 4-5 (CONTINUED)
PROPELLANT VOLUMES BELOW DISCRETE PROBES

FUEL
(GALLONS)

PROBE	TANKS F-1 AND F-3	TOTAL VOLUME
P1	9,408	37,632
P2	8,750	35,002
P3	8,093	32,371
P4	7,435	29,741
P5	6,778	27,111
P6	6,120	24,481
P7	5,463	21,850
P8	4,805	19,219
P9	4,147	16,588
P10	3,489	13,957
P11	2,831	11,326
P12	2,174	8,696
P13	1,517	6,068
P14	859	3,438
P15	209	837

TABLE 4-6

LOX DRAIN TEST RESULTS

TEST NO.	SYSTEM CONFIGURATION	LOX TANK PRESSURE (PSIG)	FLOW RATE (GAL/SEC)	TIME TO DRAIN 655 INCHES, 66,250 GAL (SECONDS)
1	LOX Fill and Drain 1, 2, 3, and 4 Open	15	77.8	851.0
2	LOX Fill and Drain 2 Open	15	40.0	1656.0
3	LOX Fill and Drain 2 Open	30	44.1	1502.2
4	LOX Fill and Drain 1 and 4 Open ⚠1	20	77.8	851.4
5	LOX Fill and Drain 1 and 4 Open ⚠1	40	95.1	696.7

⚠1 Emergency dump hand valves removed.

TABLE 4-7

PREVALVE CLOSING TIMES

PREVALVE	AMBIENT ⚠1 INDIVIDUAL ACTUATION		CRYOGENIC ⚠2 SIMULTANEOUS ACTUATION		CRYOGENIC ⚠3 INDIVIDUAL ACTUATION	
	SIG-SW	SW-SW	SIG-SW	SW-SW	SIG-SW	SW-SW
LOX 1	0.888	0.604	1.371	0.969	0.996	0.692
FUEL 1	1.832	1.416	2.140	1.722	1.868	1.456
LOX 2	0.824	0.560	1.349	0.939	0.928	0.636
FUEL 2	1.868	1.420	2.234	1.736	1.896	1.440
LOX 3	0.804	0.544	1.201	0.814	0.924	0.628
FUEL 3	1.808	1.376	2.132	1.692	1.852	1.424
LOX 4	0.876	0.620	1.379	0.992	1.048	0.752
FUEL 4	1.884	1.440	2.249	1.772	1.940	1.496
LOX 5	0.720	0.512	1.102	0.822	0.844	0.600
FUEL 5	1.672	1.328	2.032	1.671	1.820	1.360
LOX 6	0.788	0.564	1.299	0.984	0.936	0.672
FUEL 6	1.820	1.396	2.237	1.818	1.868	1.448
LOX 7	0.772	0.448	1.214	0.882	0.908	0.652
FUEL 7	1.820	1.436	2.117	1.734	1.872	1.476
LOX 8	0.680	0.476	1.058	0.778	0.780	0.548
FUEL 8	1.780	1.396	2.117	1.690	1.824	1.436

⚠1 Test performed 1-20-66.

⚠2 Test SA-32, 1-17-66.

⚠3 Propellant Loading Test 1-5-66.

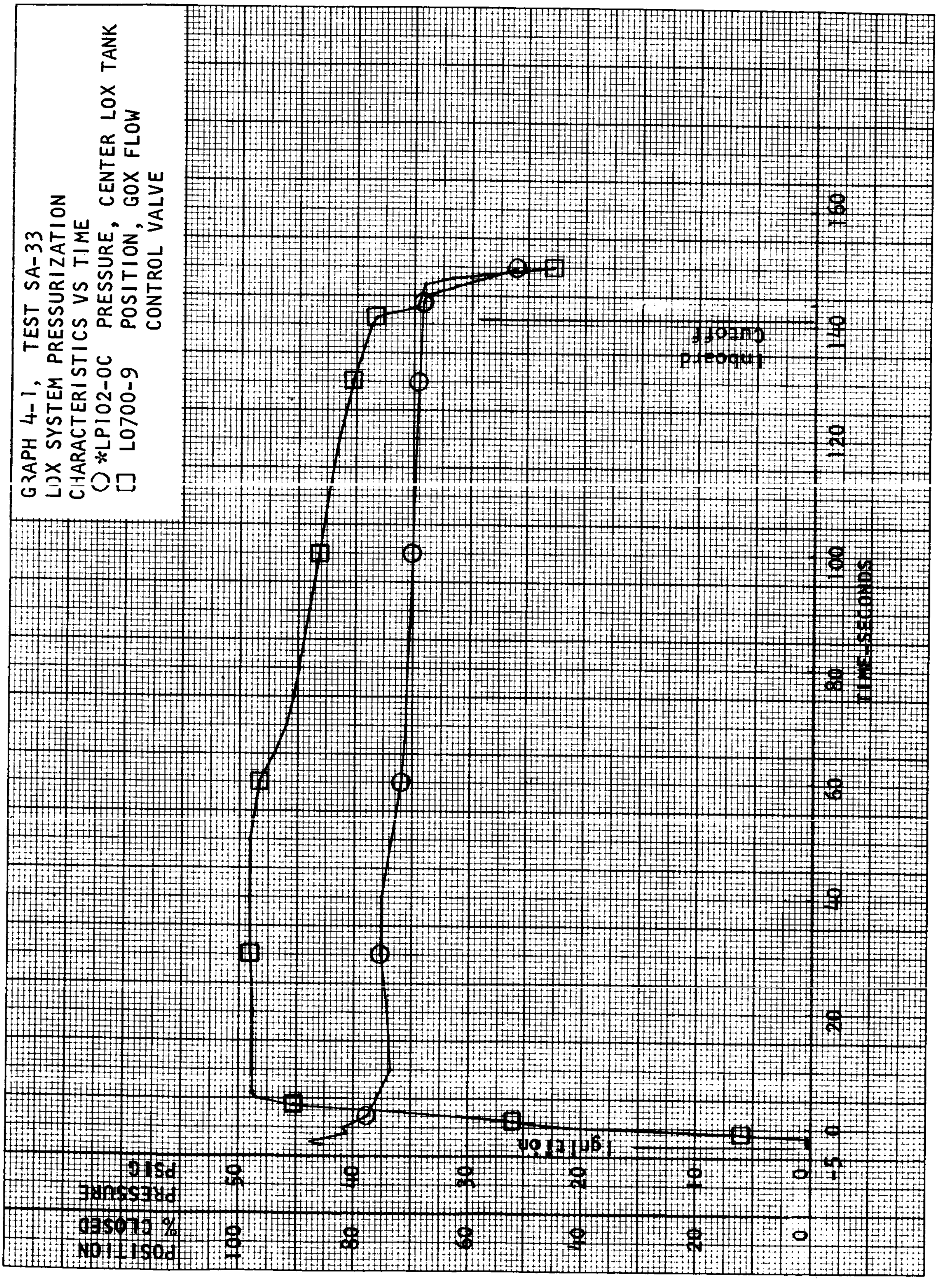
TABLE 4-7 (CONTINUED)

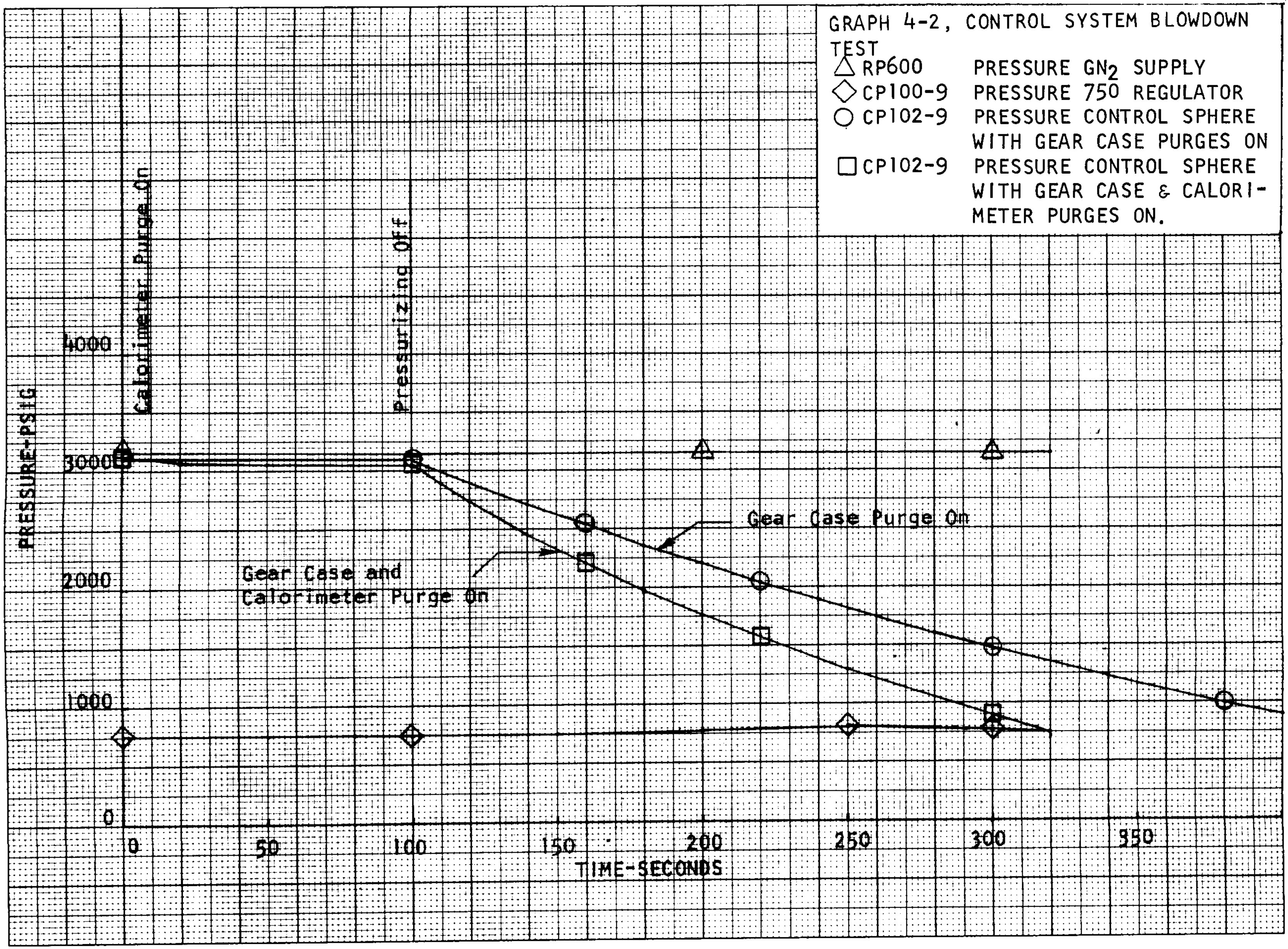
PREVALVE OPENING TIMES

PREVALVE	AMBIENT (1) INDIVIDUAL ACTUATION		CRYOGENIC (2) INDIVIDUAL ACTUATION	
	SIG-SW	SW-SW	SIG-SW	SW-SW
LOX 1	0.608	0.328	1.156	0.792
FUEL 1	3.876	2.292	4.444	2.472
LOX 2	0.716	0.388	1.180	0.764
FUEL 2	3.212	1.904	3.504	2.028
LOX 3	0.632	0.352	1.068	0.712
FUEL 3	3.396	2.004	3.900	2.116
LOX 4	0.788	0.400	1.200	0.680
FUEL 4	3.936	2.372	4.324	2.524
LOX 5	0.652	0.368	0.912	0.556
FUEL 5	3.800	2.096	4.076	2.272
LOX 6	0.636	0.348	0.904	0.548
FUEL 6	3.848	2.160	4.012	2.236
LOX 7	0.600	0.328	0.828	0.496
FUEL 7	3.806	2.332	4.436	2.492
LOX 8	0.684	0.372	0.876	0.520
FUEL 8	4.492	2.488	4.560	2.548

(1) Test performed 1-20-66.

(2) Propellant Loading Test 1-5-66.


GRAPH 4-1, TEST SA-33
LOX SYSTEM PRESSURIZATION
CHARACTERISTICS VS TIME
○ *LP102-OC PRESSURE, CENTER LOX TANK
□ L0700-9 POSITION, GOX FLOW
CONTROL VALVE
Inboard
Cutoff
Ignition
POSITION
% CLOSED
PRESSURE
PSIG
TIME-SECONDS
-5
0
20
40
60
80
100
120
140
160
0
10
20
30
40
50
0
20
40
60
80
100



GRAPH 4-2, CONTROL SYSTEM BLOWDOWN TEST
RP600 PRESSURE GN_2 SUPPLY
CP100-9 PRESSURE 750 REGULATOR
CP102-9 PRESSURE CONTROL SPHERE WITH GEAR CASE PURGES ON
CP102-9 PRESSURE CONTROL SPHERE WITH GEAR CASE & CALORIMETER PURGES ON.
Calorimeter Purge On
Pressurizing Off
Gear Case Purge On
Gear Case and Calorimeter Purge On
PRESSURE-PSIG
4000
3000
2000
1000
0
0
50
100
150
200
250
300
350
TIME-SECONDS

SECTION 5

ENGINE COMPARTMENT ENVIRONMENT

The engine compartment temperature of stage S-IB-4 was low during tests SA-32 and SA-33 causing turbine spinner temperatures to be slightly below the specified minimum of 40°F at ignition. This situation was attributed to inclement weather conditions and reduced air flow through the boattail area with the heat shield panels installed. The rerouting of the inboard H-1 engine turbine exhaust ducts through the heat shield improves the sealing of the boattail area resulting in a reduction in conditioned air flow through this area. It is recommended that the engine compartment environmental temperature be evaluated on stage S-IB-3 at KSC during the countdown demonstration test.

During test SA-32, the aluminized fabric on the flexible boot of engine 4 was burned completely through and the boot was slightly charred. The refrasil on the boot had previously been repaired by the application of an aluminized coating with a flammable base material. Since severe damage to the boot would have occurred during the long duration firing, a spare boot was installed.

Following test SA-33, the flame curtains at the four outboard engines were tattered on all inboard quadrants. The peripheral static test radiation shield was torn slightly at Fin IV.

Post test SA-32 inspection of the boattail revealed that the heat shield support beam assemblies (60C30459-1) had not been deformed.

Following, test SA-33, an inspection of the boattail section revealed that these four heat shield support beam assemblies were distorted. The top flanges were deformed as shown in FIGURE 5-1. It is recommended that the study of heat shield beam assembly damage during static firings be continued.

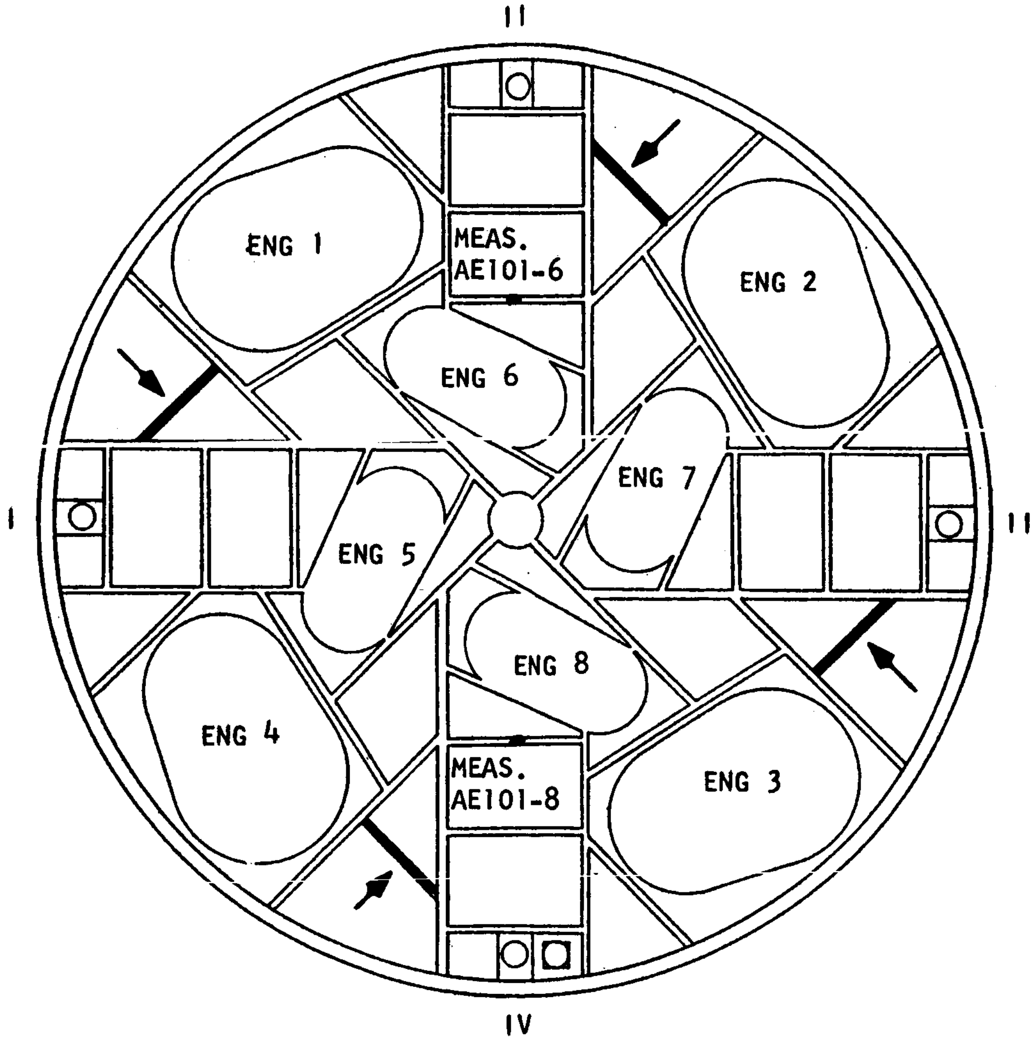
An attempt was made to take motion pictures of the heat shield beam movement near the inboard engines on the Fin II - Fin IV axis during SA-32. This attempt was unsuccessful due to a failure in the camera lighting system. Camera coverage during test SA-33 was successful and good pictures were obtained during the engine start sequence. The maximum camera frame speed attainable with the available boattail lights was 128 fps instead of the requested 250 fps.

The deflections of the heat shield support beam assemblies during the ignition and cutoff sequences are presented in GRAPH 5-1 and 5-2, respectively. Measurement AE101-6 is not shown in the cutoff sequence graph as this measurement malfunctioned at approximately X+19 seconds. The deflection of these beams during engine start reached a maximum positive displacement of 0.75 inch at X-2.03 seconds and a maximum negative displacement of 1.35 inches at X-1.81 seconds. The deflections of the beams during the cutoff transition were not as severe as during ignition. The configurations of the cameras and deflection indicator assemblies utilized to obtain motion pictures of beam movement during test SA-33 are shown in FIGURES 5-1 and 5-2. The maximum values of heat shield support beam strain during test SA-33 are shown in TABLE 5-2.

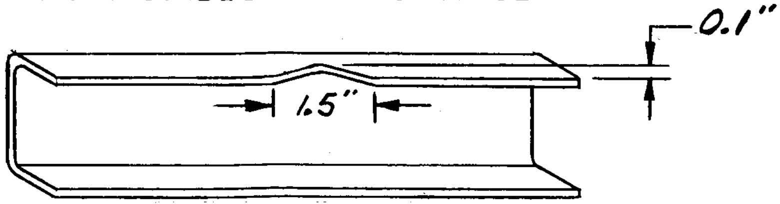
Post test SA-33 inspection of the stainless steel honeycomb heat shield panels revealed that only slight damage was incurred. Approximately 155 square inches of M-31 insulation material separated from the panels. The post test status of the heat shield panels is shown in FIGURE 5-3 and TABLE 5-1.

There was no evidence of any fire or hot gas leaks in the engine compartment during test SA-32 or SA-33.

Meteorological data for tests SA-32 and SA-33 are presented in APPENDIX D.



AFT LOOKING FORWARD
HEAT SHIELD BEAM DAMAGE



BEAM 60C30459-1
MAXIMUM DISTORTION NOTED

FIGURE 5-1

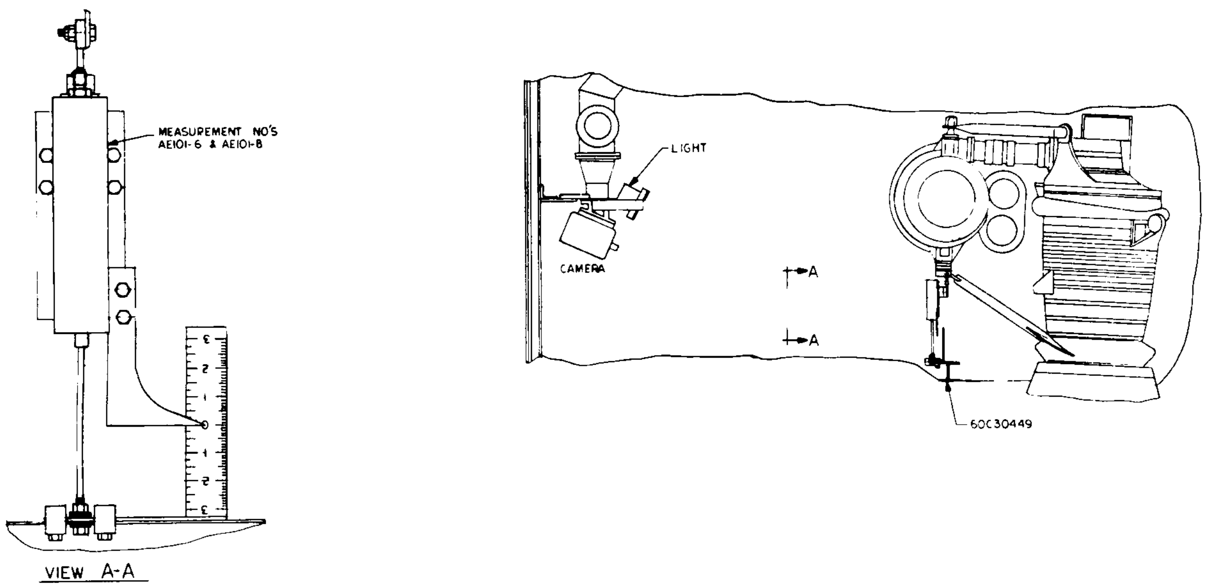


FIGURE 5-2
HEAT SHIELD VERTICAL DISPLACEMENT INDICATOR
STATIC TEST SA-33

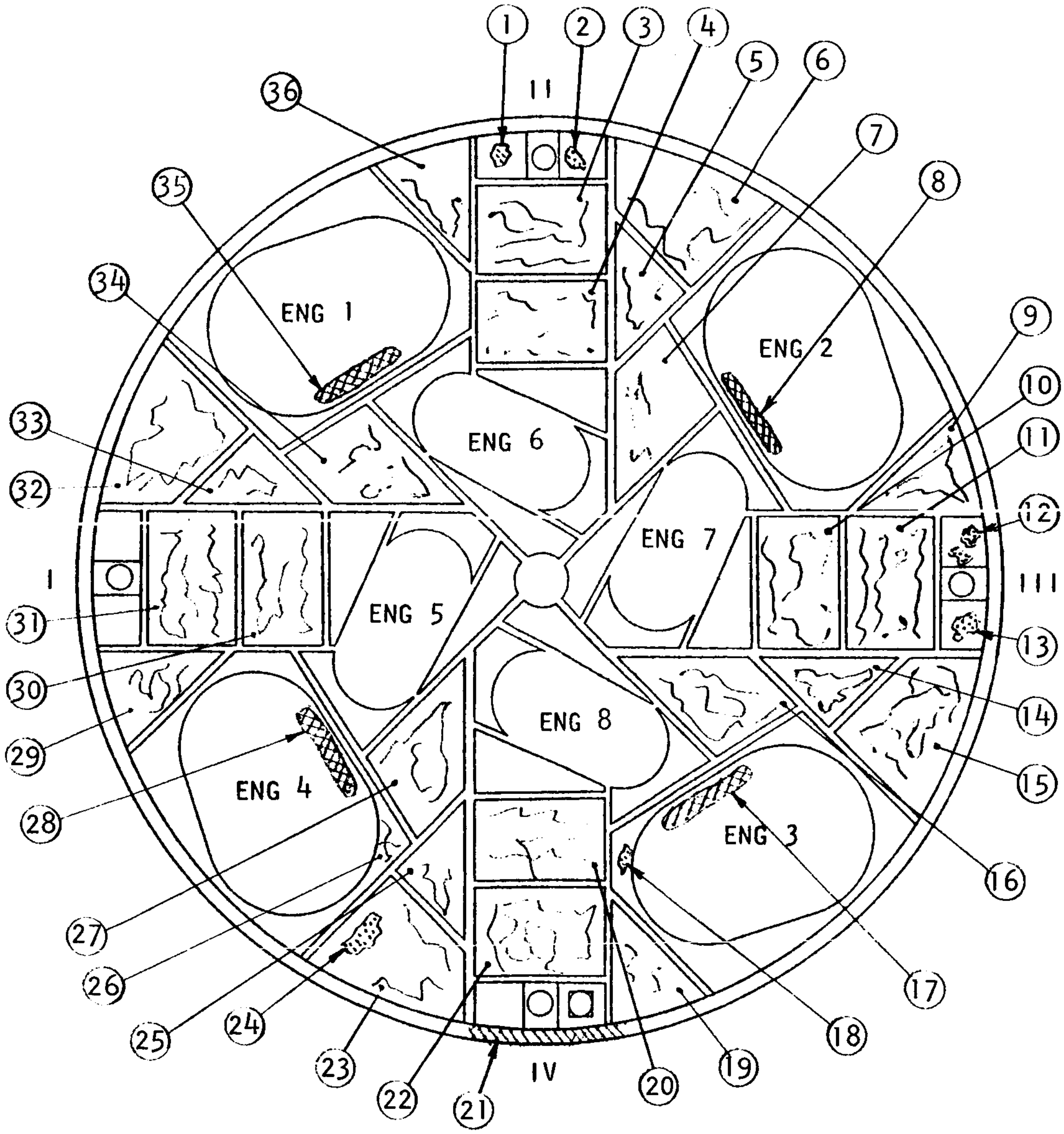


FIGURE 5-3

TEST SA-33 HEAT SHIELD DAMAGE
(AFT LOOKING FORWARD)

TABLE 5-1

HEAT SHIELD DAMAGE
TEST SA-33

REFERENCE FIG. 5-1	EXTENT OF DAMAGE
1	25 square inches of M-31 fallen away.
2	22 square inches of M-31 fallen away.
3	75 lineal inches of cracked M-31.
4	60 lineal inches of cracked M-31.
5	23 lineal inches of cracked M-31.
6	65 lineal inches of cracked M-31.
7	20 lineal inches of cracked M-31.
8	Tattered reflective heat shield curtain.
9	30 lineal inches of cracked M-31.
10	55 lineal inches of cracked M-31.
11	65 lineal inches of cracked M-31.
12	27 square inches of M-31 fallen away.
13	31 square inches of M-31 fallen away.
14	21 lineal inches of cracked M-31.
15	54 lineal inches of cracked M-31.
16	50 lineal inches of cracked M-31.
17	Tattered reflective heat shield curtain.
18	15 square inches of M-31 fallen away.
19	20 lineal inches of cracked M-31.
20	38 lineal inches of cracked M-31.

TABLE 5-1 (CONTINUED)

REFERENCE FIG. 5-1	EXTENT OF DAMAGE
21	Tattered radiation shield curtain.
22	65 lineal inches of cracked M-31.
23	22 lineal inches of cracked M-31.
24	35 square inches of M-31 fallen away.
25	25 lineal inches of cracked M-31.
26	20 lineal inches of cracked M-31.
27	35 lineal inches of cracked M-31.
28	Tattered reflective heat shield curtain.
29	35 lineal inches of cracked M-31.
30	48 lineal inches of cracked M-31.
31	65 lineal inches of cracked M-31.
32	40 lineal inches of cracked M-31.
33	21 lineal inches of cracked M-31.
34	25 lineal inches of cracked M-31.
35	Tattered reflective heat shield curtain.
36	28 lineal inches of cracked M-31.

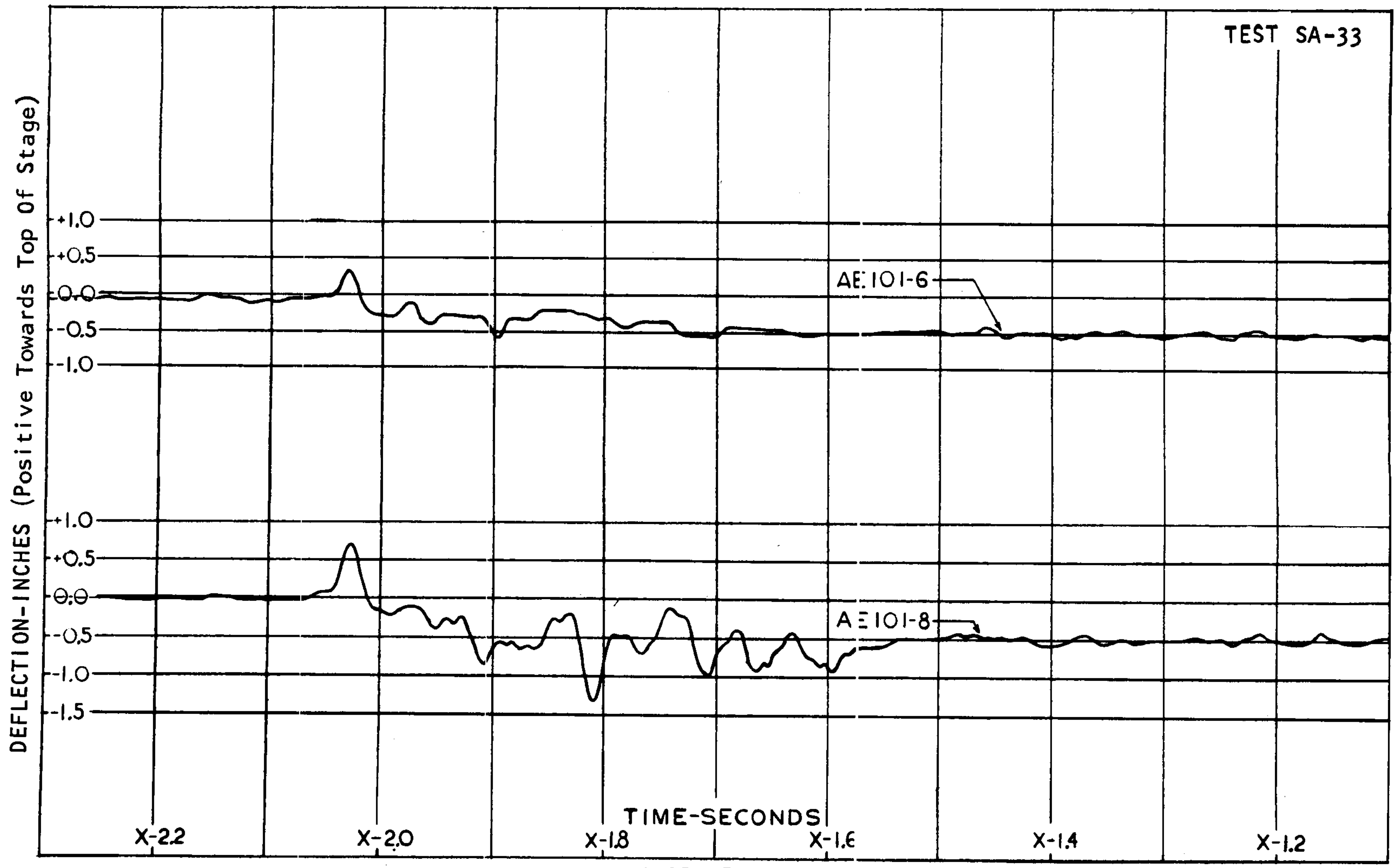
TABLE 5-2

HEAT SHIELD SUPPORT BEAM STRAINS (1)
μ INCHES/INCH

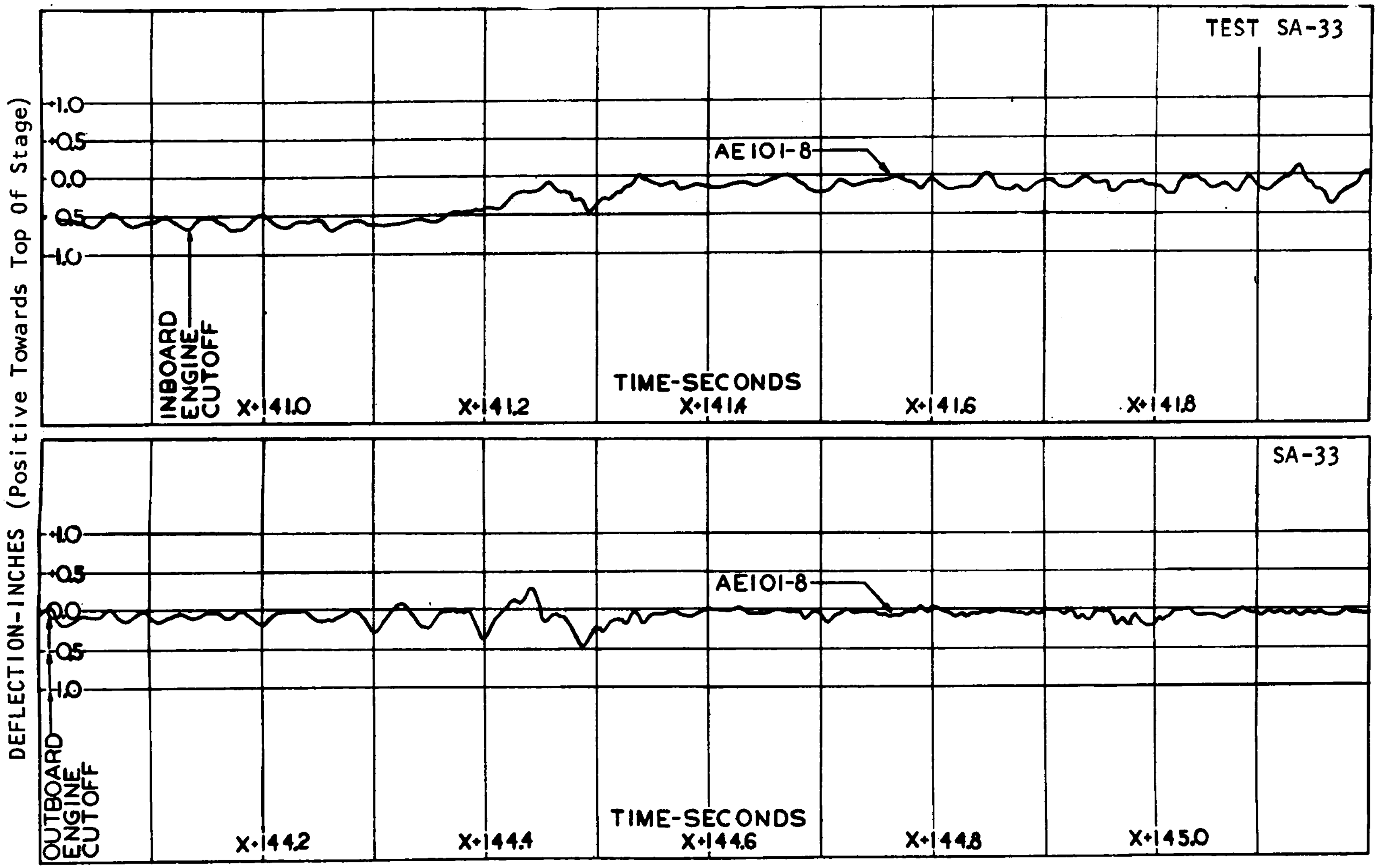
TEST SA-33

MEASUREMENT NO.	MAXIMUM VALUES DURING		
	IGNITION	MAINSTAGE	CUTOFF
AS152	+350	+450	+800
AS153	-230	+300	+550
AS154	-300	-300	+325
AS155	-410	-410	-800
AS156	-430	-330	-550
AS157	±450	-450	-1150
AS158	-580	-450	-910
AS159	±450	±150	-800
AS160	-400	-160	-400
AS161	-390	-350	-600
AS162	-400	-300	-530
AS163	-610	-750	-1350
AS164	-720	-760	-1230
AS165	-620	-340	-700
AS166	+1550	+280	-700
AS167	+1450	+450	+1240
AS168	-900	-300	-350
AS169	-800	-450	-750
AS170	-900	-440	-670
AS171	-990	-420	-730
AS172	-980	-470	-950
AS173	+850	+300	+650
AS174	-810	-450	-550
AS175	-850	-450	-650
AS176	±750	-450	-670
AS177	-860	-450	-710
AS178	-900	-440	+1270

(1) + denotes compression; - denotes tension.



GRAPH 5-1
HEAT SHIELD BEAM DEFLECTION
IGNITION TRANSITION



GRAPH 5-2
HEAT SHIELD BEAM DEFLECTION
CUTOFF TRANSITIONS

SECTION 6

VIBRATION AND SPECIAL INSTRUMENTATION

VIBRATION INSTRUMENTATION

A total of 117 vibration measurements were recorded during static test of stage S-IB-4. Useful information was obtained on 113 and 110 of these measurements during tests SA-32 and SA-33, respectively. A more detailed discussion of the vibration data will be published in the "Vibration and Acoustical Evaluation Report, Stage S-IB-4" by Systems Static Test Branch.

The post tests SA-32 and SA-33 gearcase vibration checks conducted on all engines did not indicate any abnormal conditions. Questionable data were obtained during the initial post test SA-33 gearcase vibration checks conducted on engines 4 and 8. Tests were made again on these engines. A review of test data from these engines and the final gearcase vibration checks indicate that no abnormal conditions exist at these two engine positions.

During test SA-32, abnormal LOX dome vibrations were recorded at engine 1. Rough combustion cutoff (RCC) measurement *PV700-1 commenced counting at approximately X+15.5 seconds. The measurement accumulated a total of 19 counts. Oscillograph records substantiated RCC counting at this time. The 19 counts represent a vibration level in excess of 100 g rms for less than 0.5 millisecond. The RCC measurements averaged approximately 6 g rms during mainstage.

During test SA-33 abnormal LOX dome vibrations were recorded on engines 1 and 3. Rough combustion cutoff (RCC) measurement *PV700-1 counted at approximately X+17.5 seconds and X+18.8 seconds and accumulated a total of 37 counts. Measurement *PV700-3 counted at five different times (approximately X+15.9, X+19.6, X+21.0, X+21.2, and X+22.2 seconds) and accumulated a total of 101 counts. The 37 counts represent a vibration level in excess of 100 g rms for approximately 0.7 millisecond, and the 101 counts represent a vibration level in excess of 100 g rms for approximately 2.0 milliseconds. The RCC measurements averaged approximately 7 g rms during mainstage. There was no indication of excessive chamber pressure variations during any period of RCC vibration.

FIRE DETECTION SYSTEM

The fire detection system for stage S-IB-4 consisted of 12 Test Laboratory harnesses and 4 flight harnesses. The automatic fire detection system was set for a rise rate of five chart scales per second (3.0 mv) with a cutoff time delay of 1 second for the Test Laboratory harnesses and a time delay of one-half second for the flight harnesses. The 16 rise rate indicators were all active in the cutoff circuit. This equipment functioned as required, and no abnormal temperatures were detected.

HEAT AND FLAME SHIELD INSTRUMENTATION

Test data from the heat and flame shield instrumentation are shown in GRAPHS 6-1 through 6-22 and TABLES 6-2, 6-4, and 6-5 of the "Preliminary Static Test Report" for test SA-32, and in GRAPHS 6-1 through 6-25 and TABLES 6-2, 6-4, and 6-5 of the "Preliminary Static Test Report" for test SA-33.

Measurements AT130 and AP109 were dropped for both tests due to open circuits.

No valid data for test SA-32 were obtained on the following measurements:

AA115	Defective Accelerometer
AT129	Equipment Discrepancy
AP106	Blockhouse Discrepancy
AP110	Blockhouse Discrepancy
AP113	Defective Transducer
AP115	Defective Transducer

All of the above measurements with the exception of measurement AP113 were corrected prior to test SA-33. The AP113 transducer was not replaced at Static Test because of its location in the flame shield assembly.

For test SA-33, discrepancies were noted on the following measurements:

AP113	Defective Transducer
AP106	Cable Connector Opened at X+40 Seconds
AT113-4	Transducer Opened at X+32 Seconds

The locations of all measurements discussed in this report are documented in the "Static Test Measurement Locations Report, Stage S-IB-4", or the supplement to that report.

SECTION 7

ELECTRICAL CONTROL SYSTEMS

NETWORKS

Ignition command time of day (X-3 seconds) and test durations in seconds from ignition command to inboard engine cutoff signal (IECOS) and outboard engine cutoff signal (OECOS), for the two static tests of stage S-IB-4, are listed below:

Test	Date	Ignition Command Time of Day	Test Duration to: IECOS	OECOS
SA-32	January 17, 1966	16:44:10.636	35.227	35.339
SA-33	January 21, 1966	16:40:19.820	143.934	147.110

Test SA-32 was terminated by the firing panel operator as planned at commit plus 32.227 seconds. All electrical systems functioned properly during this test. A hold was called in the automatic sequence at X-6 seconds and was held for approximately 20 seconds.

Termination of test SA-33 was as planned with inboard engine cutoff being initiated by the switch selector, 3.19 seconds after the LOX low level sensor 3 in LOX tank 0-4 was uncovered. Outboard engine cutoff was initiated by Thrust OK pressure switch dropout at engine 3 due to LOX depletion.

For test SA-32 the LOX vent and relief valves were closed at firing command. LOX bubbling was initiated at 173 seconds prior to commit, and fuel tank pressurization began at 161 seconds prior to commit.

The turbine spinner pressure switch on engine 2 malfunctioned during test SA-32 and remained in the closed (pressurized) position after termination of the test. This pressure switch was removed and replaced during post test checkout.

The hypergol burst indication on engine 6 was not received during the ignition transition of test SA-32. It did not pick up until X+11.9 seconds. However, the hypergol unit did function properly during the test as verified by other engine measurements. The switch was not replaced. Proper operation of this switch was noted during test SA-33.

In the process of removing spent initiators and Conax valves during post test securing operations following test SA-33, connector P2 separated from cable W2 on engine 3. Investigation revealed that the potting was cracked and the conductors were broken. The initiator ports on the turbine spinner were inspected, and it appears that this initiator did not fire properly.

Thrust OK pressure switch circuitry for stage S-IB-4 was the same as that used for test SA-31 of Saturn stage S-IB-3.

The operating times for major functions of test SA-33 from firing command to reset are shown in FIGURES 7-1 through 7-3.

GIMBAL CONTROLS

While attempting to perform the final gimbal system checkout during the X-15 minute countdown of test SA-32 attempted on January 14, it was noted that engine 3 was not controllable from the blockhouse in the yaw plane. After several minutes of checkout to confirm the problem, the countdown was aborted. Following securing operations, investigation revealed a high resistance of approximately 500K ohms between the center tap and wiper of the beta (feedback) potentiometer. This resistance should be 500 to 750 ohms. UCR 02935 was written and the actuator was replaced.

During performance of the prestatic SA-33 gimbal test procedure 5-CH SIB-461 as required in the firing day countdown procedure (7-CH SIB-602B), the auxiliary hydraulic pump for engine 4 was turned on and the input signal to the yaw actuator brought to zero. Although this action should have moved the engine to the null position, the position indicators at the blockhouse were showing the engine resting in a position approximately 0.1 degree off null. Personnel on the test stand were notified of the indications and visual observation verified the condition. While the visual observation was in progress, the engine moved rapidly to the null position. The problem also occurred just prior to test SA-32 although visual verification was not obtained.

Investigation of the oscillograph records revealed a deflection of approximately 0.11 degree, 0.94 milliamp control valve current, and zero psig pressure across the actuator pistons just prior to the shift in engine position. The records also show that an increase in supply pressure and normal action of the differential pressure trace occurred just after the engine movement. This was observed on records of gimbal checks prior to tests SA-32 and SA-33 (see GRAPHS 7-1 and 7-2). This could have been caused by a temporary restriction in the low pressure return line. Attempts to duplicate the deflections were unsuccessful. Operation during subsequent checks and during both the test firings was satisfactory.

Since this problem did occur on two occasions, recommendations were made on UCR 02956 that the servo valve and actuator be removed and investigated extensively upon stage arrival at Michoud.

Engine 3 actuators were locked out during test SA-33. The oscillograph record of this engine, however, showed a ± 0.031 degree movement. The frequency of these oscillations ranged from 60 to 70 cps. The possible cause of the oscillations could be vibration of the wiper on the measuring potentiometer. An additional possible cause could be 60 cps line voltage appearing on the trace. The other engine oscillograph traces also showed these oscillations.

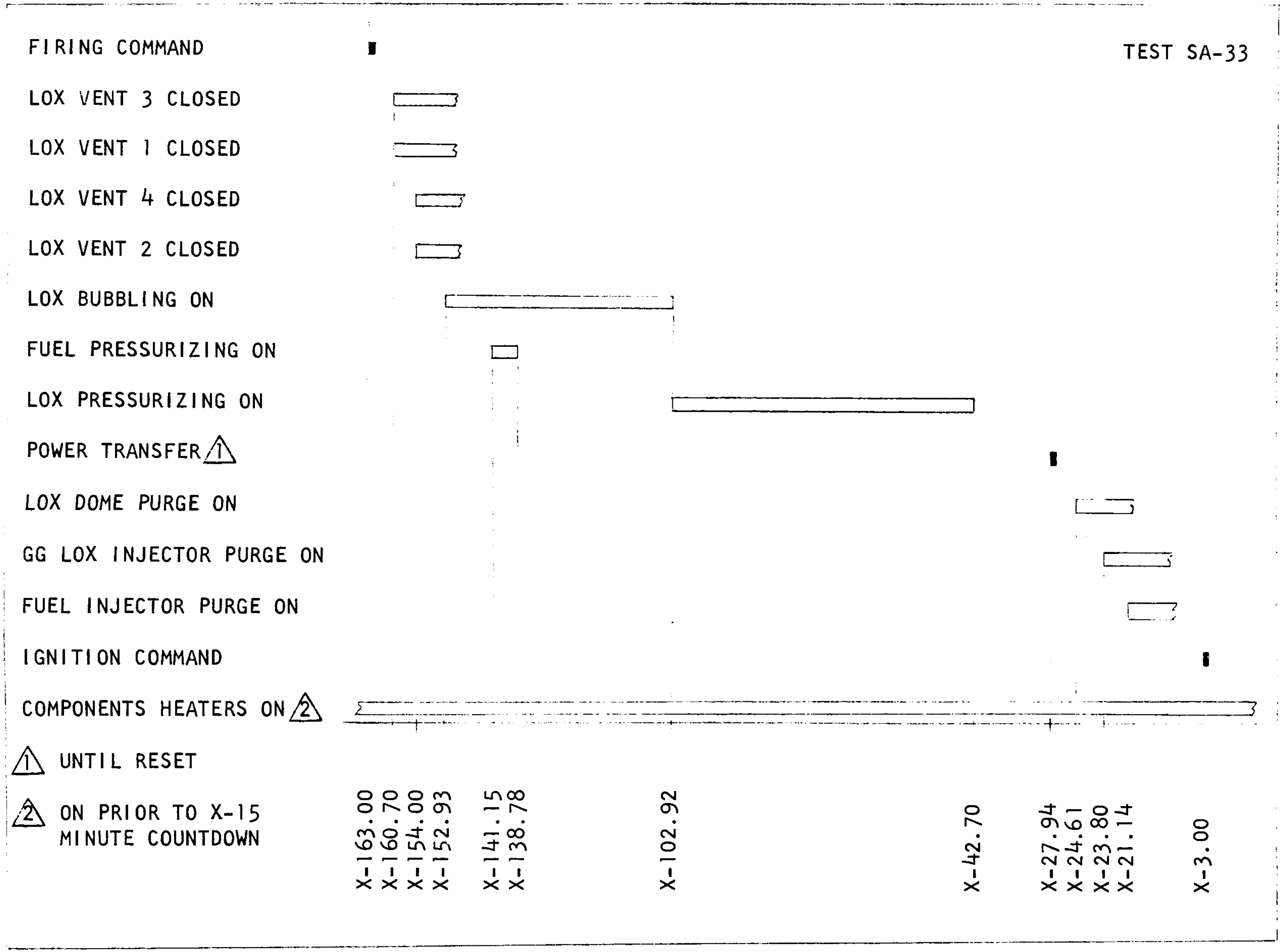


FIGURE 7-1. LOX VENTS CLOSED TO IGNITION COMMAND

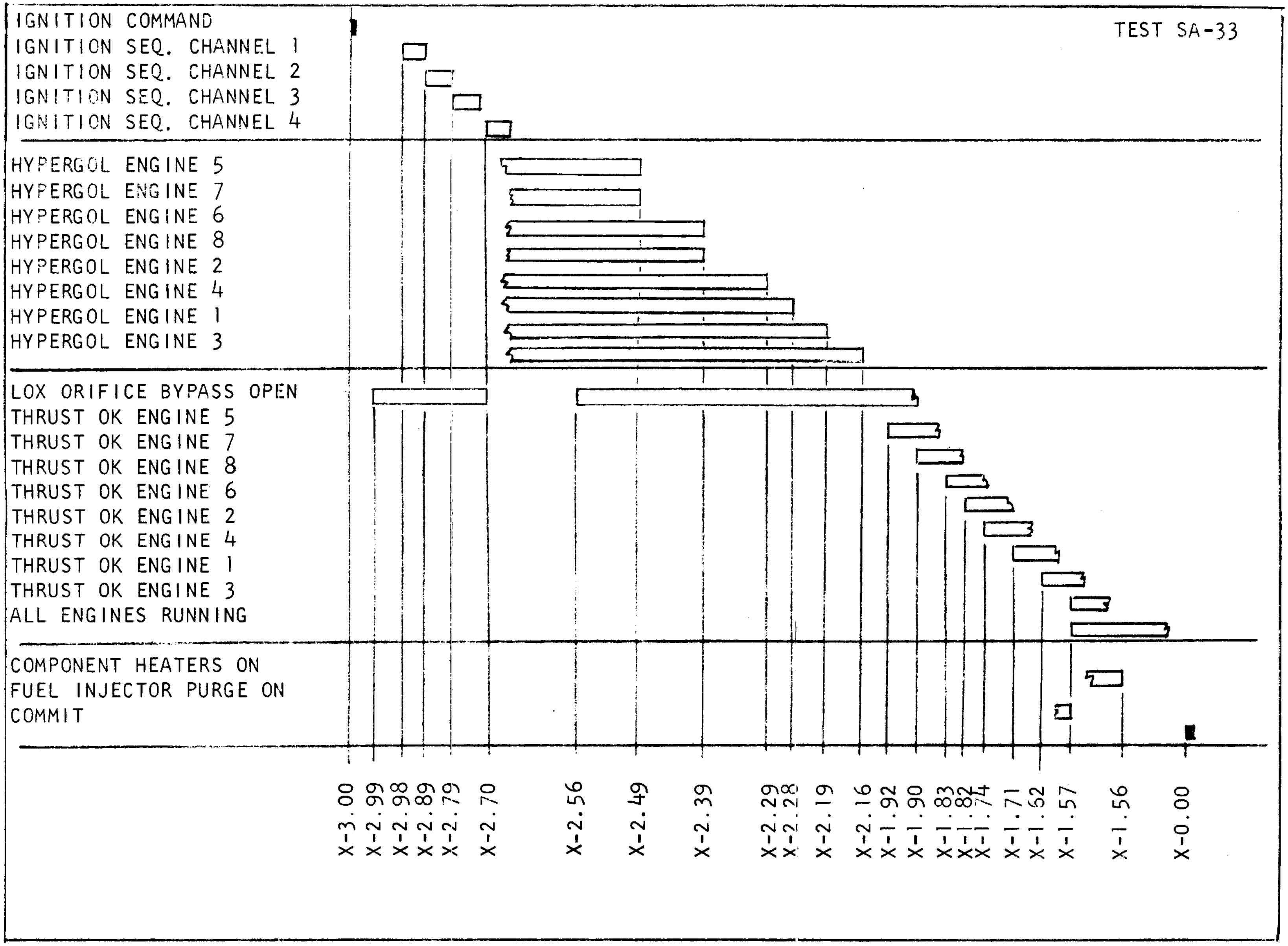


FIGURE 7-2. IGNITION COMMAND TC COMMIT

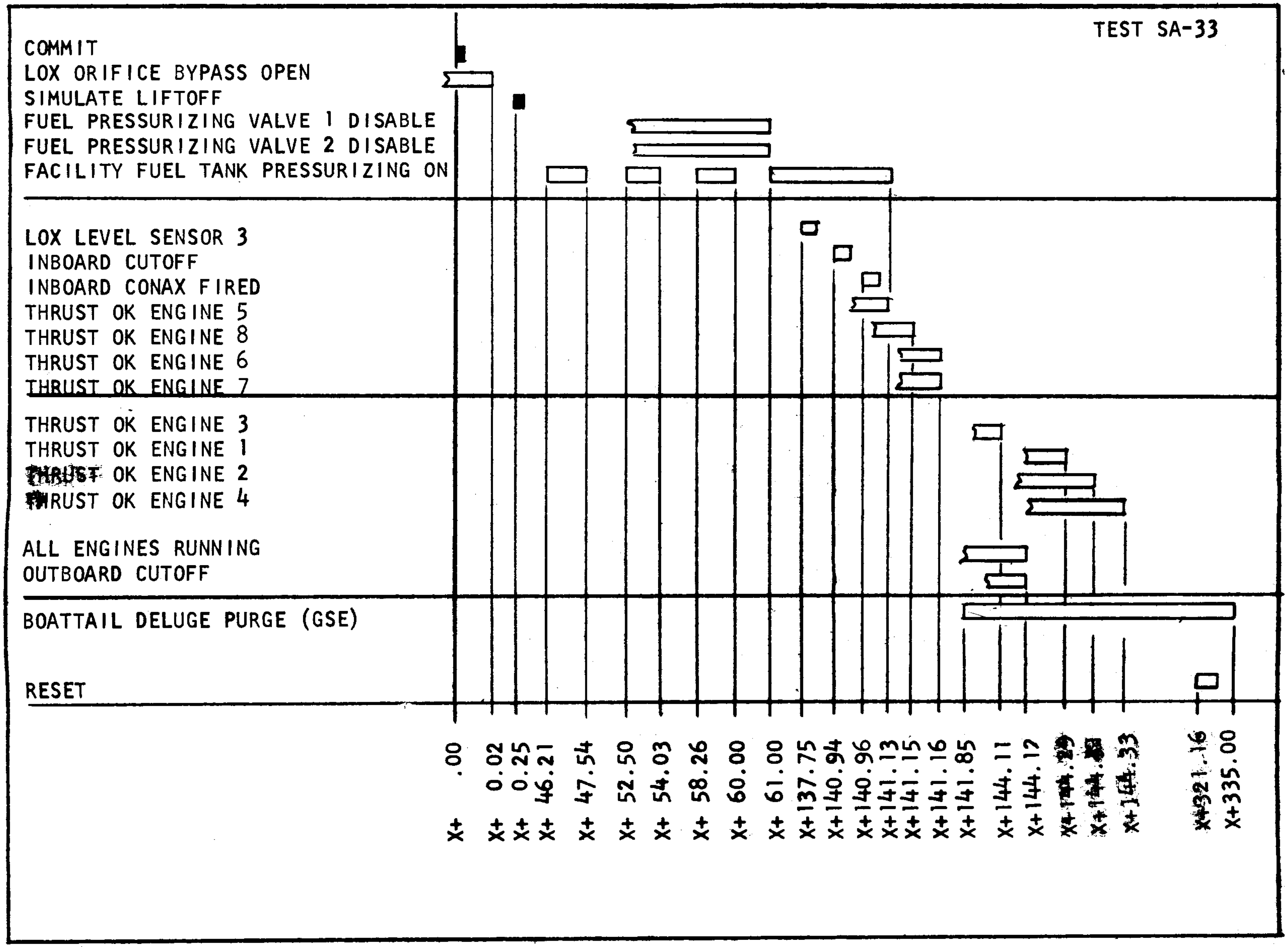
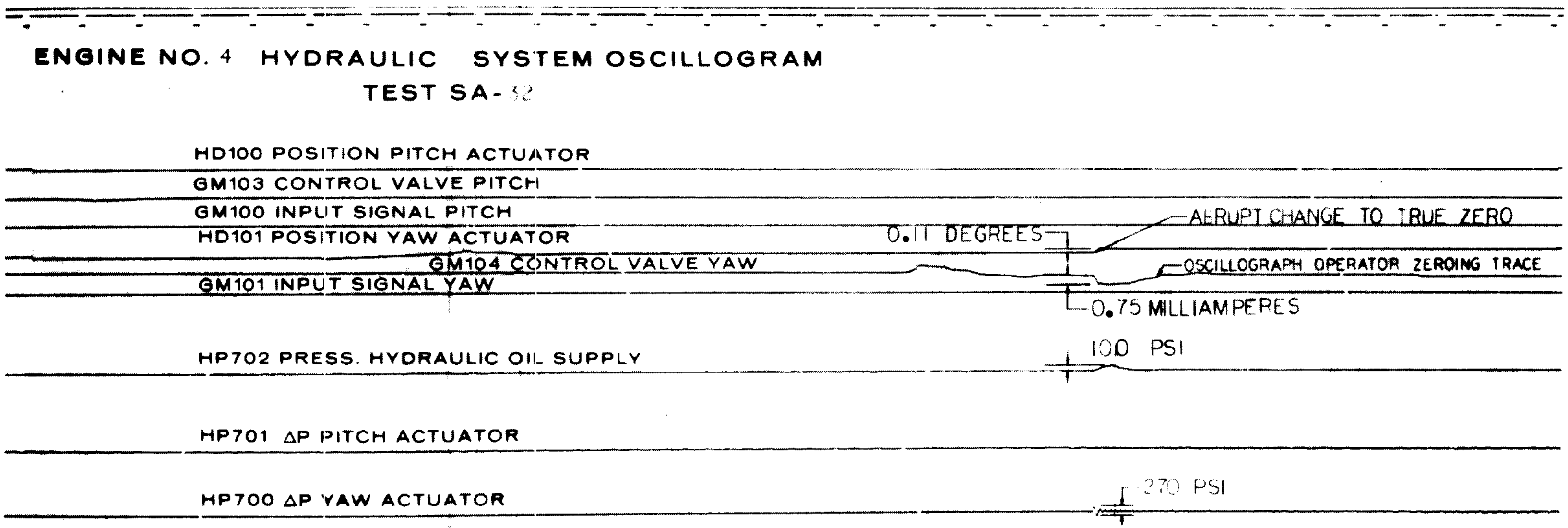
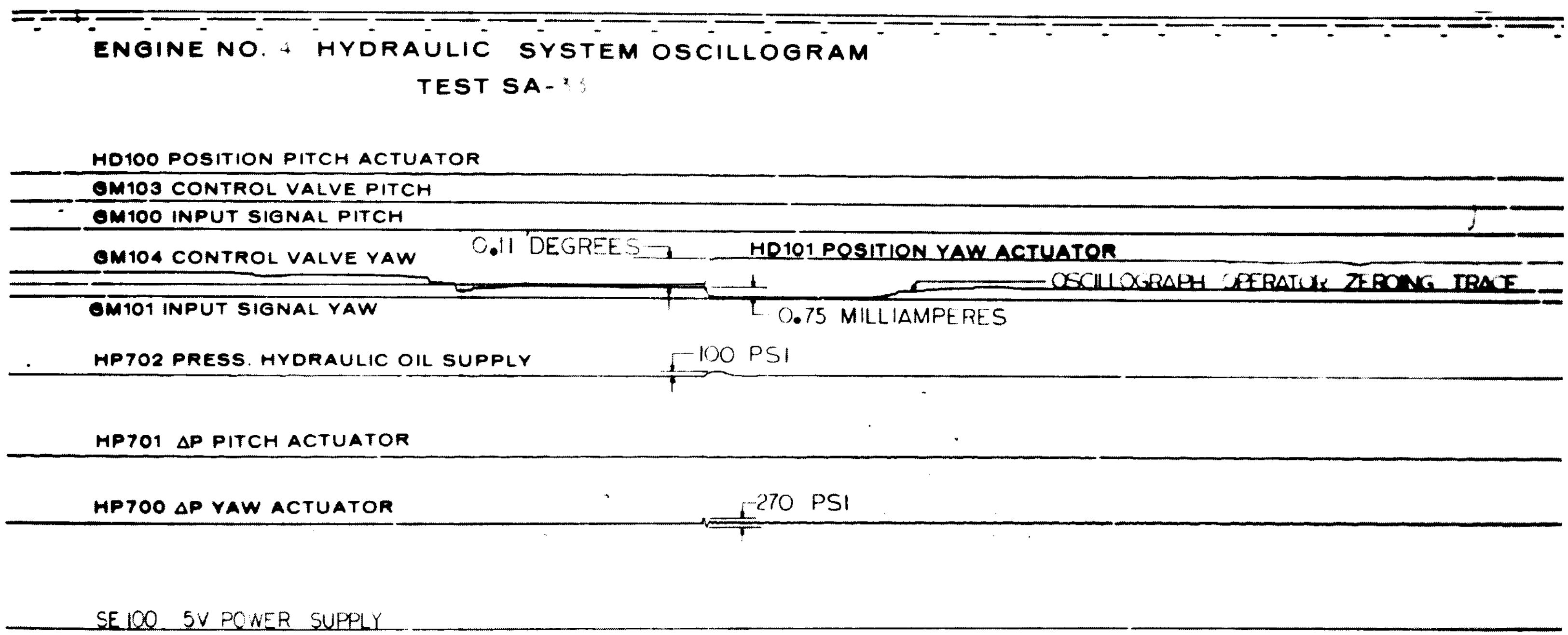


FIGURE 7-3. COMMIT TO RESET



GRAPH 7-1
DEFLECTIONS IN HYDRAULIC PARAMETERS
TEST SA-32 GIMBAL CHECK



GRAPH 7-2
DEFLECTIONS IN HYDRAULIC PARAMETERS
TEST SA-33 GIMBAL CHECK

SECTION 8

TELEMETRY SYSTEMS

Flight instrumentation requirements for stage S-IB-4 are specified on drawing 60C50008, Instrumentation Program and Components List. A Measurements Data Flow Chart is shown in FIGURE 8-1. The primary purpose of operating the telemetry (T/M) system during static test is to verify the proper operation of the flight T/M components in a simulated flight environment prior to launch. During static test, signals from the various flight transducers and simulated signals are transmitted via RF links from the static test tower antennas to the Chrysler T/M Ground Station.

The status of flight transducers during static test of S-IB-4 is shown below:

	HARDWIRED	SIMULATED	ACTIVE	TOTAL
SA-32	58	65	301	424
SA-33	56	65	303	424

The hardwired measurements are required for acceptance test data evaluation and redline monitoring. Sixty-five transducers, which were removed or not installed, were simulated by utilizing a constant signal for checkout of the telemeter system. The remainder of the stage measurements were in flight condition for static test.

Results from tests SA-32 and SA-33 indicate that the overall function of the T/M systems was satisfactory. The percentage of T/M system instrumentation discrepancies is shown in TABLE 8-1. Discrepancies in the flight measurements and simulated measurements are itemized in TABLES 8-2 and 8-3, respectively.

A significant number of parameters were measured independently by T/M and hardwire. Comparisons of T/M and hardwire measurement values from test SA-33, taken at simulated lift-off plus 30 seconds for a slice time of 1 second, are shown in TABLES 8-4, 8-5, and 8-6.

PRESTATIC TEST TELEMETRY OPERATIONS

1. Calibration of the Telemetry-Airborne DDAS. The verification of the accuracy of the Telemetry-Airborne DDAS was performed through the use of the RCA 110 computer located in the blockhouse. Satisfactory results were obtained.

2. Initial Status of Measurements. Upon initial application of power to stage S-IB-4 at the static test tower, an automated scan of flight measurements was performed through the DDAS to determine the initial status of flight instrumentation. Since all measurements do not appear on the DDAS link, a measurement scan was also performed on single sideband type measurements. The initial scan revealed that 46.9 percent of the measurements were in the NO-GO condition. The apparent high percentage of NO-GO measurements can be attributed to two factors. Simulators had not been installed, and documentation used to test the vehicle was updated through Engineering Order 69 to drawing 60C50008 while the vehicle configuration had only been updated through Engineering Order 61.

3. T/M Package RF Power Measurements. Prior to test SA-32, the frequency of the F2 RF assembly (P/N 50C12196-9, S/N 002) was found to drift. This RF assembly was replaced with P/N 50C12196-9, S/N 001. The RF power radiated by each of the telemetry packages was measured. Frequency measurements were made of the RF power radiated from the major telemetry packages. These frequency values were within tolerance. Prior to test SA-32, all subcarrier oscillators of the telemetry packages were monitored and were found to be within tolerance.

4. Pl Multiplexer. Fourteen telemeter channels to the Pl multiplexer have no assigned measurements. These channels are wired to open-circuit terminals in a measurement distributor. The 100K ohm load resistors for these channels, located on a submultiplexer card in the Pl multiplexer, have been removed.

The open-circuit input and unloaded conditions generated approximately 2 volts of noise prior to PCM transfer on channels P1B0-07-01, P1B0-07-06, P1B0-08-10, and P1B0-09-10.

5. Special Tests. In conjunction with proposed procedures that intended to minimize onboard adjustments of measurements with DC amplifiers, a drift study of DC amplifiers was conducted at Static Test on stage S-IB-4. This drift study was conducted for fifteen consecutive days on all measurements with DC amplifiers, with a tolerance of 1 percent in the Hi-Cal mode. A computer scan over the DDAS loop was performed daily (at about 10:00 a.m.). Measurements that exceeded the 1 percent tolerance at any time were flagged NO-GO and

these measurements are tabulated in TABLE 8-7. It was found that 17 measurements out of a possible total of 101 were marginal at this 1 percent tolerance. These measurements appeared to drift very slightly with a change in ambient temperature. On cold days the measurements produced lower output than on warmer days. An approximate 0.4 percent drift occurred with a 20°F change in ambient temperature. Of the 17 measurements, 2 exhibited poor Lo-Cal characteristics, and these 2 amplifiers were replaced at Static Test.

It was observed that with the new Static Test tolerances of 2 percent in Hi-Cal and 3 percent in Lo-Cal, four of the 101 measurements would have been NO-GO.

It is concluded that negligible drift occurs on the DC amplifiers of stage S-IB-4. The planned method of operation at Static Test will be to monitor all 1 percent tolerance NO-GO measurements for drift for a period of two weeks and to replace amplifiers if they drift beyond the 2 percent tolerance limit. The only amplifiers to be adjusted will be the ones on a small number of critical measurements where accuracy is of prime concern. All adjustments will be to a 0 percent error.

To implement the new philosophy of making no adjustments to DC amplifiers on board the vehicle, an increase in spare amplifiers in logistic spares will be required at Static Test.

6. Tape Recorder Assembly 13A479. The tape recorder records information from the F1 and F2 telemeter packages commencing with step 5 of the switch selector (simulated lift-off plus 39.2 seconds) until 26 seconds after the separation prestart S-IB to S-IVB signal. At that time, a command from the 26-second timer starts the tape recorder playback function. The tape recorder plays back until step 14 of the switch selector.

Evaluation of the static firing data from tests SA-30 and SA-31 revealed that an approximate 200-millisecond dropout of information occurred on approximately 80 percent of the PAM type measurements on both F1 and F2 telemetry systems and on PCM telemetry. This dropout occurred at step 5 of the switch selector (tape recorder starts to record). (Reference: "Preliminary Static Test Report, Test SA-31", Telemetry Section, paragraph 5 of Static Test Telemetry Operations.) Investigation prior to test SA-32 revealed that a dropout of PCM telemetry occurred for about 200 milliseconds during the sequence test. This dropout occurred at tape recorder start to record command.

An intensive investigation revealed that a negative spike in excess of 100 volts occurred at record command on pin S, plug J1, on the tape recorder. The circuit involved is shown in FIGURE 8-2. Relay K15, located in distributor 12A26, provides the ready-to-record indication. At record command the relay is deenergized. No suppression diode was installed across the relay coil. Diode CR1 of the control logic module in the tape recorder will not function as a suppression diode. Since no suppression is available, a large negative transient is generated in the relay coil at record command. It is believed that the transient in the vicinity of sensitive telemetry synchronization circuits is the cause of the loss in data for about 200 milliseconds.

For tests SA-32, and SA-33, a suppression diode was installed through the use of a cable across relay K15. The PCM dropout problem did not occur with the diode installed.

Since this transient was suppressed by this method, any one of three alternate methods of suppression is proposed:

a. Install a suppression diode across the coil of K15 inside the distributor 12A26 as shown in FIGURE 8-2.

b. Require the tape recorder vendor to change diode CR1 to a zener diode of about 30 volts.

c. Remove the relay K15 and reconnect pins of J1 on the tape recorder directly to the tape recorder ready indication in the telemetry system.

7. Flight Measurement Status Prior to Tests SA-32 and SA-33. All flight measurements were accepted for static firing with the exception of those measurements shown in TABLE 8-8.

STATIC TEST TELEMETRY OPERATIONS

1. Turbine RPM Measurements T12-1 Through T12-8. During test SA-32, unrealistic data were received from all turbine rpm measurements with the exception of T12-4. During test SA-33, data were again unrealistic from all turbine rpm measurements with the exception of T12-4 and T12-6. The values from these two measurements compared favorably with the hardwire values and are shown in TABLE 8-5.

Following test SA-32 an extensive investigation was conducted to determine the reliability of the turbine rpm instrumentation. No problem was found with flight turbine rpm measurements.

At static test, the flight turbine tachometers are paralleled with hardwire instrumentation. Approximately 200 feet of cable connect the turbine tachometers and the hardwire line isolation amplifiers which are located on the $1\frac{1}{2}$ level of the test tower.

Prior to test SA-33, the line isolation amplifier for hardwire measurement *PR100-6 (T12-6) was relocated to the $3\frac{1}{2}$ level of the test tower. This reduced the cable between the tachometer and line isolator from 200 feet to approximately 30 feet. Good data were received from measurement T12-6 during test SA-33.

On previous tests when the hardwire line isolation amplifiers were located near the turbine tachometers, good data were received over the RF telemetry loop from all turbine measurements. This indicates that the bad turbine measurements are related to the long leads between the flight tachometers and the line isolation amplifiers. For stage S-IB-5, two fixes are being proposed. On four of the engines, the cable length between the engines and the line isolation amplifier will be shortened from 200 feet to 25 feet. On the other four engines, a phase shift capacitor will be added in parallel with the existing 200 foot cable to reduce the effect of harmonics now present in the system.

2. Combustion Chamber Pressure, Measurements D1-1 Through D1-8. Telemetry combustion chamber pressure measurements were calibrated by means of the DDAS. Chamber pressure measurements *PP103-1 through *PP103-8 were transmitted over a hardwire loop to the blockhouse. A comparison of these two measurements is shown in TABLE 8-6. Telemetered chamber pressure data were satisfactory.

3. Tape Recorder Assembly 13A479. During test SA-33, the tape recorder recorded 131.98 seconds of information. The playback function started 25.78 seconds after the separation prestart S-IB to S-IVB signal, which occurred 7.60 seconds after the LOX low level sensor (K16-04) was energized. The tape recorder operated satisfactorily, and good data were obtained.

4. Vibration, Thrust Chamber Dome. As part of the continuous investigation of the vibration thrust chamber dome measurements, an investigation of the response of measurements E33-1, E33-3, E33-5, and E33-7 was continued on stage S-IB-4. Prior to test SA-32, the measurements were arranged into the configuration shown below:

Measurement	Configuration
E33-1, E33-5	Glennite flight transducer removed and replaced by transducer CEC P/N 4-280-0105
E33-3, E33-7	Glennite flight transducer

The response of these measurements was similar to that reported in previous tests. The Glennite flight transducers produced data that appeared high and unrealistic, while the CEC transducers produced an output of about 2 volts peak to peak and appears realistic. An Engineering Order, not yet incorporated on this vehicle, requires that the Glennite transducers be replaced by CEC type transducers for these particular measurements.

5. Pulse Detector. Prior to static test SA-32, the pulse detector was found to generate random pulses. The pulse detector was readjusted in accordance with Michoud engineering design procedures. During test SA-32, the pulse detector generated one random pulse approximately two seconds prior to engine cutoff.

Post test investigation revealed that random pulses will be generated due to noise of transients in the +28 volt power being fed to the detector when the trigger pulse is adjusted to 2 volts peak between terminals J1 and J2. However, when the sensitivity of the detector is readjusted to a level where the pulse detector rejects the noise and transients, the detector will not respond to the outboard engine cutoff signal (reference UCR 02944).

It is believed that the pulse detector design is weak, and it is recommended that the associated circuitry be redesigned to achieve a more reliable operation of this system.

6. Level Sensor Settings and Indications. During the long duration static firing, the low level cutoff sensors in the LOX and fuel tanks operated satisfactorily. The propellant heights at the time the low level sensor actuated in each tank (as indicated by the continuous level probes) are shown below for detanking following the propellant loading test and test SA-32, and during test SA-33.

TANK	CONTINUOUS LEVEL PROBE HEIGHTS (INCHES)		
	PROPELLANT LOADING TEST	TEST SA-32	TEST SA-33
O2	18.4	14.4	14.8
O4	△1	12.8 △2	16.4
F2	20.4	20.8	20.7
F4	20.0	20.0	△3

△1 Low level cutoff sensor defective, replaced prior to test SA-32.
△2 Low level cutoff sensor defective, replaced prior to test SA-33.
△3 Defective continuous level measurement L44-F4 (reference TABLE 8-2).

The actual location of the LOX level cutoff sensors is 14.06 inches above the zero position of the continuous level probe, and fuel level sensors are 20.96 inches above the zero position in the fuel tanks (reference FIGURES 4-1 and 4-3 in the PROPELLANT AND PNEUMATIC SYSTEMS section of this report).

Since the height of the cutoff sensors is nominal, it is concluded that all sensors operated properly.

7. Continuous Liquid Level Measurements. Measurement L44-F4, continuous liquid level in fuel tank F-4, failed during test SA-33. Investigation revealed that the associated adapter had malfunctioned.

A review of the history of the continuous level adapters aboard stage S-IB-4 during static testing reveals an excessive failure rate. The S-IB-4 adapters that malfunctioned at Static Test are shown as follows:

	ADAPTER		
MEAS.	PART NUMBER	SERIAL NUMBER	STATIC TEST UCR
L47-02	50C10699	48	02918
L49-04	50C10699	49	02937
L48-03	50C10699	27	02938
L49-04	50C10699	14	02945
L44-F4	50C10699	9	02964

A total of nine adapters are required aboard stage S-IB-4, and five of these adapters malfunctioned. This is believed to be an excessive rate of failure. It is recommended that an investigation be conducted to determine if improved design, manufacture, or quality control can improve the reliability of the liquid level adapters.

8. Command Destruct Receivers. During static test SA-33, the following EBW measurements did not respond to interrogation at simulated lift-off +102 seconds:

MEASUREMENT	TITLE
VK134-11	EBW Pulse Sensor Indication Destruct No. 1
VK135-11	EBW Pulse Sensor Indication Destruct No. 2
M63-11	Destruct EBW Voltage No. 1
M64-11	Destruct EBW Voltage No. 2

All EBW and destruct measurements were found to operate properly during simulated flight tests at Static Test. It is believed that the above measurements are not discrepant even though they failed during the static firing. An investigation failed to show the cause for this malfunction. It is suspected that this malfunction was the result of a mispositioned switch in the ground support equipment.

9. Vibration Pitch and Yaw Actuator Measurements E271-4 Through E276-4. Data on the following vibration measurements were questionable for tests SA-32 and SA-33:

MEASUREMENT	TITLE
E271-4	Vibration Pitch Actuator, Pitch
E272-4	Vibration Pitch Actuator, Yaw
E273-4	Vibration Pitch Actuator, Longitudinal
E274-4	Vibration Yaw Actuator, Pitch
E275-4	Vibration Yaw Actuator, Yaw
E276-4	Vibration Yaw Actuator, Longitudinal

Investigation following test SA-33 revealed crosstalk between measurements E271-4, E272-4, and E273-4 and between measurements E274-4, E275-4, and E276-4. One of the three measurements was placed in the Hi-Cal mode, and its output monitored. At this time, a second measurement was also placed in Hi-Cal. The first measurement was observed to increase its output when the second measurement was placed in Hi-Cal. This crosstalk phenomenon was observed between each of both groups of three measurements.

Further investigation revealed that each of the transducers and the associated emitter followers were electrically interconnected with safety wire. Both groups of three measurements were safety wired in a similar manner causing similar crosstalk. When the safety wire was removed, the crosstalk cleared up.

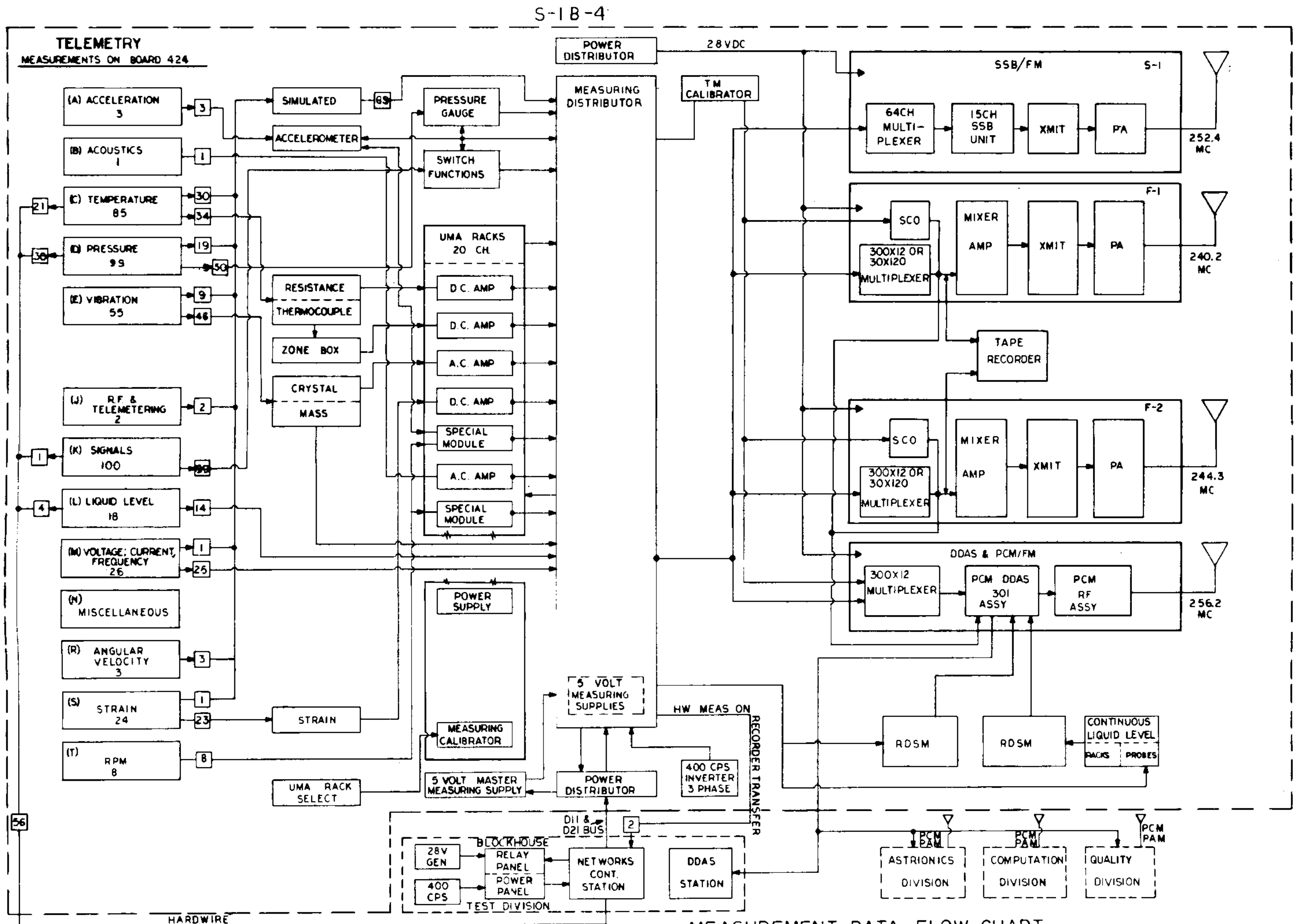
It is recommended that Manufacturing, Checkout, and Quality Control personnel be notified of the resulting crosstalk when these insulated transducers and emitter followers are safety wired together (reference UCR 02961).

10. Measuring Rack 12A440. No data were obtained from sixteen measurements located in universal measuring adapter 12A440 during test SA-33. Post static test investigation revealed that cable 12W46-P2 (between UMA rack 12A440 and distributor 12A26) had been disconnected during prestatic test checkout and had not been reconnected. These measurements are itemized in TABLE 8-9.

11. <u>T/M Package RF Power Measurements</u>. Following test SA-33, the RF power radiated by each of the telemetry packages was measured. All values measured were within tolerance. Frequency measurements were made of the RF radiated from the major telemetry packages. These frequency values were within tolerance. All subcarrier oscillators of the telemetry packages were monitored, and minor preemphasis adjustments made where required. Preemphasis and frequency status of all subcarrier oscillators were within tolerance.

12. <u>Remote Digital Submultiplexer 9A700</u>. Prior to test SA-33, the remote digital submultiplexer, P/N 50C12088-5, S/N 006, failed to operate properly (reference UCR 02957) and was replaced with P/N 50C12088-3, S/N 009. The remote digital submultiplexer S/N 009 operated satisfactorily during test SA-33.

13. <u>Measurements that Exceeded Their Operational Range</u>. TABLE 8-10 shows five measurements that exceeded their operational range during static test SA-32 and two measurements that exceeded their operational range during static test SA-33. Except for the excessive operating range, the measurements appeared satisfactory and are not considered discrepant.



MEASUREMENT DATA FLOW CHART

FIGURE 8-1

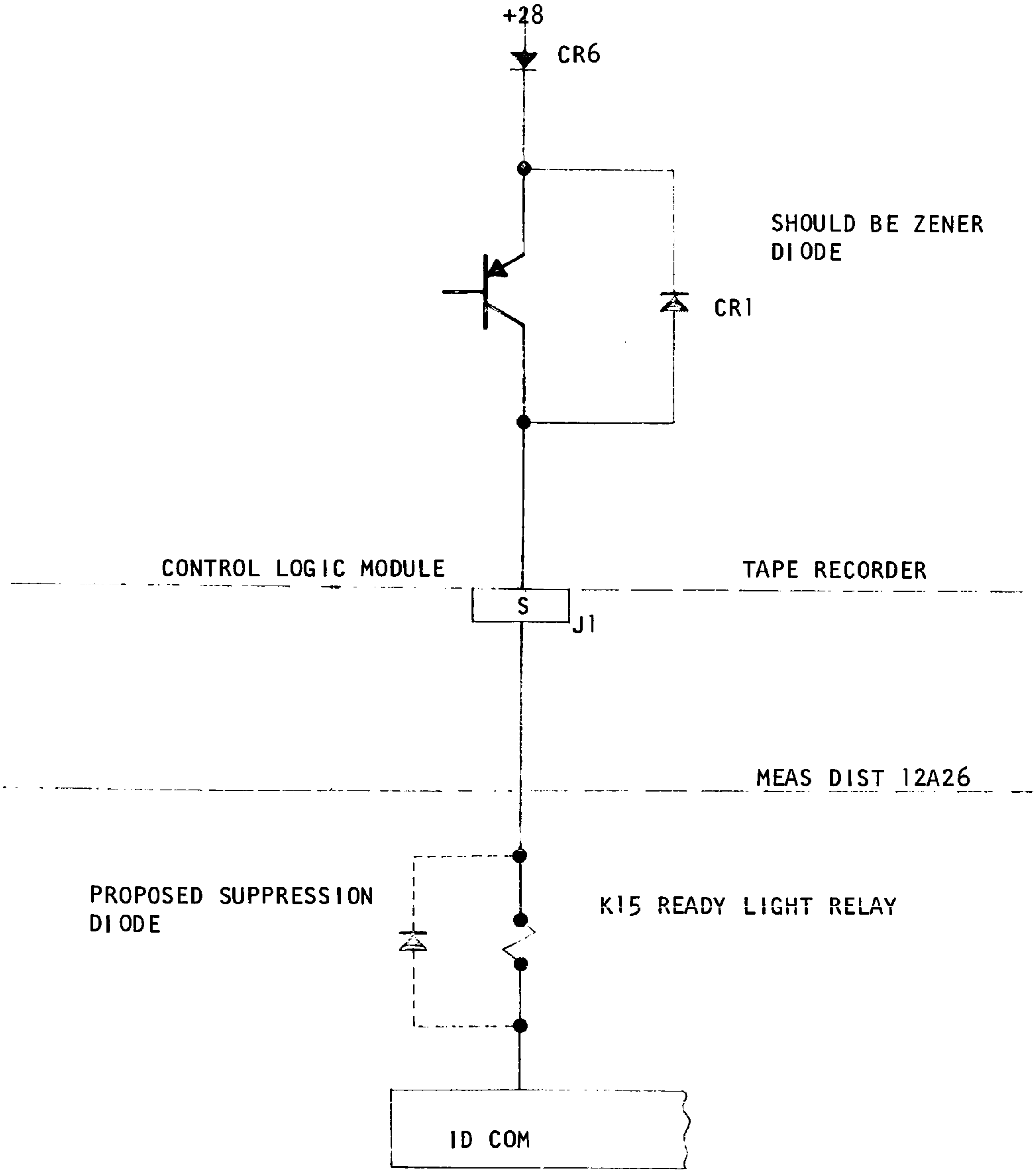


FIGURE 8-2

TAPE RECORDER-RECORD COMMAND
CIRCUITRY

TABLE 8-1

PERCENTAGE OF TELEMETRY SYSTEM INSTRUMENTATION DISCREPANCIES

	TEST SA-30	TEST SA-31	TEST SA-32	TEST SA-33
Active Flight Measurements...........	350	354	301	303
Discrepant Measurements.........	6	9	16	12
Percent Failure.................	1.71%	2.54%	5.32%	3.96%
Simulated Measurements...............	176	174	123	121
Discrepant Measurements.........	5	2	0	1
Percent Failure.................	2.84%	1.15%	0.0%	0.83%
Total Measurements..................	526	526	424	424
Total Discrepant Measurements...	11	11	16	13
Total Percent Failure...........	2.09	2.09%	3.77%	3.07%

TABLE 8-2

FLIGHT MEASUREMENT DISCREPANCIES

The telemeter data received from test SA-32 and SA-33 were not considered satisfactory for the following flight measurements:

MEASUREMENT NUMBER TELEMETER CHANNEL MEASUREMENT NAME	DISCREPANCY
C9-1 F2A2-06-05 Temperature Gas Generator Chamber (SA-33)	No data; read zero. Post static checks revealed faulty transducer.
C54-8 P1B0-05-08 Temperature LOX Pump Inlet (SA-32)	Data bad; read 5 volts throughout firing. Transducer replaced.
C267-9 F2A2-09-09 Temperature Skin, Tail Section (SA-33)	No data; read zero until lift-off plus 80 seconds then drops to -0.1 volt. Post static checks revealed bonding between thermocouple and skin broken.
D34-7 P1B0-03-07 Pressure GG Fuel Injector (SA-33)	Data questionable; became noisy at lift-off +27 seconds and remained noisy until lift-off +94 seconds. Cause undetermined. Checked good after firing.
D502-9 S1-12E02 Vibration Engine Thrust Beam, Longitudinal (SA-33)	No data; read zero volts. Post static checks revealed bad cable between emitter follower and accelerometer.
E11-6 S1-01D03 Vibration Thrust Chamber Dome, Lateral (SA-32 and SA-33)	Data bad; extremely noisy. Measurement checked good during post static checks. UCR 02965 has been written requesting removal of the measurement at Michoud for bench investigation.

TABLE 8-2 (CONTINUED)

MEASUREMENT NUMBER TELEMETER CHANNEL MEASUREMENT NAME	DISCREPANCY
E33-3 S1-02D02 Vibration Thrust Chamber Dome, Longitudinal (SA-32 and SA-33)	Data unrealistic; exceeded range.
E33-7 S1-02D04 Vibration Thrust Chamber Dome, Longitudinal (SA-32 and SA-33)	Data unrealistic; exceeded range.
E276-4 S1-08D04 Vibration Yaw Actuator, Longitudinal (SA-32)	No data; read zero volts. Checked good after firing. Cause undetermined.
E502-9 S1-12E02 Vibration Engine Thrust Beam, Longitudinal (SA-32)	No data; read zero volts. Checked good after firing. Possible moisture problem.
E504-11 S1-08D01 Vibration Spider Beam, Longitudinal (SA-32)	Switching transients in run condition. Vibration level high. Post static check revealed bias set at approximately 4.5 volts instead of 2.5 volts.
E505-11 S1-11E02 Vibration Spider Beam, Perpendicular (SA-32)	Switching transients in run condition. Exceeded range. Post static checks revealed bias set at approximately 4.5 volts instead of 2.5 volts.
K3-12, K67-12 F1A1-07-06 Cutoff Signal Outboard Cutoff Signal Inboard (SA-32)	Had an erroneous pulse 2 seconds prior to cutoff.

TABLE 8-2 (CONTINUED)

MEASUREMENT NUMBER TELEMETER CHANNEL MEASUREMENT NAME	DISCREPANCY
L19-0C F1A1-23 LOX Level Discrete (SA-33)	Data good; pulses 8, 10, 11, and 12 noisy. Solar cells checked good after firing. Cause undetermined.
L19-03 F1A1-16 LOX Level Discrete (SA-32)	No data from probe 3. Operation of probe 3 occurred during an inflight calibration and the measurement is not considered discrepant.
L44-F4 P1B0-06-04 Fuel Level Continuous (SA-33)	No data. Post static checks revealed faulty adapter.
M63-11 F1A1-0505 Destruct EBW Voltage 1 (SA-33)	Did not operate. Checked good after firing. Cause undetermined.
M64-11 F1A1-07-05 Destruct EBW Voltage 2 (SA-33)	Did not operate. Checked good after firing. Cause undetermined.
T12-1 F1-15 Turbine RPM (SA-32 and SA-33)	Data bad. Landline interference.
T12-2 F2-11 Turbine RPM (SA-32 and SA-33)	Data bad. Landline interference.
T12-3 F1-09 Turbine RPM (SA-32 and SA-33)	Data bad. Landline interference.

TABLE 8-2 (CONTINUED)

MEASUREMENT NUMBER TELEMETER CHANNEL MEASUREMENT NAME	DISCREPANCY
T12-5 F1-10 Turbine RPM (SA-32 and SA-33)	Data bad. Landline interference.
T12-6 F2-08 Turbine RPM (SA-32)	Data bad. Landline interference.
T12-7 F1-11 Turbine RPM (SA-32 and SA-33)	Data bad. Landline interference.
T12-8 F2-15 Turbine RPM (SA-32 and SA-33)	Data bad. Landline interference.
VK94-9 P1B0-13R03-06 LOX Prevalve 4 Closed Indication (SA-33)	Did not operate. Checked good after firing. Cause undetermined.
VK134-11 P1B0-13R10-08 EBW Pulse Sensor Indication, Destruct 1 (SA-33)	Did not operate. Checked good after firing. Cause undetermined.
VK135-11 P1B0-13R10-09 EBW Pulse Sensor Indication, Destruct 2 (SA-33)	Did not operate. Checked good after firing. Cause undetermined.
UMA Rack 12A440 (SA-33)	The sixteen measurements listed in TABLE 8-9 of this report, did not depict good data during test SA-33. Cable 12W46-P2 between UMA rack 12A440 and distributor 12A26 was not connected for this test.

TABLE 8-3

SIMULATED MEASUREMENT DISCREPANCIES

The telemeter data received from test SA-32 and SA-33 were not considered satisfactory for the following simulated measurements:

MEASUREMENT NUMBER TELEMETER CHANNEL MEASUREMENT NAME	DISCREPANCY
C1-4 P1B0-01-04 Temperature LOX Pump Bearing 1 (SA-33)	Data good until L/O +118 seconds. Then data became noisy and remained noisy until inboard cutoff. Checked good after firing. Cause undetermined.

TABLE 8-4

COMPARISON OF TELEMETERED VS HARDWIRE MEASUREMENTS

$$\text{PERCENT DIFFERENCE} = \frac{HW - TM}{HW} \cdot 100$$

HARDWIRE NUMBER	MEASURED VALUE [1]	FLIGHT NUMBER	MEASURED VALUE	PERCENT DIFFERENCE
CP102-9	2454 psia	D40-9	2450 psia	0.16
CP100-9	768 psia	D41-9	775 psia	-0.91
FP101-F3	22.4 psia	D2-F3	22.0 psia	1.79
LP102-OC	52.0 psia	D3-OC	52.0 psia	0.00
PP100-1	700 psia [2]	D34-1	728 psia	-4.00
PP100-2	770 psia [2]	D34-2	759 psia	1.43
PP100-3	740 psia [2]	D34-3	740 psia	0.00
PP100-4	725 psia [2]	D34-4	720 psia	0.69
PP100-5	710 psia [2]	D34-5	714 psia	-0.56
PP100-6	710 psia [2]	D34-6	735 psia	-3.52
PP100-7	750 psia [2]	D34-7	688 psia	8.27
PP100-8	755 psia	D34-8	730 psia	3.31
PP113-1	37.5 psia	D12-1	37.0 psia	1.35
PP113-2	39.0 psia	D12-2	37.0 psia	5.13
PP113-3	38.9 psia	D12-3	38.0 psia	2.37
PP113-4	38.7 psia	D12-4	38.7 psia	0.00

[1] All hardwire values are digital unless otherwise specified.
[2] Oscillograph value.

TABLE 8-4 (CONTINUED)

HARDWIRE NUMBER	MEASURED VALUE (1)	FLIGHT NUMBER	MEASURED VALUE	PERCENT DIFFERENCE
PP114-1	66.9 psia	D13-1	65.8 psia	1.64
PP114-2	66.8 psia	D13-2	63.9 psia	4.34
PP114-3	66.7 psia	D13-3	65.8 psia	1.35
PP114-4	(2)	D13-4	66.9 psia	—
PP115-1	143.5 psia (3)	D20-1	140.8 psia	1.88
PP115-2	130.5 psia (3)	D20-2	126.9 psia	2.76
PP115-3	121.5 psia (3)	D20-3	117.7 psia	3.13
PP115-4	117.5 psia (3)	D20-4	116.4 psia	0.94
HP702-1	3194 psia (4)	D29-1	3155 psia	1.22
HP702-2	3235 psia (4)	D29-2	3235 psia	0.00
PT102-1	1229 °F	C9-1	(2)	—
PT102-2	1239 °F	C9-2	1234 °F	0.40
PT102-3	1257 °F	C9-3	1234 °F	1.83
PT102-4	1209 °F	C9-4	1184 °F	2.07
PT102-5	1229 °F	C9-5	1184 °F	3.66
PT102-6	1299 °F	C9-6	1220 °F	6.08
PT102-7	1279 °F	C9-7	1202 °F	6.02
PT102-8	1294 °F	C9-8	1202 °F	7.11

(1) All values are digital unless otherwise specified.
(2) Measurement discrepant.
(3) Strip chart value.
(4) Oscillograph value.

TABLE 8-4 (CONTINUED)

HARDWIRE NUMBER	MEASURED VALUE [1]	FLIGHT NUMBER	MEASURED VALUE	PERCENT DIFFERENCE
PT107-1	-293.00 °F [2]	C54-1	-293.26 °F	-0.09
PT107-2	-293.35 °F	C54-2	-294.56 °F	-0.41
PT107-3	-294.01 °F	C54-3	-294.16 °F	-0.05
PT107-4	-293.50 °F	C54-4	-293.89 °F	-0.13
PT107-5	-293.92 °F	C54-5	-293.98 °F	-0.02
PT107-6	-293.64 °F	C54-6	-293.58 °F	0.02
PT107-7	-293.76 °F	C54-7	-293.87 °F	-0.04
PT107-8	-293.63 °F	C54-8	-294.48 °F	-0.29

[1] All hardwire values are digital unless otherwise specified.
[2] Strip chart value.

TABLE 8-5

COMPARISON OF T/M AND HARDWIRE TURBINE RPM VALUES

TEST SA-33

HARDWIRE NUMBER	MEASURED VALUE ⚠1	FLIGHT NUMBER	MEASURED VALUE	RPM DIFFERENCE
*PR100-1	32,910	T12-1	39,384 ⚠2	-
*PR100-2	33,237	T12-2	63,327 ⚠2	-
*PR100-3	32,897	T12-3	65,641 ⚠2	-
*PR100-4	32,407	T12-4	32,367	40
*PR100-5	32,300	T12-5	64,483 ⚠2	-
*PR100-6	32,977	T12-6	32,894	83
*PR100-7	32,907	T12-7	57,528 ⚠2	-
*PR100-8	32,683	T12-8	52,405 ⚠2	-

⚠1 All hardwire values are digital unless otherwise specified.
⚠2 Telemeter data unrealistic. Landline interference.

TABLE 8-6

COMPARISON OF TELEMETERED AND HARDWIRED CHAMBER PRESSURE MEASUREMENTS

TEST SA-33

HARDWIRE NUMBER 1	MEASURED VALUE 2	FLIGHT NUMBER	MEASURED VALUE 2	PERCENT DIFFERENCE
*PP103-1	-	D1-1	-	-0.14
*PP103-2	-	D1-2	-	+0.75
*PP103-3	-	D1-3	-	-0.15
*PP103-4	-	D1-4	-	+4.09
*PP103-5	-	D1-5	-	+0.66
*PP103-6	-	D1-6	-	-0.71
*PP103-7	-	D1-7	-	+1.90
*PP103-8	-	D1-8	-	-2.04

1 All hardwire values are digital.

2 The actual values of combustion chamber pressures can be obtained from the "Confidential Supplement, Stage S-IB-4".

TABLE 8-7

DRIFT STUDY OF DC AMPLIFIERS - STAGE S-IB-4

MEASUREMENT NUMBER		C1-5		C1-6		C54-2		C54-2		C59-1		C61-5		C63-6	
		HI-CAL	LO-CAL	HI-CAL	LO-CAL	HI-CAL	LO-CAL	HI-CAL	LO-CAL	HI-CAL	LO-CAL	HI-CAL	LO-CAL	HI-CAL	LO-CAL
CALIB. CURVE		4.189	0.559	4.190	0.559	4.059	0.425	4.037	0.271	4.129	0.454	4.159	0.514	4.049	0.429
Date, Measured Value, and Percent Drift when Tolerance was Exceeded.	12/20/65	-1.1% 4.133	0.533	4.164	0.538	4.077	0.436			-1.3% 4.062	0.426	-1.4% 4.087	0.497	4.036	0.415
	12/21/65	4.149	0.554	4.185	3.7% 0.744	4.072	4.4% 0.646			4.092	0.456	-1.4% 4.087	0.508	4.041	0.426
	12/22/65	4.154	0.554	4.190	Noisy 0.682	4.072	8.2% 0.831			4.092	0.456	-1.4% 4.087	0.508	4.036	0.426
	12/23/65	4.149	0.554	4.190	Noisy 0.708	Amplifier Removed		Amplifier Installed		4.092	0.462	-1.4% 4.087	0.508	4.046	0.431
	12/27/65	4.154	0.559	4.195	Noisy 0.595			4.015	9.5% 0.754	4.092	0.456	-1.3% 4.092	0.508	-1.1% 3.995	0.426
	12/28/65	4.154	0.559	4.195	0.559			Recalibrated 4.026	0.272	4.097	0.462	-1.3% 4.092	0.508	4.015	0.426
	12/29/65	4.154	0.559	4.190	0.559			4.015	0.287	4.097	0.456	-1.4% 4.087	0.508	4.026	0.431
	12/30/65	4.159	0.564	4.195	0.564			4.026	0.277	4.097	0.462	-1.3% 4.092	0.508	4.056	0.431
	1/3/66	4.159	0.559	4.200	0.554			4.026	0.272	4.092	0.462	-1.2% 4.097	0.508	4.046	0.431
	1/4/66	4.159	0.564	4.205	0.564			4.031	0.272	4.097	0.462	Recalibrated 4.159	0.518	4.010	0.431
	1/6/66	4.149	0.554	4.190	0.544			4.026	0.277	4.082	0.446	4.154	0.513	4.000	0.426

TABLE 8-7 (CONTINUED)

MEASUREMENT NUMBER		C180-11		C602-5		C604-5		D1-5	D1-7	M16-12	M17-12	M18-12	M500-12	M501-12	M504-9
		HI-CAL	LO-CAL	HI-CAL	LO-CAL	HI-CAL	LO-CAL	HI-CAL	HI-CAL	HI-CAL	HI-CAL	HI-CAL	HI-CAL	HI-CAL	HI-CAL
CALIB. CURVE		3.947	0.533	4.359	0.689	4.082	0.528	4.357	4.289	4.497	4.494	4.525	4.505	4.499	4.499
Date, Measured Value, and Percent Drift when Tolerance was Exceeded.	12/20/65	Negative		Negative		Negative		-1.3% 4.292	-1.2% 4.226	-1.1% 4.441	-2.2% 4.385	-1.3% 4.462	-1.6% 4.426	-2.3% 4.385	-1.9% 4.405
	12/21/65	5.082	0.533	-1.8% 4.267	0.672	-1.2% 4.021	0.518	4.308	4.241	-1.1% 4.441	-2.1% 4.390	-1.0% 4.482	-1.6% 4.426	-2.0% 4.400	-1.7% 4.415
	12/22/65	5.087	0.538	-1.5% 4.282	0.677	-1.2% 4.021	0.523	4.313	4.251	-1.0% 4.446	-2.1% 4.390	-1.0% 4.482	-1.6% 4.426	-2.0% 4.400	-1.5% 4.421
	12/23/65	Recalibrate 3.944	0.538	-1.5% 4.282	0.682	-1.2% 4.021	0.523	4.318	4.256	4.451	-2.1% 4.390	4.487	-1.6% 4.426	-1.9% 4.405	-1.5% 4.421
	12/27/65	Neg.	Neg.	-1.4% 4.287	0.682	-1.2% 4.021	0.523	4.308	4.256	4.462	-2.1% 4.390	4.497	-1.5% 4.431	-1.9% 4.405	-1.5% 4.421
	12/28/65	0.000	0.005	-1.4% 4.287	0.682	-1.2% 4.021	0.523	4.313	4.267	4.462	-2.0% 4.395	4.492	-1.5% 4.431	-1.8% 4.410	-1.4% 4.426
	12/29/65	0.000	0.000	-1.4% 4.287	0.682	-1.1% 4.026	0.523	4.313	4.256	UMA DID NOT SWITCH					-2.3% 4.385
	12/30/65	0.000	0.000	-1.4% 4.287	0.682	-1.1% 4.026	0.523	4.318	4.272	4.451	-2.0% 4.395	4.492	-1.5% 4.431	-1.8% 4.410	-1.4% 4.426
	1/3/66	0.000	0.000	-1.2% 4.297	0.687	-1.0% 4.031	0.533	4.313	4.272	4.467	-1.8% 4.400	4.523	-1.5% 4.431	-1.8% 4.410	-1.4% 4.426
	1/4/66	0.000	0.000	Recalibrate 4.359	0.697	Recalibrate 4.097	0.533	4.333	4.277	4.477	Recal. 4.492	4.513	Recal. 4.518	Recal. 4.503	Recal. 4.518
	1/6/66	0.000	0.000	4.354	0.687	4.092	0.533	4.357	4.277	4.451	4.492	4.503	4.518	4.497	4.487

TABLE 8-8

The following measurements were discrepant prior to static test and did not depict realistic data.

MEASUREMENT STATUS PRIOR TO TEST SA-32

MEASUREMENT NUMBER	REMARKS
C54-6	Amplifier Intermittent (Replacement Spare Unavailable)
S22-04	Defective Strain Gage. Simulated with a Dummy Strain Gage. (Transducer to be replaced at Michoud.)
L19-03	Pulse 13 Missing; Defective Solar Cell. (To be replaced at Michoud.)

MEASUREMENT STATUS PRIOR TO TEST SA-33

MEASUREMENT NUMBER	REMARKS
S22-04	Defective strain guage; simulated with a dummy strain gauge, transducer to be replaced at Michoud during post static checkout.
L19-03	Pulse 13 missing; defective solar cell, to be replaced at Michoud during post static checkout.
K2-12, K3-12, and K67-12	Erratic pulsing; UCR's 02928 and 02927 have been written requesting a design evaluation of the pulse detector.
K65-13 and K66-13	The 12/second sampling rate of the telemetry channel assigned to monitor the 20M/second pulse width output of these measurements is not sufficient. UCR 02933 has been written requesting a telemetry channel assignment change.
C59-1	Defective amplifier; replacement spare unavailable.

TABLE 8-9

MEASURING RACK 12A440

The following measurements located in UMA rack 12A440, did not produce meaningful data during test SA-33 as a result of a disconnected cable (12W46-P2) between UMA rack 12A440 and distributor 12A26.

MEASUREMENT NUMBER	NAME
A53-11	Acceleration, Pitch
A54-11	Acceleration, Yaw
C36-F3	Temperature Gas Top Fuel Tank
C180-11	Temperature S1/S4 Interstage Ambient
C183-11	Temperature S1/S4 Interstage Ambient
C236-11	Temperature High Pressure Spheres
E504-11	Vibration Spider Beam, Longitudinal
E505-11	Vibration Spider Beam, Perpendicular
S21-01	Strain Mounting Stud
S21-02	Strain Mounting Stud
S21-03	Strain Mounting Stud
S21-04	Strain Mounting Stud
S22-01	Strain Mounting Stud
S22-02	Strain Mounting Stud
S23-03	Strain Mounting Stud
S22-04	Strain Mounting Stud

TABLE 8-10

MEASUREMENTS THAT EXCEEDED THEIR RANGE

TEST SA-32

MEASUREMENT NUMBER AND DESCRIPTION		RANGE	READING
A54-11	Acceleration, Yaw	±0.5 g	-0.6 g +0.5 g
E167-10	Vibration Center Tank Pitch	±0.5 g	+0.6 g
E168-10	Vibration Center Tank Yaw	±0.5 g	+0.6 g
E226-11	Vibration Upper Structure, Longitudinal	±5.0 g	±5.5 g
E227-11	Vibration Upper Structure, Pitch	±5.0 g	±5.5 g

TEST SA-33

MEASUREMENT NUMBER AND DESCRIPTION		RANGE	READING
E167-10	Vibration Center Tank Pitch	±0.5 g	+0.6 g -0.5 g
E168-10	Vibration Center Tank Yaw	±0.5 g	+0.6 g -0.5 g

SECTION 9

CONCLUSIONS

Based on the preliminary analysis of the results of tests SA-32 and SA-33 and the post test hardware inspection, the following conclusions are presented:

All stage systems performed satisfactorily during tests SA-32 and SA-33 with the exception of engine 3 hydraulic system during test SA-33.

There was no evidence of LOX pump seal leakage during engine start as verified by drain line temperatures.

The engine aspirator lip erosion which occurred during test SA-33 and on stage S-IB-3 static tests was caused by hot gases, flowing from the aspirator chamber drain screw access port, being diverted by engine calorimeter support brackets onto the aspirator lip. The calorimeters should not be installed in this area on future stages.

An abnormally high number of engine hydraulic system failures occurred on stage S-IB-4 at Static Test. They are listed below in chronological order.

1. The hydraulic system of engine 1 was replaced in its entirety because of gross contamination found when verifying gas leakage into the oil system.

2. The hydraulic package assembly was replaced on engine 4 because of a recurrent open circuit in the oil level potentiometer.

3. Leakage occurred past the low pressure reservoir piston on engine 1 on L-1 day necessitating locking this engine in null for the test SA-32 attempt on January 14.

4. On January 14, during the gimbal system functional test at X-10 minutes, it was found that engine 3 could not be controlled in the yaw plane. The beta (feedback) potentiometer in the yaw actuator was found to have excessive resistance between the wiper and the center tap. Test SA-32 was rescheduled for January 17.

On January 15, engine 1 hydraulic package and engine 3 yaw actuator were replaced, and the systems were filled and cleaned in preparation for the test on January 17. Test SA-32 was conducted with no further hydraulic system problems.

5. During the firing day functional checks for test SA-33, the engine 3 hydraulic system was found to be grossly contaminated while verifying GN_2 leakage into the high-pressure oil cavity. The main hydraulic pump was removed from engine 3 and the actuators locked in the null position for test SA-33.

The GN_2 precharge leakage into the high-pressure oil cavities and the oil sample contamination at engine 3 are believed to be identical to the problem experienced by the hydraulic package assembly at engine 1 prior to test SA-32. Investigation of the engine 1 hydraulic package revealed that leakage had occurred past the static seal which is located between the accumulator sleeve and housing.

The contamination noted in the engine 1 and engine 3 hydraulic package assembly was found to be caused by the introduction of metallic particles to the system by the Vickers auxiliary pump, by normal accumulator piston O-ring wear, and by MIL-I-8660 lubricant used when installing the accumulator piston into the sleeve.

From LOX bubbling test data it is concluded that:

1. The reduction in LOX pump inlet temperature is greater when the ullage is vented during bubbling.

2. There was little difference in LOX pump inlet temperature when the helium bubbling flowrate was varied between 30 and 45 scfm.

Results of the overboard LOX dump tests show that if the ground system is redesigned to provide a lower pressure drop, equal flow capacity could be achieved using two fill and drain valves instead of the present four valves.

The gimbal boot damage at engine 3 during test SA-32 is a result of prior refurbishment of this boot by the application of an aluminized coating with a flammable base adhesive.

Low engine compartment temperatures experienced during tests SA-32 and SA-33 were the result of low ambient temperature and reduced flow of conditioned air through this area. The reduced flow is the result of improved sealing of the boattail area when the inboard turbine exhaust ducts were rerouted through the heat shield.

At tape recorder start-to-record command, a 200 millisecond drop-out of telemetry information occurred. This was caused by a large negative transient generated by relay K15 in distributor 12A26. Suppression of this transient eliminates the data loss.

A drift study was conducted on measurements utilizing DC amplifiers in conjunction with proposals to minimize onboard adjustments of these measurements. Negligible drift occurs on the DC amplifiers. The method of operation at Static Test will consist of a monitor of NO-GO measurements for drift, and replacement of amplifiers if they are drifting. An increase of spare amplifiers in logistics spares will be required for implementation of this proposed method of operation.

Investigation of invalid telemetry turbine rpm data for both static firings revealed that the cause of the data loss was related to the long leads between the flight turbine tachometers and the line isolation amplifiers.

SECTION 10

RECOMMENDATIONS

Based on the preliminary analysis of the test data and post test hardware inspections, the following recommendations are presented:

ENGINE SYSTEMS

No reorificing of the engines is recommended prior to launch.

The Material Review Board and Rocketdyne should determine what repair action, if any, is necessary on the two slight seep leaks at engine 6.

It is recommended that the aspirator lip erosion at engine 3 not be repaired since the erosion will not affect engine performance for flight. It is also recommended that no future measurements be located in the area of the thrust chamber drain screw access ports.

Post test leak checks showed leaks on five engines at the gas generator turbine inlet flange. It is recommended that these leaks not be corrected since they are minor fuzz leaks at low pressure.

ENGINE HYDRAULIC SYSTEMS

It is recommended that a design change be made to the hydraulic package assemblies to correct the GN_2 precharge leakage past the static seal to the high-pressure oil cavities. The accumulator sleeve and housing should be made an integral part, which would eliminate the static seal between the GN_2 and the oil cavities.

The Engineering Order which has been initiated to replace the Vickers auxiliary pumps with Kellog pumps, effective on stage S-IB-9 and subsequent, should be altered to include earlier stages. In conjunction with this action, investigations should be conducted to determine if the contamination caused by O-ring wear is detrimental to system operation, and to determine if the MIL-I-8660 lubricant can be eliminated by chamfering the accumulator housing.

The O-rings (P/N 20C85013-4) at the engine 1 auxiliary pump inlet and outlet bleed valve connections should be replaced upon return of the stage to Michoud to correct the slight hydraulic oil leak at these locations.

The servo valve and actuator of engine 4 should be removed and investigated at Michoud to determine the cause of the hydraulic parameter deflections noted on gimbal test records.

ENGINE COMPARTMENT ENVIRONMENT

Post test SA-33 inspection of the boattail area revealed that four heat shield support beam assemblies were slightly distorted during the static firing. The heat shield support beam assembly damage should be studied further to determine what modifications are needed to maintain the structural integrity of the beams.

It is recommended that when gimbal boots require refurbishment, new reflective material be stitched to the boot rather than attempting repair of burned refrasil using a flammable aluminized coating.

It is recommended that the engine compartment environment temperature of stage S-IB-3 be evaluated at KSC during the countdown demonstration test.

TELEMETRY SYSTEMS

An investigation should be made to determine if the reliability of the continuous liquid level adapters can be improved.

To suppress the large negative transient generated in the relay K15 coil at tape recorder record command, it is recommended that one of three methods be adopted:

1. Install a suppression diode across the coil of relay K15 in distributor 12A26.

2. Remove relay K15 and reconnect pins of J1 on the tape recorder directly to the tape recorder ready indication.

3. Require the tape recorder vendor to change diode CR1 in the tape recorder to a zener diode with a value of 30 volts.

To implement the philosophy of making no adjustments to DC amplifiers on board the stage, an increase in spare amplifiers in logistic spares at Static Test is recommended.

It is also recommended that the design of the pulse detector be improved to achieve more reliable operation of this system.

APPENDIX A

REFERENCES

REFERENCES

Preliminary Static Test Report, Stage S-IB-3, Test SA-31, November 15, 1965.

Saturn S-IB Static Test Plan, Stage S-IB-4, November 29, 1965.

Rocketdyne Program Office Letter 648, December 20, 1965.

Static Test Measurement Locations Report, Stage S-IB-4, December 24, 1965.

Preliminary Static Test Report, Stage S-IB-4, Test SA-32, January 28, 1966.

Confidential Supplement, Stage S-IB-4, Tests SA-32 and SA-33, February 1, 1966.

Preliminary Static Test Report, Stage S-IB-4, Test SA-33, February 7, 1966.

Vibration and Acoustical Evaluation Report, Stage S-IB-4.

APPENDIX B

REDLINE AND BLUELINE VALUES FOR STAGE S-IB-4

APPENDIX B

REDLINE AND BLUELINE
VALUES FOR STAGE S-IB-4

Values for parameters which were monitored to assure vehicle safety are outlined below. Prerun checks were made to verify satisfactory engine compartment conditions prior to clearing the stand. Parameters monitored after the start of the automatic countdown as well as mainstage values are listed.

REDLINE LIMITS

1. Prerun Verifications (see BLUELINE LIMITS).

2. Preignition Verifications.

Measurement Number	Description	Maximum	Minimum
*PT107	Temperature LOX Pump Inlet (Immediately prior to ignition)	-275° F	-300° F
*PP114	Pressure, LOX Pump Inlet		65 psig
*LP102-0C	Pressure, LOX Tank Ullage	50 psig	36 psig
*PT100-8	Temperature, Fuel Pump Inlet	110° F	0° F
*PP113	Pressure, Fuel Pump Inlet		25 psig
*FP101-F3	Pressure, Fuel Tank Ullage	20 psig	14 psig
PT156	Temperature, LOX Seal Drain		-275° F
△1 △2	Prior to ignition plus 3 seconds, if the temperature drops below -275° F for more than one second cutoff is to be initiated.		

△1 Redline limit added since the publication of the "Saturn S-IB-4 Static Test Plan".
△2 Test SA-32 only (see PT156 Mainstage Verification for SA-33).

3. Mainstage Verifications.

Measurement Number	Description	Maximum	Minimum
*PP103	Pressure, Combustion Chamber After mainstage equilibrium has been established any change in either P_c or GG Conisphere Temperature must be accompanied by a similar change in the other parameter before cutoff is initiated.	720 psig	
*PT102	Temperature, GG Conisphere After mainstage equilibrium has been established, any change in either P_c or GG Conisphere Temperature must be accompanied by a similar change in the other parameter before cutoff is to be initiated.	1,400° F	
*PP112	Pressure, Gearcase Cutoff is to be initiated only if the corresponding pressure switch indication is obtained.	10 psig	
*LP102-OC	Pressure, LOX Tank Ullage	56 psig	5 psig
*FP101-F3	Pressure, Fuel Tank Ullage	21.5 psig	2 psig
*PP115	Pressure, Turbopump Bearing No. 1 Lube Jet (within 10 seconds after Ignition Command)		75 psig
*CP102-9	Pressure, Control Spheres		1,000 psig

Measurement Number	Description	Maximum	Minimum
PT156	Temperature, LOX Seal Drain		
△1	a. If the temperature drops below -275° F between △2 Ignition and Commit; (X-3 to X-0) and remains below -275° F for one second, initiate cutoff.		
	b. If the temperature is below -255° F at Commit (X-0) initiate cutoff.		
	c. If the temperature is below -220° F at X+2 seconds, or drops below thereafter, initiate cutoff.		
*PP114	Pressure, LOX Pump Inlet		20 psig
	If the recorder pegs downscale at maximum rate, cutoff shall not be initiated unless the corresponding prevalve closed indication is obtained. If the pressure decays gradually below the redline value, cutoff shall be initiated without regard to the prevalve position indicator.		
*PP113	Pressure, Fuel Pump Inlet		5 psig
	If the recorder pegs downscale at maximum rate, cutoff shall not be initiated unless the corresponding prevalve closed indication is obtained. If the pressure decays gradually below the redline value, cutoff shall be initiated without regard to the prevalve position indicator.		

△1 Redline limit added since the publication of the "Saturn S-IB-4 Static Test Plan".
△2 Test SA-33 only (see PT156 Preignition Verifications for SA-32).

Measurement Number	Description	Maximum	Minimum
RP200 RP201	Water Pressure, Deflector Cutoff shall be initiated only if the corresponding pressure switch indication is obtained.		65 psig
*PV700	Rough Combustion Cutoff The RCC device will initiate cutoff after 100 milliseconds of vibration level greater than 100 g rms in the frequency range of 960 to 6,000 cps.		
*DT100-1/8	Fire Detection System		
*DT101-1/4 *DT700 *DT701 *DT702 *DT703	The fire detection system for stage S-IB-4 will consist of 12 Static Test Harnesses and 4 flight harnesses. Each rise rate indicator will be set at 5 chart scales per second (3.0 mv) with a time delay of 1/2 second for the flight harnesses and 1 second for Static Test harness. All 16 rise rate indicators will be active in the cutoff circuitry. For observer monitoring, the redline value is an increase of five major chart divisions per second.		

General instructions for fire detection chart watchers are as follows:

1. If any one fire detection harness pegs upscale - no action.

2. If two or more fire detection harnesses peg upscale - initiate cutoff.

3. If static test LOX or flight harnesses peg downscale - no action.

4. If static test fuel harnesses peg downscale - initiate cutoff if recorder does not return within 5 seconds.

BLUELINE LIMITS

The following measurements will be monitored to assure vehicle safety during static test operations. If any blueline tolerance is exceeded, the Test Conductor shall be notified.

1. Prerun Verifications. The following measurements will be monitored from LOX loading to start of automatic sequence to ensure a satisfactory engine compartment environment and component operation. △1

Measurement Number	Description	Maximum	Minimum
*PT700	Temperature, Turbopump Bearing 1		0° F
*PT701	Temperature, Oronite	156° F	105° F
*PT101	Temperature, Turbine Spinner Surface	75° F	40° F
*PP101	Pressure, GG LOX Injector Manifold	192 psig	158 psig

2. Preignition Verifications.

Measurement Number	Description	Maximum	Minimum
*HT700	Temperature, Hydraulic Oil	210° F	40° F
*H0700	Position, Hydraulic Reservoir Piston	68%	18%
*PP112	Pressure, Gearcase	7 psig	2 psig
*FP103-11	Pressure, High Pressure Spheres	3,200 psig	2,800 psig
*CP102-9	Pressure, Control Spheres	3,200 psig	2,800 psig
*ST100-9	Temperature, GOX Line		-65° F
PT156 △2	Temperature, LOX Seal Drain		-200° F

△1 This group of measurements were changed from redline for test SA-32 to blueline for test SA-33.

△2 Blueline limit added since the publication of the "Saturn S-IB-4 Static Test Plan". Used for test SA-33 only.

3. Mainstage Verifications.

Measurement Number	Description	Maximum	Minimum
*HT700	Temperature, Hydraulic Oil	275° F	
*H0700	Position, Hydraulic Reservoir Piston		10%
*PT700	Temperature, Turbopump Bearing 1		0° F
*PT108	Temperature, Turbopump Bearing 8	600° F	
*FP101-F3	Pressure, Fuel Tank		5 psig

APPENDIX C

STAGE AND GROUND SUPPORT
TEST DATA SHEETS
STAGE S-IB-4

APPENDIX C

STAGE AND GROUND SUPPORT
TEST DATA SHEET
STAGE S-IB-4

1. TEST NUMBERS:

Short Duration Test - SA-32
Long Duration Test - SA-33

2. IGNITION COMMAND TIME AND DATE:

Test SA-32	16:44:10.636 CST	January 17, 1966
Test SA-33	16:40:19.820 CST	January 21, 1966

3. TEST DURATION FROM IGNITION COMMAND (Seconds):

	INBOARD ENGINE CUTOFF	OUTBOARD ENGINE CUTOFF
Test SA-32	35.227	35.339
Test SA-33	143.934	147.110

4. ENGINE NUMBERS:

Position 1 H-7062	Position 2 H-7063	Position 3 H-7064	Position 4 H-7065
Position 5 H-4058	Position 6 H-4059	Position 7 H-4060	Position 8 H-4061

5. TEST OBJECTIVES:

Short Duration Test SA-32

a. Verification of airborne/ground control systems compatibility.
b. Determine propellant tank draining rates.
c. Check performance of gimbal control system.
d. Verify reliability and performance of telemetry equipment.
e. Verification of engine performance.

5. Short Duration Test SA-32 (Continued)

f. Evaluation of propellant tank pressurization transients with flight ullages.
g. Evaluation of fuel pressurization system with minimum fuel sphere pressure (2,800 psig).
h. LOX overboard drain test with hand valves removed from facility drain lines to be performed post-firing.
i. Investigation of heat shield structure movement.

Long Duration Test SA-33

a. Verification of engine performance.
b. Check performance of gimbal control system.
c. Verify reliability and performance of telemetry equipment.
d. Verification of airborne tank pressurizing systems.
e. Determination of propellant tank drain rates.

6. TEST CONDITIONS:

a. Short duration test cutoff will be initiated by the Firing Panel Operator.
b. Long duration tests cutoff will be initiated by uncovering of the first propellant low level sensor and will be controlled by the Switch Selector in the following sequence at cutoff:

0.0 Second	- Level sensor actuation
+3.2 Seconds	- Inboard engine cutoff
+3.7 Seconds	- Arm fuel depletion probes and Thrust OK pressure switches
+7.2 Seconds	- Outboard engine cutoff (backup timer)

c. The Center LOX tank orifice will be 21 inches in diameter.
d. Propellants at X-163 seconds (short duration test).

LOX	655.0 inches	(LOX Tank 0-C)	1.53 percent ullage
FUEL	634.5 inches	(Fuel Tank F-4)	2.00 percent ullage

Propellants at X-163 seconds (long duration test).

LOX	632 inches	(LOX Tank 0-C)	4.90 percent ullage
FUEL	631 inches	(Fuel Tank F-4)	2.50 percent ullage

f. Engines to be gimbaled as outlined in the gimbal program. Short duration test, see TABLE 3-1; long duration test, see TABLE 3-2.

6. TEST CONDITIONS (CONTINUED):

g. Fuel emergency pressurizing armed at power transfer and disarmed at cutoff.
h. The LOX vents will be closed at X-163 seconds, bubbling will be initiated at X-153 seconds.

7. COMMENTS:

a. Fleming initiators will be used for both tests.
b. The ground LOX pressurizing orifice diameter for the short duration test is 0.099 inch; for the long duration test, 0.149 inch.
c. The LOX bubbling rate will be 45 scfm.
d. At X+61 seconds the stage fuel pressurization will be terminated and facility fuel pressurization initiated (long duration test only).
e. The fuel sphere pressure will be 2,800 psig.
f. Fire wall panel (P/N 60C30143-3) was removed and Static Test Panel installed to permit access of electrical cables.
g. A secondary LOX seal cavity drain line was installed in the swab port and temperature and pressure measurements made in the primary drain line.
h. High speed cameras and special instrumentation will be installed in the boattail to investigate heat shield structure movement.
i. A radiation shield is installed on fuel tank F-3 to prevent the occurrence of ripples in the tank.

8. STAGE PRESSURE SWITCHES:

	Description	Actuation	Deactuation
a.	LOX Tank Pressurized	57.7 ± 0.8 psia	55.3 psia min.
b.	LOX Tank Emergency Vent	67.5 ± 1.5 psia	63.0 psia min.
c.	Fuel Tank Pressurized	32.4 psia max.	29.6 psia min.
d.	Fuel Spheres Pressurized	2965 ± 30 psia	2835 psia min.
e.	Control Sphere Pressurized	2965 ± 30 psia	2835 psia min.
f.	Control 750 OK	625 ± 25 psig	△1
g.	Thrust OK	800 ± 45 psia	△2

△1 Shall deactuate within 50 psi of actuation setting.

△2 Shall deactuate within 15 to 65 psi of actuation setting. Actuation and deactuation pressures are measured from the calibration port.

9. STAGE RELIEF VALVES:

	Description	Cracking	Reseat
a.	Fuel Vent Valves No. 1&2	19.0 (+0.00,-0.02)	-
b.	LOX Relief Valves No. 1&2	60.0 ± 5 psig	53.0 psig

10. STAGE ORIFICES:

	Description	Number	Diameter (Inches)
a.	Fuel Tank Pressurizing	1	0.210 (sonic)
b.	Fuel Bubbling	8	0.018 (+0.002,-0.000)
c.	LOX Bubbling	8	0.102 (+0.002,-0.000)
d.	105-Inch LOX Tank Sump	1	21.0

11. GSE PRESSURE SETTING:

	Description	Setting (psig)
a.	Fuel Bubbling (GN_2) Pressure Switch	110 ± 15
b.	Fuel Bubbling Regulator Output	140
c.	LOX Bubbling (Helium) Pressure Switch	315 ± 15
d.	LOX Bubbling Regulator Output	575
e.	LOX Dome Purge Pressure Switch	195 ± 15
f.	LOX Dome Purge Regulator Output	250
g.	GG LOX Injector Purge Pressure Switch	250 ± 15
h.	GG LOX Purge Regulator Output	300
i.	Fuel Injector Purge Pressure Switch	375 ± 15
j.	Fuel Injector Purge Regulator Output	490
k.	Turbine Spinner Pressure Switch	40 ± 10
l.	Gearcase Pressure Switch	12
m.	Facility Helium Pressure Switch	3000 ± 100
n.	Facility GN_2 Pressure Switch	3000 ± 100
o.	Auxiliary LOX Dome Purge Pressure Switch	450 ± 50
p.	Auxiliary LOX Dome Purge Regulator Output	650
q.	Emergency Fuel Pressurizing Switch	5.5 ± 0.5

12. GSE ORIFICES:

	Description	Number	Diameter (Inches)
a.	Ground LOX Pressurizing (Helium)	1	0.099 (SA-32) 0.149 (SA-33)
b.	Fuel Sphere Supply (Helium)	1	0.100
c.	Control Spheres Supply	1	0.063
d.	Fuel Jacket Fill Line	1	0.189

12. GSE ORIFICES (CONTINUED):

Description	Number	Diameter (Inches)
e. Ground LOX Orifice Bypass	1	0.370
f. Facility LOX Pressurizing (GN_2)	1	0.537

13. PROPELLANT LOW LEVEL SENSORS:

Description	LOX	Fuel
a. Height Above Probe Flange	25.45 inches	25.98 inches
b. Height Above Theoretical Tank Bottom	27.48 inches	31.50 inches

14. ENGINE ORIFICE SIZES (Inches):

ENGINE POSITION NUMBER	1	2	3	4	5	6	7	8
ENGINE SERIAL NUMBER	H-7062	H-7063	H-7064	H-7065	H-4058	H-4059	H-4060	H-4061
GG LOX ORIFICE △1	0.385	0.397	0.404	0.365	0.353	0.385	0.373	0.402
GG FUEL ORIFICE	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700
MAIN LOX ORIFICE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
MLV CONTROL ORIFICE	0.116	0.116	0.116	0.116	0.116	0.116	0.116	0.116
MAIN FUEL ORIFICE	2.645	2.640	2.770	2.734	2.777	2.680	2.785	2.742
MFV CONTROL ORIFICE	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073
LOX TO H.E. ORIFICE △2	0.101	0.101	0.101	0.101	0.101	0.101	0.101	0.101

△1 All 200K engines are equipped with dual orifices in the GG LOX bootstrap line. A fixed 0.400-inch diameter orifice is plumbed in series with the removable orifice listed above.

△2 Three orifices per engine.

APPENDIX D

METEOROLOGICAL DATA
TESTS SA-32 AND SA-33

METEOROLOGICAL DATA
TEST SA-32

LOCATION	BLOCKHOUSE			TOP STATIC TEST TOWER	
TIME OF DAY	TEMP. (°F)	BAROM. PRESS. (IN. HG.)	REL. HUMIDITY (PERCENT)	WIND VEL. (MPH)	WIND DIR. (DEGREES) △1
10:00 a.m.	29	29.70	49	4	325
10:30 a.m.	30	29.69	43	4	305
11:00 a.m.	30	29.69	38	5	305
11:30 a.m.	31	29.68	37	5	335
12:00 m.	33	29.67	36	8	330
12:30 p.m.	34	29.66	34	7	325
1:00 p.m.	36	29.64	33	7	320
1:30 p.m.	37	29.68	30	8	305
2:00 p.m.	37	29.68	30	4	310
2:30 p.m.	38	29.68	30	5	315
3:00 p.m.	39	29.68	29	6	345
3:30 p.m.	38	29.68	28	7	330
4:00 p.m.	38	29.68	29	4	330
4:30 p.m.	37	29.67	30	4	340
5:00 p.m.	37	29.66	32	5	340

△1 Wind is from the direction given in degrees starting north going clockwise.

METEOROLOGICAL DATA
TEST SA-33

LOCATION	BLOCKHOUSE			TOP STATIC TEST TOWER	
TIME OF DAY	TEMP. (°F)	BAROM. PRESS. (IN. HG.)	REL. HUMIDITY (PERCENT)	WIND VEL. (MPH)	WIND DIR. (DEGREES) [1]
10:00 a.m.	38	29.55	43	11	115
10:30 a.m.	38	29.54	42	13	105
11:00 a.m.	39	29.52	41	11	110
11:30 a.m.	40	29.51	40	8	90
12:00 m.	41	29.50	39	9	105
12:30 p.m.	41	29.49	39	6	90
1:00 p.m.	42	29.48	39	5	145
1:30 p.m.	42	29.47	39	4	70
2:00 p.m.	42	29.47	39	6	85
2:30 p.m.	42	29.47	39	5	75
3:00 p.m.	42	29.46	40	3	65
3:30 p.m.	42	29.46	40	4	55
4:00 p.m.	42	29.46	40	2	70
4:30 p.m.	41	29.45	41	4	70
5:00 p.m.	41	29.43	41	4	85

[1] Wind is from the direction given in degrees starting north going clockwise.

APPENDIX E

OPERATING TIME/CYCLE HISTORY OF STAGE S-IB-4 COMPONENTS WHILE AT STATIC TEST

APPENDIX E

OPERATING TIME/CYCLE HISTORY OF STAGE S-IB-4 COMPONENTS AT STATIC TEST

COMPONENT PART NUMBER	SERIAL NUMBER	OPERATION CYCLES	OPERATION MINUTES
Auxiliary Hydraulic Pump 1 (20C85064)	MX100729A	-	2.1
Auxiliary Hydraulic Pump 1 (20C85064) ⚠1	MX99281	-	31.8
Auxiliary Hydraulic Pump 1 (20C85064) ⚠1	MX85015	-	52.4
Auxiliary Hydraulic Pump 2 (20C85064)	MX100732A	-	82
Auxiliary Hydraulic Pump 3 (20C85064)	MX100733A	-	73
Auxiliary Hydraulic Pump 4 (20C85064)	MX885008	-	20.8
Auxiliary Hydraulic Pump 4 (20C85064) ⚠1	MX85010A	-	57
Auxiliary Hydraulic Pump Motor 1 (20C85065)	1335461	5	2.1
Auxiliary Hydraulic Pump Motor 1 (20C85065) ⚠1	1297833	11	31.8
Auxiliary Hydraulic Pump Motor 1 (20C85065) ⚠2	1335461	17	52.4
Auxiliary Hydraulic Pump Motor 2 (20C85065)	135438	20	82

⚠1 Replaced previous item.

⚠2 Same item as first listed above. Pump motor 1335461 was removed from pump MX100729A and reinstalled on pump MX85015.

COMPONENT PART NUMBER	SERIAL NUMBER	OPERATION	
		CYCLES	MINUTES
Auxiliary Hydraulic Pump Motor 3 (20C85065)	1297657	23	73
Auxiliary Hydraulic Pump Motor 4 (20C85065)	1297662	5	20.8
Auxiliary Hydraulic Pump Motor 4 (20C85065) ⚠	1335456	21	57
Fuel Prevalve, Engine 1 (60C20340)	128	159	-
Fuel Prevalve, Engine 2 (60C20340)	137	159	-
Fuel Prevalve, Engine 3 (60C20340)	136	158	-
Fuel Prevalve, Engine 4 (60C20340)	132	158	-
Fuel Prevalve, Engine 5 (60C20340)	131	160	-
Fuel Prevalve, Engine 6 (60C20340)	139	157	-
Fuel Prevalve, Engine 7 (60C20340)	138	158	-
Fuel Prevalve, Engine 8 (60C20340)	135	158	-
LOX Prevalve, Engine 1 (60C20339)	128	161	-
LOX Prevalve, Engine 2 (60C20339)	136	160	-
LOX Prevalve, Engine 3 (60C20339)	132	159	-

⚠ Replaced previous item.

COMPONENT PART NUMBER	SERIAL NUMBER	OPERATION	
		CYCLES	MINUTES
LOX Prevalve, Engine 4 (60C20339)	131	156	-
LOX Prevalve, Engine 4 (60C20339) ⚠1	106	2	-
LOX Prevalve, Engine 5 (60C20339)	134	160	-
LOX Prevalve, Engine 6 (60C20339)	127	159	-
LOX Prevalve, Engine 7 (60C20339)	137	159	-
LOX Prevalve, Engine 8 (60C20339)	133	159	-
Fuel Fill and Drain Valve 3 -	-	84	-
Fuel Tanks Pressurized -	-	41	-
Fuel Pressurizing 3,000 psig OK -	-	167	-
Fuel Pressurizing Valve 1 (60C20790)	108	199	-
Fuel Pressurizing Valve 2 (60C20790)	124	182	-
Fuel Vent Valve 1 (60C20358)	12	5	-
Fuel Vent Valve 1 (60C20358) ⚠1	14	37	-

⚠1 Replaced previous item.

COMPONENT PART NUMBER	SERIAL NUMBER	OPERATION	
		CYCLES	MINUTES
Fuel Vent Valve 2 (60C20358)	21	90	-
Fuel Vent Valve 2 (60C20358) ⚠1	19	84	-
LOX Fill and Drain Valve 3 -	-	98	-
LOX Tanks Pressurized to 60 psig -	-	68	-
LOX Emergency Pressurizing Switch -	-	68	-
LOX Emergency Vent Switch (60C20058)	25250	17	-
LOX Relief Valve 3 (20C30460-1)	0015	192	-
LOX Relief Valve 3 (20C30460-1) ⚠1	0016	38	-
Control Sphere 3,000 psig Switch -	-	36	-
Control Sphere Vent Valve -	-	17	-
RF Assembly S1 (50C12196-5)	007	146	1291
RF Assembly F1 (50C12196-7)	007	500	3127
RF Assembly F2 (50C12196-9)	002	-	168
RF Assembly F2 (Bench Test) (50C12196-9) ⚠2	002	-	60

⚠1 Replaced previous item.

⚠2 A total of 60 minutes of operation time was expended on a bench test of the F2 RF assembly at Static Test.

APPENDIX E (CONTINUED)

COMPONENT PART NUMBER	SERIAL NUMBER	OPERATION	
		CYCLES	MINUTES
PCM/RF Assembly P1 (50C12187-1)	006	158	1481
Vibration Multiplexer (50C12192-7)	001	-	1291
TM Multiplexer P1 (60C50081-15)	006	70	12962
SS/FM Assembly S1 (50C12195-3)	005	146	1291
Telemeter Assembly F1 (60C50087-9)	007	70	12,962
Telemeter Assembly F2 (60C50087-11)	008	70	12,962
PCM/DDAS Assembly (P1) (60C50079-1)	003	70	12,962
+1D11 Bus -	-	51	12,876
+1D21 Bus -	-	50	14,503
+1D24 Bus -	-	87	12,813
Master Measuring Power Supply (40C20002)	13585	70	12,962
Master Measuring Power Supply (40C20002)	13590	70	12,962
Master Measuring Power Supply (40C20002)	18824	70	12,962
22.5-Volt Power Supply (9A531) (60C50071)	001	70	12,962

COMPONENT PART NUMBER	SERIAL NUMBER	OPERATION CYCLES	MINUTES
22.5-Volt Power Supply (9A516) (60C50071)	003	70	12,962
22.5-Volt Power Supply (9A522) (60C50071)	005	70	12,962
22.5-Volt Power Supply (9A530) (60C50071)	007	70	12,962
22.5-Volt Power Supply (12A440) (60C50071)	009	70	12,962
22.5-Volt Power Supply (9A520) (60C50071)	14	70	12,962
22.5-Volt Power Supply (9A528) (60C50071)	017	70	12,962
22.5-Volt Power Supply (9A528) (60C50071)	19	70	12,962
22.5-Volt Power Supply (9A526) (60C50071)	045	70	12,962
22.5-Volt Power Supply (9A517) (60C50071)	053	70	12,962
Switch Selector (50C04008)	027	515	12,813
EBW Firing Unit Secure Command Receiver 1 (40M39515-111)	426	-	21
EBW Firing Unit Secure Command Receiver 2 (40M39515-111)	427	-	21
EBW Firing Unit 1, Separation (40M39515-107)	327	-	5.9
EBW Firing Unit 2, Separation (40M39515-107)	343	-	5.9

APPENDIX E (CONTINUED)

COMPONENT PART NUMBER	SERIAL NUMBER	OPERATION	
		CYCLES	MINUTES
EBW Firing Unit 1, Retrorocket 1 (40M39515-105)	153	-	5.9
EBW Firing Unit 1, Retrorocket 2 (40M39515-105)	155	-	5.9
EBW Firing Unit 1, Retrorocket 3 (40M39515-105)	147	-	5.9
EBW Firing Unit 1, Retrorocket 4 (40M39515-105)	150	-	5.9
EBW Firing Unit 2, Retrorocket 1 (40M39515-105)	151	-	5.9
EBW Firing Unit 2, Retrorocket 2 (40M39515-105)	156	-	5.9
EBW Firing Unit 2, Retrorocket 3 (40M39515-105)	148	-	5.9
EBW Firing Unit 2, Retrorocket 4 (40M39515-105)	154	-	5.9
Secure Command Receiver 1 (50C10697)	16	29	5171.5
Secure Command Receiver 2 (50C10697)	53	22	3640.6
Range Safety Decoder 1 (50C10698)	10	19	5171.5
Range Safety Decoder 2 (50C10698)	12	22	3640.6
Tape Recorder (50C10338)	070	556	207
Outboard TOP Switch 1 (NA5-27446)	25323	179	-

COMPONENT PART NUMBER	SERIAL NUMBER	OPERATION	
		CYCLES	MINUTES
Outboard TOP Switch 2 (NA5-27446)	25432	114	-
Outboard TOP Switch 3 (NA5-27446)	25430	56	-
Outboard TOP Switch 4 (NA5-27446)	25493	55	-
Outboard TOP Switch 5 (NA5-27446)	25486	57	-
Outboard TOP Switch 6 (NA5-27446)	25373	60	-
Outboard TOP Switch 7 (NA5-27446)	25365	84	-
Outboard TOP Switch 8 (NA5-27446)	25368	55	-
Inboard TOP Switch 1 (NA5-27446)	25381	79	-
Inboard TOP Switch 2 (NA5-27446)	25427	54	-
Inboard TOP Switch 3 (NA5-27446)	25487	54	-
Inboard TOP Switch 4 (NA5-27446)	25492	54	-
Inboard TOP Switch 5 (NA5-27446)	25495	120	-
Inboard TOP Switch 6 (NA5-27446)	25425	74	-
Inboard TOP Switch 7 (NA5-27446)	25321	52	-

APPENDIX E (CONTINUED)

COMPONENT PART NUMBER	SERIAL NUMBER	OPERATION	
		CYCLES	MINUTES
Inboard TOP Switch 8 (NA5-27446)	25488	35	-
Third TOP Switch 1 (NA5-27446)	25485	114	-
Third TOP Switch 2 (NA5-27446)	25409	103	-
Third TOP Switch 3 (NA5-27446)	25490	108	-
Third TOP Switch 4 (NA5-27446)	25492	106	-
Third TOP Switch 5 (NA5-27446)	25316	103	-
Third TOP Switch 6 (NA5-27446)	25435	107	-
Third TOP Switch 7 (NA5-27446)	25379	107	-
Third TOP Switch 8 (NA5-27446)	25403	107	-

APPENDIX F

UNSATISFACTORY CONDITION REPORTS

APPENDIX F

UNSATISFACTORY CONDITION REPORTS

UCR NUMBER PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
02900 Tube Assembly 60C10566 N/A	During initial stage inspection it was noted that tube assembly 60C10566-1 was creased at the B-nut on both ends of the tube. Reference squawk V00291-4.	The tube assembly was bent out of it's normal position, probably causing the kinks on both ends. A replacement part has been ordered.and as a temporary correction,a flex hose was installed in place of tube assembly 60C10566-1. It is recommended that more care be taken in this area.
02901 Swivel Washer 45170 N/A	When removing the AFT ring clamps, prior to lifting the stage off the transporter, one of the washers was found to be badly cracked in several places. The washers used are in matched sets: one concave on one side and one convex on one side.	There are 2 reasons why the washer was cracked: 1. Washers are mild steel and are not designed for the high compression load they carry. 2. The failed swivel washer was mated with another which was larger both I.D. and O.D. It is recommended that all swivel washers on the AFT ring clamps be replaced with high strength steel, flat washers. This will alleviate a safety problem caused by the washers breaking apart under load and possibly striking personnel in the face.
02902 Tape Recorder 50C10338 007	Upon arrival of S-IB-4 at the Static Test Facility, an initial inspection was performed on telemetry components. At this time.it was discovered that the flight tape recorder was not pressurized.	The cause of the loss in pressure is not known. Loss of pressure does not affect the operation of the tape recorder at Static Test; therefore the unit will be used without pressure at this facility. It is recommended that the unit be removed and resealed during post static test operations.
02903 RF Container Assembly F-1 50C12196-7 007	Upon arrival of S-IB-4 at the Static Test Facility, an initial inspection was performed on telemetry components. At this time it was discovered that the RF assembly F-1 was not pressurized.	The cause of the loss in pressure is not known. Loss of pressure does not affect the operation of the RF assembly at Static Test; therefore the unit will be used without pressure at this facility. It is recommended that the unit be removed and resealed during post static test operations.
02904 Valve, Fuel Vent 60C20358 12	During the sequence test conducted on stage S-IB-4,the fuel vent valve 1 failed to give a closed indication when the valve was in the closed position. The valve delivered a closed indication only after the fuel tanks were pressurized approximately 2 psig.	A discrepant position indication switch is suspected as the probable cause of the above condition. This condition could have resulted from the fact that this valve had been subjected to fuel vapor on stage S-IB-3. No liquid fuel came into contact with this valve on stage S-IB-4. The discrepant valve will be replaced by a safety relief valve P/N 60C21490 when received by Systems Static Test. Reference squawk V00293-13 and DMN H00412.
02905 Tape Recorder 50C10338 007	While performing an operational test of the airborne tape recorder through the Telemeter Ground Station,it was noted that the 120KC tape speed compensation frequency in the tape recorder was deviating F-1 and F-2 RF transmitters approximately 60KC. Deviation should have been 20KC ± 5KC.	Output amplitude of 120KC oscillator was not adjusted properly prior to vehicle installation. The unit was removed from the vehicle and properly adjusted at the Static Test Facility.
02906 Outline Drawing - Receiver 50M10697 53, 16	Upon arrival of S-IB-4 at the Static Test Facility, an initial inspection was performed on all RF components. At this time,it was discovered that both Secure Command Receivers (Number 1, S/N 16; and Number 2, S/N 53) were not pressurized.	The cause of the loss in pressure is not known. Loss in pressure will not affect the operation of the Secure Command Receiver at Static Test; therefore, these two units will be used without pressure at this facility. It is recommended that these units be checked for leaks and pressurized during post static test operations.

APPENDIX F (CONTINUED)

UNSATISFACTORY CONDITION REPORTS

UCR NUMBER PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
02907 Decoder 50M10698 112	Upon arrival of S-IB-4 at the Static Test Facility, an initial inspection was performed on all RF components. At this time it was discovered that the Secure Range Safety Decoder was not pressurized.	The cause of the loss in pressure is not known. Since loss in pressure will not affect the operation of the decoder at Static Test, the unit will be used without pressure at Static Test. It is recommended that this unit be checked for leaks and repressurized during post static test operations.
02908 TM Assembly F-2 60C50087-1 008	While performing an operational check of F-2 270 channel multiplexer through the telemeter ground station, it was observed that the sampling rate of the multiplexer was 3350 samples per second when it was not slaved to the PCM/DDAS assembly. It should have been 3400 ± 20 samples per second.	The cause of this discrepancy is unknown. The sampling rate was adjusted per specification by STTE on the vehicle. The sampling rate will be checked periodically by STTE to ascertain that the clock does not drift.
02909 RF Assembly F-2 50C12196-9 002	While performing a check of F-2 RF transmitter frequency through the telemeter ground station, it was discovered that the RF radiated frequency drifted too high in frequency after 15 minutes of operation. Frequency was 244.325 MC after 15 minutes warm up and 244.330 after one hour warm up. Frequency should have been 244.300 ± .01%. The stage's supply was + 28.1 VDC.	The cause of this discrepancy is unknown. It is recommended that the unit be adjusted to generate its correct frequency and subjected to a long period of operation to determine whether the transmitter experiences an excessive drift in frequency.
02910 AC Amplifier Assembly 50C10382-3 C190	Prior to test SA-32, the input calibration AC voltage was tested at the input to the AC amplifier (S/N C190). It was found that this voltage was erratic with an average amplitude of about 0.01 volt. Normal voltage should have been constant at 0.16 volt. The amplifier could not be adjusted to produce this correct value.	A faulty potentiometer in the amplifier is the suspected cause of the malfunction. The faulty amplifier was replaced by a spare amplifier and its kit. It is recommended that the cause of the malfunction be investigated.
02911 Anti-Vortex Screen Assembly 20C0082 N/A	Difficulty was encountered in removing the flight center LOX tank orifice because three bolts were misaligned with respect to the orifice hole circle. When installation of the static test orifice was attempted, three bolts could not be engaged without using undue force. The bolt hole pattern of the two orifice plates was found to be identical, therefore a misalignment of the nut plates (installed by the tank manufacture) is suspected.	The probable cause of this condition is either the buildup of tolerances on failure to adhere to specifications. The orifices (both flight and static test) were modified by elongating the fastener holes (2) to allow proper installation of the orifices. Reference repair instructions S-IB4-1 and S-IB4-2.
02912 DC Amplifier 50C10394-77 2065	Prior to test SA-32 a scan of all flight instrumentation was performed. At this time it was found that the output of measurement C54-2 (Temperature LOX Pump Inlet) indicated 0.83 volt in the Lo-Cal mode. It should have indicated 0.43 volt + 3% full scale. (0.83 volt is + 8% full scale above correct reading.) The Hi-Cal reading was within tolerance.	The cause of the faulty reading is not known. Reference is made to NASA memo to Mr. Lee B. James, I-I/IB-Mgr. and Dr. A. L. Rudolph, I-V-Mgr; from chief, Instrumentation & Communications Div. R-ASTR-I; Date Sept. 9, 1965, Subject: Instrumentation Checkout Tolerances for all Stages of S-IB and S-V. It is recommended that the above amplifier be subjected to a bench test for a drift study and that a new laboratory calibration curve be made in accordance with the referenced memo.
02913 Hydraulic Package 20C85053 140	Initial pretest checkout of the engine hydraulic systems revealed a discrepant condition at engine 1. Prior to turning the auxiliary pump on, a fluid level of 97 percent was indicated. The following steps were taken to determine the cause of the high fluid level. 1. The precharge pressure was checked and found to be 1,470 psig, but no hydraulic fluid was present in the precharge cavity. 2. The system was precharged again, and an immediate reading of the fluid level with the auxiliary pump running indicated 41 percent.	The cause of the high fluid level was due to the GN_2 precharge leaking past the accumulator piston into the hydraulic fluid. This leakage and the contamination of the fluid was probably a result of the accumulator piston galling in the sleeve. The lubricant found in the analysis is possibly lubricant used in old type installation of fittings. Because of the high contamination level, the entire hydraulic installation will be replaced. The defective system will be returned to Michoud for further investigation.

UNSATISFACTORY CONDITION REPORTS

UCR NUMBER
PART NAME
PART NUMBER
SERIAL NUMBER — DESCRIPTION — REMARKS

02913 (CONTINUED)

Description:

3. While the auxiliary pump was running, the system was bled from the top of the accumulator reservoir. Nothing but gas came out of the bleed valve until the fluid level reached 28 percent, and gas was still present when the level reached 18 percent. When the precharge was bled off, hydraulic oil was present in the precharge cavity.

4. A sample of fluid was taken from the high pressure bleed valve on the front of the accumulator, and was found to be contaminated as shown below:

Particle Size	Particle Count
10-25* Microns	140,000
25-50* Microns	6,580
50-100* Microns	2,000
Over 100** Microns	338
Fibers	29

Particle * 20 percent rubber, 30 percent metallic, 50 percent lubricant type

Content ** 10 percent metallic

02914
Wiring List
60C40429
N/A

Description: While performing initial checkout procedure 3-CH SIB-506, measurement L47-02 was noted to have no output in the Hi-Cal mode. Investigation revealed that the connector (9W175-P2) on the continuous liquid level adapter was not properly connected and that pins 4 and 5 were severely bent.

Remarks: The cause of the bent pins is believed to be due to personnel not properly aligning the cable connector and the plug on the liquid level adapter during prestatic checkout.

More caution should be exercised in connecting coax connectors in the continuous liquid level circuits and circuits in general. This should be brought to the attention of manufacturing and quality manufacturing personnel. The damaged plug will be replaced at the static test facility.

02915
Wiring List
60C40429
N/A

Description: While performing initial checkout procedure 3-CH SIB-506, measurement L49-04 was noted to have no output voltage in the Hi-Cal mode. Investigation revealed that the shoulder or seat of pin 5 protruded beyond the teflon insulation. One segment of the outer conductor surrounding pin 5 was bent and shorting to the center conductor. In the process of straightening the segment, pin 5 was broken.

Remarks: The cause of the bent segment (outer conductor) was caused by misalignment of the cable connector and the plug on the liquid level adapter during prestatic checkout.

Connector damage should be brought to the attention of all manufacturing and checkout personnel. More care should be exercised in the connecting of all cables. The damaged connector will be replaced at the static test facility.

02916
Subcarrier Oscillator
50C60032-3
770

Description: The channel 2 subcarrier oscillator (.560 KH) of the F-1 telemetry package, S/N 770, P/N 50C60032-3 and the channel 3 subcarrier oscillator, S/N 773, P/N 50C60032-5 (.730 KH) of the F-2 telemetry package have no measurements assigned. This UCR recommends that the unused SCO's be removed from their respective telemetry packages.

Remarks: Advantages of removing the unused SCO's from telemetry packages are:

1. Since SCO's are expensive, their removal will result in a monetary savings to the customer.

2. It is an inherent characteristic of the FM telemetry system for crosstalk to exist (although to a small degree) between each channel of all the SCO's. With unused SCO's removed, some reduction in crosstalk can be achieved.

UNSATISFACTORY CONDITION REPORTS

UCR NUMBER PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
02917 TM Assembly F-1 60C50087-9 007	While performing a programming check of the F-1 telemeter subcarrier oscillators through the Telemeter Ground Station, it was observed on the oscillograph records that the .730 KH SCO was programmed to receive an inflight calibration. It should not receive an in-flight calibration in accordance with the instrumentation and components list.	The program plug on the F-1 telemeter package has not been wired in accordance with EO 1 of P/N 60C50088-5 (ET-50663-2). It is recommended that the program plug be changed in post static checkout at Michoud.
02918 Liquid Level Adapter 50C10699 48	Reference is made to UCR 02914. This referenced UCR indicates that pins 4 and 5 of connector 9W175-P2 were damaged due to improper mating during prestatic checkout. At a later time, an inspection of the plug that mates to the connector revealed that the plug (located on the continuous level adapter) was also damaged. The center conductor (female connector) of pins 4 and 5 was bent, and the teflon insulation associated with these pins was punctured.	The cause of the bent pins is believed to be caused by improper mating of the connector and plug prior to arrival of the S-IB-4 at Static Test. Checkout personnel should be instructed to use great care at the time of mating of these highly fragile connectors. The damaged adapter will be replaced as soon as a replacement part is available.
02919 Mounting Stud Assembly 30C00595 C64	During initial checkout prior to test SA-32, a compensation simulator was installed in measurement S22-04 to compensate for the lack of the upper stages at Static Test. Following a scan of measurements, the amplifier output was noted to be greater than +5 volts. Investigation revealed that the resistance readings between terminals of the transducer were 109 ohms - terminal A to B, and 113 ohms - terminal B to C. These resistive readings should have been 120 ohms ± 0.2 ohms.	The cause of the low resistive readings of the transducer is not known. This measurement will be simulated to give the telemeter channel an input of approximately 2.5 v.d.c. It is recommended that the mounting stud be removed and replaced at CCSD Michoud.
02920 DC Amplifier Assembly 50C10194-41 1710	Prior to test SA-32, an evaluation of all flight instrumentation was performed. It was noted that the output voltage of the amplifier of measurement C180-11 in all modes was zero. Investigation into the problem revealed that the D.C. amplifier was faulty.	The cause of the amplifier failure is unknown. A component failure is the suspected cause. It is recommended that the faulty amplifier be returned to CCSD-Michoud for failure analysis. The faulty amplifier will be replaced as soon as a spare amplifier is available.
02921 Submultiplexer Assembly 50C12088-3 006	While performing an operational test of the RDSM through a DDAS ground station, it was discovered that the word 1 gate card was a type that used low level input (0 to +5 volts) signals. This gate card should have been replaced by a high level input (0 to +28 volts) gate card in accordance with EO 49 to drawing 60C50008, Instrumentation Program and components list.	The RDSM was not modified to its latest required configuration. Static Test Operations are not effected by the present configuration of the RDSM and it will be used in its present form. It is recommended that the RDSM be modified during post static test operations at Michoud.
02922 750 Regulator Assembly 20C30134 CH-019	During the pneumatic preparation for performance of the components test procedure, it was noted that the 750 regulator outlet pressure was approximately 830 psig. The regulator was then readjusted to 750 psig. The facility reference gage was checked against the pressure transducer measurement CP100-9 and was within 3 psig of the other. The following day the outlet pressure was noted to be approximately 700 psig. The 750 regulator was then replaced. Upon examination of the 750 regulator outlet pressure gage it was found that this facility pressure gage was out of calibration approximately 50 psig.	Suspect a faulty 750 regulator outlet pressure gage. It is requested that a failure analysis be performed on the replaced 750 regulator to determine whether it will not hold a setting or whether the discrepant facility pressure gage caused an unwarranted replacement of the regulator.
02923 LOX Level Sensor 60C21497 ASL3005	During LOX detanking following performance of the Propellant Loading Test Procedure (7-CH SIB-609C), the LOX and fuel low level cutoff sensors were armed by manual operation of the Substitute Flight Computer (Code 01110111). Although approximately 500 inches of LOX was on board at the time of sensor arming, LOX level sensor 3 (Measurement K16-04) in tank O-4 indicated dry. This indication was verified on sequence recorder pens and DDAS records. All other sensors indicated wet.	Since these sensors were redesigned prior to shipment to Static Test, the cause of the failure is unknown. It is recommended that a failure analysis be conducted on this component to determine the cause of the malfunction.

APPENDIX F (CONTINUED)

UNSATISFACTORY CONDITION REPORTS

UCR NUMBER PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
02924 DC Amplifier Assembly 50C10388-37 0583	Prior to test SA-32, measurement S21-01, strain mounting stud, was tested in each of its test modes (Hi-Cal, Lo-Cal and Run). It was noted that the measurement could not be placed in the Hi-Cal mode. Investigation revealed that the DC amplifier had malfunctioned.	The cause of the malfunction of the amplifier is not known. It is recommended that the cause of the malfunction of the amplifier be investigated and that a historical record of this type failure be compiled.
02925 Cabling to AP109 N/A N/A	In the attempt to pressure calibrate measurement AP109 it was found that there was no electrical continuity. Further checks revealed that the open circuit was in the aft section of the center chute. A continuity check revealed that all three pins of the cable going to the Wiancko transducer were open.	The cabling at the transducer is either broken or the cabling is not connected to the transducer. An attempt was made to isolate and repair the problem but since the transducer is mounted on the center chute no repairs could be made. AP109 is an R&D measurement which was installed by CCSD manufacturing-Michoud.
02926 Transducer 2.596 N/A	Prior to performing a gimbal functional, Instrumentation was notified by Blockhouse personnel that measurement *H0700-4 (Hydraulic Oil Level) was reading erratic. A check at the transducer confirmed that with no activity on engine 4 a loss of continuity was occurring. The transducer resistance was monitored at the engine for approximately 30 minutes with the erratic resistance reading being noted.	A loss of continuity in the transducer is occurring. If another Hydraulic Package is available or becomes available it will be installed, otherwise, the package should be disabled for static test SA-32.
02927 Pulse Detector 60C50094 0031	Prior to test SA-32, a simulated flight test revealed that the output of measurement K3-12, cutoff signal, outboard pulse detector, produced random pulses. An attempt was made to readjust the triggering level of the pulse detector. A dual trace oscilloscope was used with a trace connected to red terminal J1 and the second trace to red terminal J4 of the pulse detector. Black terminal J2 of the pulse detector was connected to scope ground with the scope being grounded to the vehicle. Later tests revealed the pulse detector malfunctioning with a constant output of approximately 10 volts. Investigation revealed that the red terminals were negative and the black terminals were positive. It also is noted that apparently all other UMA components aboard the vehicle have the revesrse color coding. This caused the investigating technicians to connect a positive terminal of the pulse detector to ground.	The cause of the random pulses was due to improper adjustment of the pulse detector during prestatic operations. A reverse color coding of the test terminals compared to all other UMA components caused testing technicians to connect positive terminals to ground. Safety practices forbid use of an ungrounded oscilloscope aboard the vehicle. All pulse detectors should be calibrated in accordance with the latest design engineering calibration instructions. It is recommended that the test terminals of all pulse detectors use positive and negative color codes in a like manner with other UMA components.
02928 Pulse Detector 60C50094 0027	Prior to test SA-32, pulse detector (S/N 0031) was found to malfunction and was replaced by detector (S/N 0027). This detector (S/N 0027) was found to generate random pulses. Investigation revealed that an input signal threshold level of about 3 volts could trigger the detector. It was readjusted in place to trigger at a threshold level of about 12 volts. (To accomplish this, the "gain" control was adjusted until the triggering signal level at J1 and J2 was a 2 volt positive pulse ± 0.2 volts).	The pulse detector was not adjusted properly during prestatic operations. The pulse detector appears to operate properly when adjusted properly.
02929 Harness Assembly-02602 502310 6368606	During inspection of the turbine spinner initiators and Conax valves following performance of procedure I-CH SIB-419C (ordnance checkout with launch failure cutoff), the potting of connector P3 of cable W10 on engine 8 was found to be movable. Further investigation revealed that the potting, with the potting boot still in place, could be moved while the connector was held stationary. During the course of inspection, the conductors were broken and the connector separated from the cable and the potting.	The cause of the potting break is unknown. However, there appears to have been poor quality workmanship during cable fabrication and the potting did not bond to the connector. The conductors were broken and the connector separated from the cable due to flexing and force exerted on it during inspection. Since this cable is GFP, DMN H00431 was prepared and a new connector will be installed prior to short duration test. However, since a problem does exist with potting of these connectors, the remaining connectors should also be inspected prior to static test. This connector will be replaced with a MS3106E-10SL-4S on a Static Test Work Order.

UNSATISFACTORY CONDITION REPORTS

UCR NUMBER PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
02930 Valve Fuel Vent 60C20358 21	During the transfer of fuel in preparation for the propellant loading test conducted January 4, 1966, facility fuel tank pressurizing was cycled in an attempt to pressurize the fuel tank to 10 psig for leak check with a fuel level of 634.5 inches and with the fuel vent valves open. It is suspected that fuel was blown through the vents causing possible contamination of the vent valves pilot valve assembly.	The probable cause was inadvertent cycling of facility fuel tank pressurizing with the fuel vents open and with a fuel level of 634.5 inches. It is recommended that a failure analysis be conducted on this valve to determine whether or not the pilot valve assembly is contaminated with fuel.
02931 Hydraulic Package Assembly 20C85053 115	The entire hydraulic system at engine 1 was replaced on 12/29/65 due to contamination caused by a defective hydraulic package assembly (reference UCR 02913). Following installation of the new hydraulic system, an engine clearance check and two functional checks were performed. No discrepancies were observed during the clearance check and the first functional check. During the latter functional check, performed on January 12, 1966, however, the fluid level (measurement*H0700-1) dropped from 44 percent at auxiliary pump start to 18.8 percent at auxiliary pump cutoff.	Visual inspection of the hydraulic system revealed no external leakage. A piece of safety wire was inserted into the vent cavity through the vent hole in top of the accumulator. When this wire was withdrawn, the presence of oil was observed on it. It is suspected that leakage exists between the low pressure reservoir and vent cavity, past the P/N MS28775-434 O-ring and the P/N MS28782-61 backup ring (reference Cadillac Gage drawing 20296, zone 3-C). The main hydraulic pump was removed from the engine and the midstroke locks were securely installed on the actuators. Following the short duration static firing, the hydraulic package assembly will be removed and replaced.
02932 DC Amplifier Assembly 50C10388-15 0592	During prefiring checkout prior to the short duration firing SA-32, it was noted on a computer scan of measurements that the output voltage of the combustion chamber pressure measurement D1-2 was reading negative. In Hi-Cal mode, the output voltage read zero volts. It should have been 4.20 volts. Investigation revealed that the DC amplifier was faulty.	The cause of the malfunction is unknown. The faulty measurement kit (D1-2) was replaced with a new unit and a calibration pressure used to verify the lab data. Results were found to be within the specified tolerance. It is recommended that an investigation be conducted to determine the cause of the malfunction of the amplifier. The amplifier and transducer were replaced as a kit.
02933 Decoder 50M10698 112	Prior to test SA-32, simulated flight tests were performed. During these tests, remote cut off and destruct commands were broadcast to the vehicle. It was noted that the response in the telemeter ground station of measurements K65-13 and K66-13, cut off and destruct indicator, CDR 1 and 2, was very marginal. In other words, the signal was received during some tests, but not for others.	Investigation revealed that these signals normally are 0.020 seconds in duration. They are assigned to telemeter channels GF 1A1-06-10 and GF 1A1-07-10 respectively. The sample rate of these two channels is 12 samples per second, i.e., 0.083 seconds between samples. Therefore, the 0.020 second pulse can easily occur between samples of the multiplexer, and no response would be observed in the Telemeter Ground Station. It is recommended that measurements K65-13 and K66-13 be reassigned to unused telemeter channels which have a sample rate of 120 samples per second (0.0083 seconds between samples). These measurements will be used as is at Static Test.
02934 Blind Nut Assembly BN 359-1032-1 N/A	In performing thrust chamber leak check, the foam rubber thrust chamber protective covers (P/N T-8100786-J) were removed. The first cover below the throat on engine 1 (S/N 7062) was found to be damaged. The major portion of a blind nut assembly sleeve P/N BN 359-1032-1 was imbedded in the foam rubber, lacking only a fraction of an inch completely penetrating the strip. Also, adjacent to the imbedded sleeve, there was a slight indentation with metal particles imbedded in the center.	The blind nut assembly (P/N BN359-1032-1) is used to install the outboard engine curtain (P/N 30C03566). It appears that during curtain installation, 2 or more of the nuts were cross threaded, thereby requiring that they be drilled out in order to replace them. When the drill bit pushed the nuts and sleeves out of the holes, one sleeve was imbedded in the foam rubber strip and the other sleeve definitely made contact with the strip. Extensive damage to the thrust chamber was barely prevented by the foam strip. It is recommended that more care be exercised during installation of the outboard engine curtains.

APPENDIX F (CONTINUED)

UNSATISFACTORY CONDITION REPORTS

UCR NUMBER PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
02935 Servo Actuator Assembly 60C60001 338	At X-15 minutes in the firing countdown, a final hydraulic gimbal checkout is performed by gimbaling the engines to assure proper operation of the hydraulic system. During this hydraulic checkout, when the auxiliary hydraulic pump for engine 3 was turned on it was noted that the yaw actuator was not completely controllable from the blockhouse. As the pump was turned on, the actuator drifted off null position. When the input pot was brought to zero input, the actuator drifted off to +3 degrees. A very small input would appear to move the actuator out to approximately 6 degrees. After several minutes of checkout in which there appeared to be very little control of the actuator from the blockhouse, the pump was turned off.	There is a high resistance reading (500K) between pins B and D, reading into the actuator. This reading is between the center tap and the wiper on the Beta Pot. There appears to be a near open in the Beta Pot current limiting resistor or the connections in the center tap of wiper lines. Several continuity and voltage checks were made in the GSE equipment and associated cabling before disturbing the cables on the vehicle. After getting a near open between the center tap and wiper of the Beta Pot by measuring in the blockhouse, the cable from the blockhouse to the Static Tower was thoroughly checked. This cable checked good. The resistance was then measured into the actuator where the high resistance was read. The actuator was locked in the null position and replaced. It is recommended that an investigation be made to determine the cause of the high resistance reading between the center tap and wiper of the Beta Potentiometer.
02936 Tape Recorder 50C10338 007	During prefiring checkout it was observed that the DDAS ground station would loose its synchronization with the DDAS wavetrain broadcast from S-IB-4. This loss of synchronization was of short duration and occurred when the airborne tape recorder was given a record command. This problem has a historical record, and reference should be made to UCR 2377 of S-IB-3. During an investigation of the problem, Pin S of J-1 on the tape recorder was monitored by use of an oscilloscope. At record command, a negative spike in excess of 100 volts was observed. An in between box was installed in the vehicle cable, and a suppressing diode was installed from pin S to ground. The DDAS synchronization drop out was no longer seen with the diode installed. The circuit involved was investigated. Diode CR1 in the control logic module of the tape recorder will not function as a suppressor diode. For suppression this diode CR1 should have been a 30 volt zener diode instead of an ordinary diode.	The cause of the drop-out-of-synchronization is believed to be radiation or feedback of this negative transient. It is recommended that a suppression diode be installed across relay K15 inside measuring distributor 12A26. As an alternate or redundant means of suppression of the negative transient, diode CR1 of the control logic within the tape recorder should be changed to a zener diode at a voltage of about 30 volts. Because of the large number of recycles of the tape recorder required to conduct this investigation, it is recommended that the tape recorder be removed from the vehicle during post static operations at Michoud for cleaning heads and degaussing of tape.
02937 Liquid Level Adapter 50C10699 49	During LOX detanking tests, it was noted that measurement L49-04, Liquid Level Continuous, appeared to operate properly until the level indicated around 25 inches. From this level until the dry condition appeared, the output indicated that the adapter was cycling. A second malfunction was noted when the measurement was placed in the Lo-Cal mode. At this time the output also appeared to cycle. A third malfunction was noted when the measurement was in the Hi-Cal mode. The measurement could be adjusted to its correct value of 39.6 inches; however, it was observed that the output would drift away from this value.	Improper operation of the electronics of the adapter is believed to be cause of the malfunction. It is recommended that the cause of the above malfunctions be investigated to determine whether or not weak design or manufacture is involved in the failure.
02938 Liquid Level Adapter 50C10699 27	Prior to test SA-33, measurement L48-03 was placed in Hi-Cal mode, and an attempt was made to adjust the output to 39.6 inches. However, the output would not adjust to this Hi-Cal value.	The cause of the malfunction is not known. It is recommended that an investigation be conducted to determine whether or not a weak design or manufacture is involved in the malfunction.
02939 Zone Box 50C10404-1 224	Following test SA-32, a visual inspection of flight instrumentation components was performed. At this time, it was discovered that the red thermocouple lead on the zone box of measurement C59-1, Temperature Hydraulic Oil, had been cut in two.	The cause of the damage is unknown. The damaged zone box was replaced at the static test facility. Personnel working this area are cautioned to use extreme care when working around delicate instrumentation equipment.
02940 Vent Valve Assembly 20M30460 0015	During the short duration firing, SA-32, the 4-inch LOX relief vent valve assembly failed to give a closed indication. The valve was visually verified to be closed and the LOX tanks pressurized to operating pressure for the test.	A malfunction of the position indicator switch was the probable cause. The 4-inch LOX vent valve S/N 0015 was replaced by a similar item S/N 0016. It is recommended that a failure analysis be performed on the vent valve assembly.

UNSATISFACTORY CONDITION REPORTS

UCR NUMBER PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
02941 LOX Level Sensor 20C30429 ASLO 111	During LOX de-tanking following performance of test SA-32 short duration firing, the LOX and fuel low level cutoff sensors were armed by manual operation of the substitute flight computer (code 01110111). As LOX was being detanked and the level sensors were being uncovered LOX level sensor 3 was giving an intermittent indication. When the LOX was completely detanked the level sensor then showed a wet indication, indicating a failure of the level sensor. The following day, the level sensors were armed again and this time the sensor indicated dry showing proper operation. This appears to be an intermittent problem.	The probable cause of the failure is unknown. It is recommended that a failure analysis be conducted on this component to determine the cause of the malfunction. It is also recommended that the sensitivity setting on the level sensor should be rechecked.
02942 Curtain, Flame 10C11462-1 N/A	The flame curtain P/N 10C11462-1, at engine position 4, S/N 7065 became severely torn in several places and the rubber portion of the curtain had started to burn during the 35 second static test SA-32.	The flame curtain used at engine 4 had apparently been used previously on an earlier vehicle for static firing and refurbished for use on S-IB-4. Repaired flame curtains at engine 3 or 4 will not withstand the turbulence and temperature created during static test. Also, the bonding material used on the entire refurbished curtains is flammable. It is recommended that flame curtains refurbished by the method of bonding reflective material to parent rubber boot not be acceptable for static test. New reflective material should be incorporated and stitched to the entire rubber boot.
02943 TY 8 Temperature Gauge 50C10412 11116	Evaluation of records of flight instrumentation of test SA-32 revealed that measurement C54-8, Temperature LOX pump inlet, indicated a full scale reading throughout the test. Investigation revealed that pins A and B of the transducer were open circuited. About 1350 ohms should have been between the two pins. This open circuit indicates a faulty thermister.	The cause of the malfunction of the transducer is not known. It is recommended that this type malfunction be compiled into a historical record. An analysis should be conducted to determine cause of malfunction.
02944 Pulse Detector 60C50094 0027	Prior to static test SA-32, the pulse detector was found to generate random pulses. At Static Test the pulse detector was readjusted in accordance with Michoud engineering design procedures. (Reference UCR's 2927 and 2928). During test SA-32, the pulse detector generated one random pulse approximately two seconds prior to engine cutoff. Post test investigation revealed that random pulses will be generated due to noise or transients in the +28 volts power being fed to the detector when trigger pulse is adjusted to 2 volts peak between terminals J1 and J2. However, when the sensitivity of the detector is readjusted to cause the pulse detector to reject this noise and transients, the detector will not respond to the outboard engine cutoff signal.	The cause of the marginal operation of the pulse detector is believed to be due to an improver design of the pulse detector circuitry. It is recommended that the associated circuitry be redesigned to effect more solid operation of this system.
02945 Liquid Level Adapter 50C10699 14	Evaluation of oscillograph records of flight instrumentation for static test SA-32 revealed that measurement L49-04, LOX level continuous, did not operate properly. The analog output should have indicated a slowly and smoothly decreasing trace. Instead, the trace indicated sharp drops in level at several points along the trace. Where bit 9 (most significant bit) changed state, all others should have reset; however, the three least significant bits showed no tendency to change. Other points are also obvious where the least significant bits are not changing properly, and a sharp dip in analog trace occurs at each of these points.	The digital converter inside the liquid level adapter is not converting properly. It is recommended that a thorough study of digital converter operation be conducted to determine the cause of the malfunction.

APPENDIX F (CONTINUED)

UNSATISFACTORY CONDITION REPORTS

UCR NUMBER PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
02946 Hydraulic Package Assembly 20C85053 114	When performing test SA-33 pretest functional, engine 3 hydraulic system fluid level (Measurement*H0700-3) was observed to be 100 percent with the auxiliary pump off and 79.5 percent with the pump running. The following investigation was conducted: 1. Checked fluid level calibration and found it to be OK. 2. Since fluid level potentiometer has been periodically erratic (Reference UCR 02947), a piece of safety wire was inserted into the vent hole on top of the accumulator to check the position of the low pressure reservoir piston. The piston was found to be at the top. 3. The fluid level was bled from 79.5 percent down to 24 percent (low pressure reservoir bleed valve) with large quantities of gas being observed along with the oil. When the auxiliary pump was cutoff, the fluid level momentarily settled out at 51 percent, then gradually rose to 68 percent. 4. Took 60-milliliter hydraulic oil sample from bleed valve on high pressure manifold. Results were as follows: a. <u>10-25 Micron</u> - *27,300 b. <u>26-50 Micron</u> - *10,300 c. <u>51-100 Micron</u> - *2,300 d. <u>Over 100 Micron</u> - *513 e. <u>Fibers</u> - 20 * 10% rubber, 30% metallic, and 40% lubricant type particles. 5. Checked GN_2 precharge. No change observed. 6. Bled off GN_2 precharge. No oil observed.	Apparently, GN_2 leaked past the accumulator piston from the precharge side to the high pressure oil side (Reference Cadillac Gage Drawing 20296, zone 2-C) following the previous functional check on Tuesday, January 18. The reason for the gradual increase from 51 percent to 68 percent following auxiliary pump cutoff is possibly due to the pressure equalizing between the low pressure and high pressure oil cavities (a slight positive oil pressure still existed after auxiliary pump cutoff). The condition of this package is possibly due to galling of the accumulator piston and failure of the piston O-Rings. 1. The main hydraulic pump was removed from engine 3 and the actuators were locked in the midstroke position for test SA-33. 2. The main hydraulic pump will be shipped loose to Michoud. The rest of engine 3 hydraulic system will be returned to Michoud with Stage S-IB-4. 3. Recommend: a. Investigation of defective hydraulic package to determine cause of failure (Reference UCR 02913). b. Disassemble and clean all of engine 3 hydraulic system components. c. Installation of new hydraulic package assembly on engine 3.
02947 Transducer 2596 N/A	In the preparation for a gimbal functional,*H0700-3 (Hydraulic Oil Level) was noted by Blockhouse Personnel as being erratic. With the Auxiliary pump on and during the short duration firing no problem was noted with this measurement. In preparation for test SA-33 it was found that with the Auxiliary pump on, this measurement was discrepant. A resistance check was made at the potentiometer and the discrepancy was noted.	The discrepancy is occurring in the transducer. Reference UCR 02946.
02948 LOX Prevalve 60C20339 131	The LOX prevalve on engine 4 failed to give a closed indication at cryogenic temperature when it was closed immediately following test SA-33. The closed indication was received after the valve had achieved ambient condition.	The probable cause is that the position switches failed to actuate at cryogenic temperature. It is recommended that a failure analysis be performed on the prevalve.
02949 Fitting, Blender Unit 454120 N/A	During Firing Day Countdown, RP-1 was noted leaking from the fuel additive blender unit inlet connection.	On disconnecting the FABU inlet line it was noted that the fitting (P/N 454120) in the FABU had several severely damaged threads, also the 37° seat had several scratches and gouges on the surface. It is recommended that more care be taken when connecting or disconnecting the FABU inlet line, as the inlet line is stainless steel and the FABU fitting is aluminum and is easily damaged.
02950 Probe Assembly-Liquid Level 60C50031 N/A	Evaluation of oscillograph records of flight instrumentation at Static Test revealed that probe 13 of L19-03, Liquid Level Discrete, did not produce a pulse when LOX uncovered the transducer. During investigation, the voltage generated by the probe was measured in the dry condition. For this test, the lamps were excited with the required +28 volts, and a 500 ohm resistor was installed across the solar cell. Under these conditions, 30 millivolts were measured across the solar cell. However, the solar cell should have generated 40 millivolts.	The measurement malfunctioned because the solar cell failed to generate sufficient voltage to operate its associated amplifier. It is recommended that the faulty transducer be replaced during post static test operations at Michoud.

UNSATISFACTORY CONDITION REPORTS

UCR NUMBER PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
02951 DC Amplifier Assembly 50C10382-3 C297	This measurement was adjusted properly for the test SA-32; however, prior to test SA-33, an attempt was made to readjust the amplifier due to questionable data from the test SA-32. At this time it was found that no output could be measured between terminals J1 and J2 on the amplifier, although a normal output appeared through the normal telemetry channel.	An open circuit apparently exists between the the test terminals on the front of the amplifier and the normal output on the back of the amplifier. It is recommended that the nature of the open circuit be investigated to determine whether or not poor quality of manufacture is involved. The amplifier was replaced as part of a kit.
02952 Heat Shield Beam Assembly 60C30459 N/A	Post Static Checkout of the four heat shield beam assemblies (60C30459-1) revealed that the beams were distorted. The top flanges are deformed with a ridge at the center.	The movement of adjacent beams causes structural stress and distortion of the four beam assemblies. It is recommended that the study of heat shield beam assemblies be continued through S-IB-205.
02953 Nut Plate Assembly 60C30569-5 N/A	Following test SA-33 the mounting plate for measurement AP106 which is spot welded to the heat shield panel (P/N 60C115941) was found to be broken loose at welds.	The spot welds failed. Other similar installations were not damaged. AP106 is an R & D measurement and has not been requested on S-IB-5.
02954 DC Amplifier Assembly 50C10394-77 2045	Prior to test SA-33, measurement C54-6, temperature LOX pump inlet, indicated properly. However, when LOX was loaded aboard the vehicle, the measurement produced no output. After the firing, the vehicle warmed up again, and the measurement again functioned properly. During investigation, while LOX was aboard, it was found that the amplifier was the faulty component.	The amplifier malfunctioned when subjected to cold temperature. It is recommended that the faulty amplifier be subjected to a functional test during post static test operations at Michoud to verify the above results. This measurement malfunctioned during test SA-32, but operated properly following the test. The amplifier was replaced along with its associated kit.
02955 DC Amplifier Assembly 50C10394-27 1752	Evaluation of oscillograph records of test SA-32, revealed no output for measurement C59-1, temperature hydraulic oil. Investigation revealed that the amplifier produced no output. A spare amplifier was installed following test SA-33, and the measurement appeared to operate properly.	The casue of the malfunction of the faulty amplifier is not known. It is recommended that the cause of the malfunction be investigated, and that the results be compiled into a historical record of this type failure.
02956 Servo Actuator Assembly 60C60001 302	During performance of the Prestatic Gimbal Test procedure (5-CH SIB-461) as required in the Firing Day Countdown procedure (7-CH SIB-602B) in preparation for test SA-33, the auxiliary hydraulic pump for engine 4 was turned on and the input signal to the yaw actuator brought to zero. Although this action should have moved the engine to the null position, the position indicators at the blockhouse were showing the engine resting in a position approximately 0.1 degree off null. Personnel on the test stand were notified of the indications and visual observation verified the condition. While the visual observation was in progress, the engine moved rapidly to the null position. The problem also occurred just prior to test SA-32 although visual verification was not obtained.	The cause of this phenomenon is unknown. Investigation of the oscillograph records following securing from the pretest checkout, revealed a deflection of approximately 0.11 degree, 0.94 ma control valve current, and zero psig pressure across the actuator pistons just prior to the shift in engine position. The records also show that an increase in supply pressure and normal action of the differential pressure trace occurred just after the engine movement. This could have been caused by a temporary restriction in the low pressure return line. Attempts were made to duplicate the action with no success. However, operation during following checks and the test firings was satisfactory. Since this problem did occur on two occasions recommendation is made that the servo valve and actuator be removed for more complete investigation after arrival at CCSD-Michoud.

UNSATISFACTORY CONDITION REPORTS

UCR NUMBER PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
02957 Submultiplexer Assembly 50C12088-5 006	Prior to test SA-33, a scan of flight instrumentation was performed. At this time, it was found that all measurements assigned to the word 9 card inside the remote digital submultiplexer failed to respond in the telemeter ground station.	The cause of malfunction is not known. The defective RDSM, P/N 50C12088-5, was replaced by a spare from logistics, P/N 50C12088-3. (Engineering Order 49 to the Instrumentation Program and Components List, Drawing 60C50008, requires RDSM, P/N 50C12088-3, on S-IB-4. Reference UCR 02921.) Prior to launch of S-IB-4, it is recommended that a careful check be made to ensure that the measurement inputs to the word I card on the RDSM, P/N 50C12088-3, are entirely compatible with that card.
02958 Temperature Gage 50C10405-1 0096	Evaluation of records of test SA-33 revealed that measurement C267-9, temperature skin tail section, had malfunctioned. It was found following the test that the temperature sensing element that attaches to the skin of the vehicle was broken away from its mounting assembly.	The cause of the damage is not known. Only moderate personnel traffic is in this area, and considerable force was necessary to cause this damage. Personnel are instructed to use care around delicate flight instrumentation equipment.
02959 Thrust Chamber Body 028959 6366986 & 6605115	Hardware inspection of the engine systems after test SA-33 revealed the following damage to the aspirator lips of engines 3 and 4: Engine 3 - Approximately 1½ inches of the aspirator lip directly below measurement AT119-3 was burned away. Engine 4 - The aspirator lip directly below measurement AT119-4 was slightly distorted and cracked at one point.	Damage resulted because of close proximity of calorimeter measurements AT119 to the aspirator chamber drain screw access port. Turbine exhaust gases are deflected down on the aspirator lip causing cracking and erosion of lip material. It is recommended that no repair be made for flight and that any measurements on future vehicles near the aspirator access port be deleted.
02960 Gas Temperature TY 45 50C10340-1 RA0440	Evaluation of records of flight instrumentation revealed that the output of measurement C9-1, temperature gas generator, appeared intermittent. During investigation, it was found that slight flexing of the connecting wire of the temperature gage would cause this intermittent signal.	An intermittent open circuit inside the temperature gage causes the measurement to malfunction. The cause of the open circuit is not known. It is recommended that all failures of this type be compiled to determine if weak design or manufacture causes this malfunction.
02961 Accelerometer 50C10406 452	Evaluation of oscillograph records of test SA-33 revealed questionable data for measurements E271-4, E272-4, and E273-4, Vibration, Pitch Actuator, Yaw, Pitch, and Longitudinal respectively. Investigation revealed the following phenomenon. The output of the AC amplifier of one of the above measurements was monitored in the Hi-Cal mode. If another of the above measurements, at this time, were placed in the Hi-Cal mode, the output of the monitored measurement was observed to increase. This "crosstalk" was observed between each of the amplifiers.	Further investigation revealed that the connectors of each of the accelerometers were safety wired with the same safety wire. The accelerometer case is insulated from missile skin, and the effect of the safety wire is to electrically connect the three accelerometer cases together. In addition, the corresponding three connectors of the associated emitter followers were also safety wired together resulting in the same improper electrical connection. When the safety wires were removed, the crosstalk disappeared. It is recommended that manufacturing and Quality Control personnel be notified of the crosstalk phenomenon when this equipment is safety wired in this manner. In addition to the above measurements, the same crosstalk and improper safety wiring was noted on measurements E274-4, E275-4, and E276-4, Vibration, Yaw Actuator, Longitudinal, Pitch, and Yaw respectively. This safety wire was removed and the crosstalk disappeared.
02962 Frequency Divider 50C10695 25502	Prior to test SA-33, all flight measurements were scanned in the Hi-Cal mode. At this time it was observed that the output of measurement T12-8, turbine rpm, produced about 72 cycles per second. It should have indicated 100 cycles per second.	The frequency divider failed to count its input properly. The cause of the frequency divider malfunction is not known. It is recommended that this type malfunction be compiled into a historical record to determine whether other malfunctions of this type are repeatable.

UNSATISFACTORY CONDITION REPORTS

UCR NUMBER PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
02963 Emitter Follower Assembly 50C10401-1 16A	Evaluation of oscillograph records of test SA-33 revealed that measurement E502-9, Vibration, Thrust Beam, Engine, malfunctioned during the test. Investigation revealed that the accelerometer cable between the emitter follower and accelerometer had an intermittent open circuit. In addition the emitter follower was found to produce no output.	The cause of the two malfunctions is not known. No replacement spares were available at Static Test, and it is recommended that the faulty components be replaced during post static test operations at Michoud. The parts left on the vehicle to be replaced at Michoud are shown below: Component — P/N — S/N Cable — 50C12265 — N/A AC Amplifier — 50C10382-3 — C249 Accelerometer — 50C10406 — 453 Emitter Follower — 50C10401-1 — 16A
02964 Liquid Level Adapter 50C10699 009	Measurement L44-F4, liquid level continuous, operated properly for test SA-32; however, no output signal was received for test SA-33. Investigation following test SA-33, revealed that the adapter produced an intermittent output signal. Further investigation revealed that slight physical shock to the adapter would cause the intermittent operation to occur.	A loose or poor connection inside the adapter is the suspected cause of the malfunction. The following liquid level adapters malfunctioned at Static Test for S-IB-4. Measurement — S/N — P/N L44-F4 — 009 — 50C10699 L47-02 — 48 — 50C10699 L47-03 — 27 — 50C10699 L49-04 — 49 — 50C10699 L49-04 — 14 — 50C10699 There are 9 liquid level adapters aboard S-IB-4. At Static Test 5 adapters malfunctioned as shown above. This appears to be a very high failure rate. It is recommended that an investigation be conducted to determine the cause of failures and action to be taken to improve the reliability of adapters.
02965 Accelerometer 50C10395 575	Following static firings SA-32 and SA-33, telemeter records revealed that noise spikes were impressed upon the data wave train of measurement E11-6 (vibration, thrust chamber dome). These noise spikes were approximately 2 volts peak. Investigation under non-vibrating condition revealed no noise spikes present in the Run or Hi-Cal modes.	The cause of the noise spikes is unknown. It is recommended that the entire measurement kit of E11-6 be removed from the vehicle and subjected to a complete vibration test on a vibration table during post static test operations. This test should isolate the source of the noise on the measurement.

DISTRIBUTION LIST

CHRYSLER CORPORATION

V. Bergamo, CCSD M
D. N. Buell, CCSD M
W. Cannizzo, CCSD H
G. L. Christen, CCSD K
H. B. Christiansen, CCSD M
T. R. Cotter, CCSD M
R. D. Cox, CCSD H
C. L. Crews, CCSD M
C. F. Davenport, Jr., CCSD H
E. J. Dofter, CCSD M
P. F. Fahey, Jr., CCSD K
H. J. Fischer, CCSD H
T. E. Flanders, CCSD H
C. C. Gage, CCSD M
J. R. Gelzer, CCSD H
D. E. Gero, CCSD M
R. F. Gompertz, CCSD K
C. Gordon, CCSD M
R. C. Hagland, CCSD M
J. E. Hughes, CCSD K
K. T. Hullinger, CCSD M (3)
W. H. Juengling, CCSD M
J. J. King, CCSD H
J. M. Landon, CCSD M
R. W. Loomis, CCSD M
H. D. Lowrey, CCSD M
B. J. Meldrum, CCSD M
W. W. Newgeon, CCSD M
J. Pakis, CCSD M
W. S. Parker, Jr., CCSD M
J. F. Patrick, CCSD M
V. F. Powell, CCSD H
M. Rehburg, CCSD M
A. M. Rice, CCSD H
R. H. Ross, CCSD M
G. Salvador, CCSD K
C. S. Sanders, CCSD H
L. T. Scherer, CCSD M
E. M. Scranton, CCSD M (2)
D. E. Shollenberger, CCSD H
R. C. Toward, CCSD H
A. R. Trahern, CCSD M (2)
F. M. Van Sickle, CCSD M
V. J. Vehko, CCSD M
R. C. Vile, CCSD M
J. V. Wible, CCSD H
R. L. Wiltse, CCSD M
J. H. Wood, Jr., CCSD H
L. H. Yount, CCSD K
Library HIC (2)
Library Michoud (2)
Attn: Màud Holmes
SSTB File

NASA

W. von Braun, DIR
O. H. Lange, AST-S
H. H. Maus, E-DIR
E. F. Rees, DEP-T

I-E

L. F. Belew, I-E-MGR
T. P. Smith, I-E-H

I-I/IB

A. W. Thompson, I-I/IB-SI/IB

I-MICH

R. Kohr, I-MICH-QPA (2)
M. Marchese, I-MICH-QPS (3)
R. L. Reimer, I-MICH-QP

M-SSVH

Col. Newman, M-SSVH

R-AERO

J. R. Eady, R-AERO-FFR

R-ASTR

J. D. Avery, R-ASTR-IMD
W. L. Howard, R-ASTR-NFS
M. A. Kalange, R-ASTR-NFS
C. H. Mandel, R-ASTR-G
H. B. Meeks, R-ASTR-EA

DISTRIBUTION LIST (CONTINUED)

R

H. K. Weidner, R-DIR

R-ME

W. R. Kuers, R-ME-DIR
M. E. Nowak, R-ME-A
F. Weckwarth, R-ME-DA

R-P&VE

J. O. Aberg, R-P&VE-V
J. F. Blumrich, R-P&VE-SA
T. Bullock, R-P&VE-SLR
F. B. Cline, R-P&VE-DIR
S. E. Clonts, R-P&VE-PPF
J. H. Farrow, R-P&VE-SV
P. W. Frederick, R-P&VE-SS
R. P. Garcia, R-P&VE-PPE
C. E. Green, R-P&VE-SVM (3)
W. R. Lucas, R-P&VE-M
J. L. Moses, R-P&VE-PTF
K. W. Rothe, R-P&VE-XF
W. A. Schulze, R-P&VE-VS (2)
D. T. Westrope, R-P&VE-PAB

R-QUAL

C. O. Brooks, Jr., R-QUAL-P
E. J. Buhmann, R-QUAL-J
O. F. Cerny, R-QUAL-J (2)
C. Covington, R-QUAL-PC
W. E. Crews, R-QUAL-J
C. T. Peigler, R-QUAL-RA

R-TEST

P. E. Cates, R-TEST-TEW
W. L. Grafton, R-TEST-C
E. K. Kaschig, R-TEST-SBT
J. H. Kastanakis, R-TEST-II
R. H. Rivers, R-TEST-DIR
J. E. Shirey, R-TEST-IE
W. H. Sieber, R-TEST-I

CC-P

I/5

MS-H

MS-IP

MS-IPL (8)

ROCKETDYNE

J. R. Hale
R. J. Jolicoeur
G. Sopp

EXTERNAL

Scientific and Technical Information Facility (2)
ATTN: NASA Representative
(S-AK/RKT)
P. O. Box 5700
Bethesda, Maryland

NASA Headquarters
MAT - Washington D.C.
ATTN: Irving Davids

R. L. Body, PA6-KSC
L. E. Fannin, VM22
T. A. Poppel, D-HIC
A. Zeiler, V-KSC